Irrigation Solution
POTATO
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Small Ideas. Big Revolutions.®

Potato Production Technology Under Drip and Sprinkler Irrigation

India is the 3rd largest Potato producer in the world with a production of about 23.12 million tones from about 1.27 million hectares with 18.2 t/ha productivity. The major potato producing states are UP (8.8 mt), West Bengal (7.6 mt), Bihar (1.5 mt), Punjab (1.4 mt), Gujarat (0.74 mt) and Madhya Pradesh (0.62 mt) and they jointly contribute about 90% of the total potato production of the country. West Bengal tops in potato productivity with 24.7 tones/ha followed by Haryana with 24.6 t/ha, Gujarat with 23.9 t/ha and Uttar Pradesh with 20.9 t/ha.

Potato is botanically known as *Solanum Tuberosum L.*, is one of the largest genera in the vegetable kingdom, with about 900 species. It is only six of these that grow filler potatos at all.

Potato is a perennial but as a crop it is treated as an annual. It is vegetatively propagated by means of tubers. Now it is also propagated by true potato seed (TPS).The tuber is an enlarged underground stem produced on the end of a stolons.

Soil and Climatic Requirement

- Potato basically requires relatively mild temperature during early growth and cool weather during tuber development.
- Potato needs about 25°C at the time of germination, about 20°C for vegetative growth but between 17-20°C for tuberization and tuber development.
- It does well under well-distributed rains or moist weather situations to high temperature, humidity rains are not conducive to potatoes as these lead to insect-pest, disease, viruses epidemics.
- Impeded drainage or lack of aeration also is considered harmful as it restricts the tuber development.
- Mild frost to the extent of -1° C partially damages the potato leaves, but when the temperature falls below –2° C, the exposed parts of the most of the varieties are destroyed.
- Well drained soil with good organic matter is essential for good Potato crop. A soil pH of 6.5 to 7.5 is good for growing potato.

Varieties

Varieities available can be classified into early, mid and late season types depending on their growth duration.

Early varieties

- **Kufri Chandramukhi:** 90 days crop; 25 t/ha yield ; susceptible to early blight.
- **Kufri Ashoka:** 70-80 days; 28-30 t/ha yield; resistant to late blight.

Mid season varieties

- **Kufri Jyoti:** 80-95 days; 20-25 t/ha yield; Resistant to late blight
- **Kufri Jawahar:** 80-95 days; 30-35 t/ha yield; Resistant to late blight.
- **Kufri Sutluj:** 90-95 days; 31-36 t/ha yield; Moderate resistance to late blight.
- **Kufri Lalima:** 110 days; 30-35 t/ha yield; High keeping quality.
- **Kufri Bahar:** 110 days; 30-35 t/ha yield; Susceptible to late blight.
- **Kufri Chipsona 3:** 110-120 days; 33 t/ha; suitable for processing.

Late varieties

- **Kufri Sindhuri:** 110-120 days; 30 t/ha yield; High keeping quality.
- **Kufri Badshah:** 110-120 days; 30-40 t/ha yield; Resistant to late blight.

Land preparation

- Potato being a tuber crop, requires a soft, friable and deep seed bed for the development of uniform large smooth tubers.
- To provide this, potato often is planted on raised seedbeds / ridges, prepared with the help of potato ridger after a thorough and deep cultivation of soil, liberally fertilized with F.Y.M., compost or other organic manures including the green manures.
- Potato usually follows a Kharif fodder or grain crop of maize or rice which are not only well fertilized but also leave sizeable quantities of root-mass after their harvest thus enriching the soil
- Land preparation tillage is largely accomplished with the help of tractor operated implements, mostly through repeated use of off-set disc harrow in the initial stages followed by 2-3 cultivator operations and planking given cross-wise to break the bigger clods and pulverize them into small size aggregates.
- This is followed by planting operation wherein potato tubers are manually placed in the rows, 20 cm apart, with a row to row spacing maintained at 60 cm. Soon after, a ridger is run to cover the potato tubers by throwing the soil from both the sides and ridges pressed .

Plant Spacing

- 90x30 cm on ridges and furrows ; ridges formed at 90 cm.
- 90 cm row to row with 2 rows on 1.2 m broad beds.

Planting material

- Select disease free tubers for seed material.
- Each seed piece should be of 25-30 g with at least 2-3 “eyes”.
- On an average 3 to 3.5 t seed material is required per ha.
- Treat the pieces in a solution of Dithane M-45 at 2g/l water dilution
- Dry the treated tuber pieces under shade before planting.
- If the tubers are brought from refrigerated storage, then keep them in the open shade at least for a week before preparing for sowing.

Planting time

Rabi crop- September 15 to November 15.

Irrigation management

Water requirement of Potato

September planting

Month	Water requirement	
	Mm/day	Lt/ha/day
September	0.81-0.92	8100-9200
October	1.92-2.30	19200-23000
November	5.50-6.39	55000-63900
December	2.92-3.56	29200-35600

October planting

Month	Water requirement	
	Mm/day	Lt/ ha /day
October	0.77-0.92	7700-9200
November	1.87-2.18	18700-21800
December	4.73-5.95	47300-59500
January	3.29-3.75	32900-37500

November planting

Month	Water requirement	
	Mm/day	Lt/ ha /day
November	0.75-0.87	7500-8700
December	1.61-2.03	16100-20300
January	5.32-6.07	53200-60700
February	4.01-4.40	40100-44000

December planting

Month	Water requirement	
	Mm/day	Lt/ ha /day
December	0.64-0.81	6400-8100
January	1.81-2.07	18100-20700
February	6.49-7.12	64900-71200
March	4.85-5.31	48500-53100

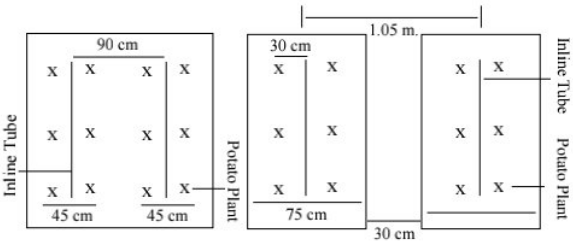
January planting

Month	Water requirement	
	Mm/day	Lt/ ha /day
January	0.72-0.83	7200-8300
February	2.21-2.43	22100-24300
March	7.84-8.59	78400-85900
April	5.31-6.02	53100-60200

Drip system lay out

Inline drip system is suitable for Potato. The drip laterals are spaced on a skip row basis i.e. at 180 cm spacing where Potato is planted on ridges at 90 cm spacing. When the ridges are spaced at 1.2 m, an inline tube is placed at every row. Potato is also planted on Broad raised beds 1.2 m wide. Two rows are planted on the bed at 90 cm space between the two rows. The drip line is palced in the centre of the bed serving the rows on either side.

In case of inline the entire strip is wetted by placing drippers at 60 cm or 75 cm (based on soil texture) along the drip line.



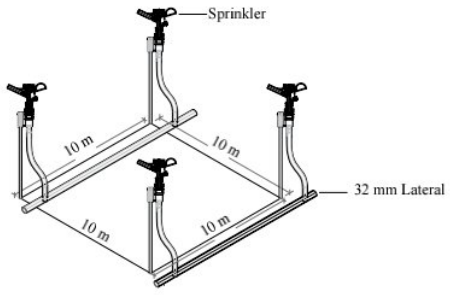
Sprinkler System layout

Different models of sprinklers of Naan Daan Jain are found suitable for Potato. One may select from Sprinkler models 5022,501U, Super 10. The placement and discharges are given below.

Sprinkler models and discharge		
Models	Sprinkler placement (m)	Discharge (lph)
5022 U	10 x 10	360-720
501 U	6 x 6	168-288
Super 10	10 x 10	360-850

Using sprinkler water is applied every 3 or 5 days depending upon the soil texture and water holding duration of the soil. But irrigation with this system will create cyclic water excesses and shortages; both of which affect the growth and production of the crop. Irrigation efficiency is also lower (60%) than that of drip.

Nevertheless this system is less expensive and farmers may find this more affordable than drip system.



Critical stages of water requirement

In Potato, following stages are considered critical from point of view of maintenance of adequate moisture in the root profile; as even small shortages at any of these stages could result in proportionally very high loss in yield.

1. Germination (Immediately after sowing)
2. Stolonization (30-35 days after sowing)
3. Tuberization (45- 65 days after sowing) Any let up in irrigation during this phase may give rise to variable size of tubers, with large proportion of chats & fewer ware grade tubers; which results both from uneven growth and uneven (non-synchronous) maturity of tubers at harvest.

Application of fertilizer

- A basal dose of 25 t/ha of farmyard manure to be applied along with the last plough.
- Sheep penning (2500-3000 sheep/ha) is also recommended.
- Neem cake at 300-400 kg/ha preferably along with basal fertilizers at the time of final ploughing.
- Green manuring can be practised by sowing cowpea or sunhemp with early rains and incorporating it after 40 days growth.
- The requirement of NPK varies for different soil types; 180:40:170 to 240:80:306 NPK.
- Potassium sulphate (SOP) is preferred over Potassium chloride (MOP)

Fertigation Schedule

Along with irrigation water fertilizers dissolved in water can also be given through the drip lines. This process is known as fertigation. A detailed schedule is given below for fertigation of Potato.

Table fertigation Schedule using water soluble special grade fertilizers.

Time of application	Type of fertilizer	Quantity	Fertigation Schedule
		(Kg per ac)	
One week a after sprouting	Urea 12:61:0	10.0 10.0	5 kg/3 days 5 kg/3 days
2-3 weeks	Urea 19:19:19	25.0 30.0	7.5 kg per 3 days 6.25 kg per 3 days
4-5 weeks	Urea	20.0	5 kg per 3 days
	12:61:0	15.0	3.75 kg per 3 days
6-8 weeks	Urea	15.0	2.5 kg per 3 days
	0:52:38	25.0	6.25 kg per 3 days
9-11 weeks	13:0:45	20.00	3.3 kg per 3 days
12-13 weeks	0:0:50	12.5	3.12 kg per 3 days

Micronutrients

In soils where Zinc deficiency is noticed, Zinc sulphate @ 50 kg/ha should be applied.

Inter cultivation and weed control

- Potato requires frequent inter cultivation.
- In the direct sown crop blade harrow is to be worked starting from 30th day of sowing. Four inter cultivations are needed at 10 days intervals alternated with blade harrow and tied harrow Junior-how.
- Final inter cultivation is to be given by the country plough.
- Inter cultivation is to be followed by hand weeding to check the weed growth.
- Weedicides are also used to control weeds in Potato.

The two major weedicides are Metribuzin at 0.5 kg a.i/ha or Isoproturon at 1.0 kg a.i applied at 1-3 days after sowing. Dissolve the chemical in 500 l water and uniformly spray over the sown plots.

Pest and disease management

Pests Of Potato

Green Leaf Hopper

- Jassid is the most destructive pest of many plants including Okra, brinjal, potato and cotton etc. It causes damage to potato in autumn season
- Spray the crop with 300 ml of rogor or metasystox or 75 ml of dimecran in 80-100 liters of water per acre. If necessary repeat the spray after 10 days.

Green peach aphid

- During winter and spring season, the potato is attacked by various aphid species like M.persicae, Aphids gossyppi and A. fabae. Out of them M. persicae causes serious damage to potato crop by transmitting various viral diseases.
- Spray 300 ml of Metasystox or 200 ml of Rogar or 75 ml of Dimecran in 100 liters of water. In case of seed crop, apply 5 kg of Thimet 10G to the soil at the time of the first earthing up.

Hadda Beetles

- Two species of hadda beetles attack different solanaceous vegetables, like brinjal, tomato and potato.
- Application of Neem, Mahua, ground nut cakes are efficient in suppressing the pest population.
- Spray of Malathion 50 EC in 200 liters of water per acre provides up to 82 percent kill of this pest.

The Greasy Cutworm

- The greasy cutworm has been reported from almost all the potato – growing regions of Northern India.
- It feeds on potato, tobacco, peas, wheat, lentil, mustard, linseed, maize, sugarcane, cucurbits, vegetable seedlings and several weeds.
- Control measures include; Break the sods in the fields. Flood the infested fields.On a small area, collection of caterpillars from soil around the plants can be done. Collection of moths in the light traps.
- Use of chlorpyriphos @ 2 l / ha to the soil before planting potato tubers.

Tobacco Caterpllar

- This polyphagous feeds on tobacco, potato, tomato, cabbage, cauliflower, peas, cowpea, and castor.
- The leaves, which have egg masses and young larvae in the gregarious phase, should be plucked and destroyed. The pest can be killed by spraying 300-400 ml of Ekalux 2 S or Thiodan in 100 liters of water per acre.

Potato Tuber Moth

- It is distributed in Bihar, Karnatak, Maharashtra, Himachal Pradesh, Kumaon hills of west Bengal, Nilgiris (Tamil Nadu), Maharashtra and submountainous areas of Punjab. This pest occurs especially in hot and dry climates. It is

destructive to potatoes and also attacks tomato, egg-plant, tobacco..

- Construct potato stores away from the fields.Cover tubers lying in stores with a thin (2.5-5.0 cm) layer of dry sand. The surface of sand cover of the potatoes should be dusted with one percent malathion dust.Carry out disposal of infested potatoes.

Whitefly

- Apart from cotton, this pest also feeds on potato, brinjal, okra, cabbage, cauliflower and some weeds.
- This pest can be controlled by spraying 300 ml of rogor or metasystox or 75 ml of dimecran in 80-100 liters of water per acre.

Diseases Of Potato

Early Blight *(Alternaria solani)*

- This is one of the common diseases of potato and is world-wide in its distribution.In India it is found on potato crops grown in the hills as well as in the plains.
- On the leaves, spots of varying size appear. The spots are irregular, brown to dark brown in colour, and with concentric lines inside the spots.
- The tuber infection is carried to the storage godowns where it may spread to cause storage-rot, resulting in considerable damage.
- The pathogen is mostly air-borne and the primary source of infection may be through tubers, though not much evidence has been obtained to substantiate this.
- Collateral hosts such as tomato may also play a significant role in the perpetuation and dissemination of the fungus.
- Fungicidal sprays, preferably with copper fungicides or Zineb given at 15 day intervals effectively control the disease.
- Since the same spray schedule controls late blight also, it has become a regular practice among potato growers in many tracts to spray the crop with copper fungicides at least three or four times, starting from about six weeks after planting.

Late Blight *(Phytophthera infestans)*

- This is one of the worst diseases of potato, which takes a heavy toll year after year in many countries.
- In India it was mostly confined to the northern hills until a decade ago, since then it has been reported from the Gangetic plains of Uttar Pradesh, in parts of West Bengal, and in some parts of South India, including the Nilgiris, the Pulneys and southern Karnataka State.
- The disease first appears as water-soaked, light brown lesions on the leaf blade. If the climatic conditions are favourable with humid and cloudy weather these lesions spread fast over the entire leaflet and petiole.
- Characteristic lesions are roundish with concentric markings on the margin, and generally involve the leaf margin.
- The severely diseased plants wilt within a few days after the first symptoms are seen on the leaves and in the field the disease spreads like wild fire, causing severe damage to the crop yield.
- The primary infection of the plants is through infected tubers.
- The disease can be controlled by adopting certain prophylactic measures.
- hey should be examined carefully before planting and also should be pre-treated by dipping in 1 per cent Bordeaux mixture or other fungicides.
- The plants must be sprayed with copper fungicides., zineb or phenyl compound at 15 day intervals, starting from about a month after planting until the crop matures.
- Ridomil at 7 kg/ha in combination with Dithane M-45 has given encouraging results.

Black Heart disease

- The black-heart of potato is a non-parasitic disease commonly found in storage godowns. This is due to high storage temperature and low oxygen supply.
- Due to high temperature the tissues break down, resulting in high respiration and failure of gas-exchange. If the affected tubers are cut to examine the cut surface turns pink, then dark brown to black. No microbial agent is associated with the disease. Providing sufficient aeration and storing the tubers in thin layers on racks help to avoid the damage.

Brown Rot *(Pseudomonas solanacearum)*

- There are two major bacterial diseases of potato which are destructive, causing vascular infections.They are (i) ring rot caused by Corynebacterium sepedonicum (Spick & Kotth.) Skapt. And Bink. And (ii) brown rot caused by Pseudomonas solanacearum IE.F. Sm.
- The first symptom of the disease in the field is dwarfing of the shoots accompanied by bronze discolouration of the leaves, followed soon by plant wilt. If the diseased plant is cut open a whitish bacterial ooze comes out of the cut ends of the stem.
- The organism persists in soil for more than 12 months. In the field the infection may take place through incidental wounds caused to the plants at the time of various cultural operations. The bacteria may spread in the field through irrigation and rainwaters, implements and tools, and by various other means.
- The disease can be checked by selecting disease-free seed tubers and by adopting various field sanitation measures.
- A crop rotation to avoid potato, tomato and egg plant in the field for not less than two and preferably three years would help in starving out the pathogen.

Harvest

With proper water management, fertigation and pest control and timely cultivation an yield of 35 t/ha is possible.

Benefits from drip irrigation

- Yield increases by 30-40%
- Irrigation water is saved up to 40-50%
- Increases fertilizer use efficiency.
- Saving of power, labour costs.
- Lesser incidence of diseases and insects.
- Potato quality improves

Dos

- Ensure good drainage in the field.
- Adopt drip or sprinkler
- Compulsorily apply organic manure as per recommendation

- Select high yielding, disease and pest tolerant variety suitable for each location.
- Practice drip irrigation from the beginning.
- Strictly follow the irrigation schedule given by the engineer.
- Follow the drip system maintenance schedule given by the engineer.
- Compulsorily weed/ inter-cultivate, timely operation helps in crop growth.
- Follow fertigation schedule as given by the engineer.
- Follow the precautions while operating the drip system as explained by the engineer.
- Apply micronutrient as and when needed.
- Follow disease and pest control measures timely and effectively.
- Apply sprays in the evening or early morning only.

Don'ts

- Don't over irrigate the crop at anytime.
- For fertigation don't mix solid fertilizers and dissolve them together. Prepare individual solutions and mix them for application.
- Don't spray the crop under hot sunlight.
- Don't use the fertigation unit for bulky organic manure and fertilizers that are not soluble in water
- Don't add solid fertilizer from the bag directly to the fertilizer tank. Prepare solution separately and pour the solution to the fertilizer tank. Prepare solution only in plastic buckets. Don't use metal container.
- Don't stir the solution with naked unprotected hand. Use wooden spoon or stick.
- Don't heat the fertilizer solution to increase solubility.

Frequently asked questions (FAQ's)

1. Whether the meagre quantity of water supplied through drip irrigation is enough?

- Irrigation rate in Drip method is estimated based on the Evapotranspiration of the location and therefore it is enough. With conventional flood / channel irrigation water completely replaces the air in root zone thereby suffocating the plant. The last few days of the irrigation cycle the crop also suffers from water stress. The periodical water logging and stress affects growth and production of Potato.

2. Can I prefer Sprinkler method of irrigation for Potato?

- Sprinkler system is less expensive and suitable. But it spreads water over the canopy and possibility of diseases are more. Moreover wastage of water per irrigation will be high.

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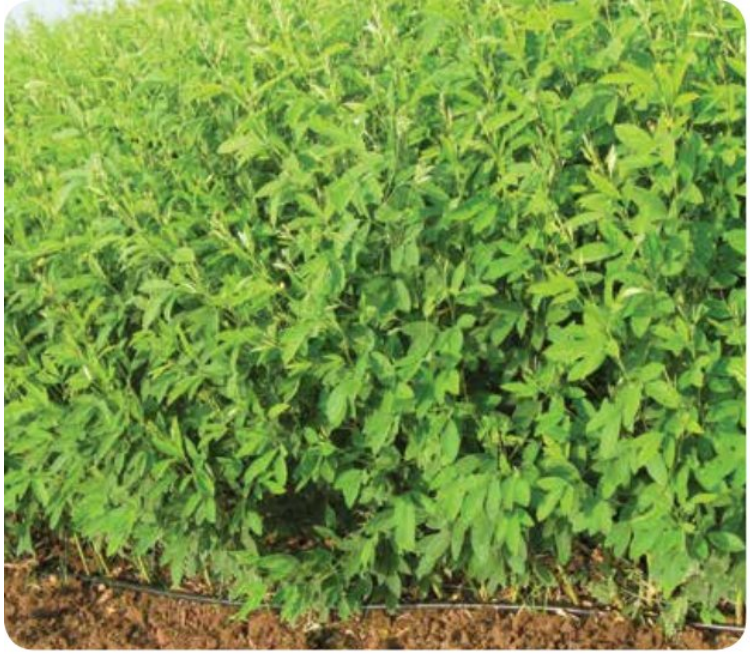


Varieties

Variety	Season	Crop Duration (days)	Yield (q/ha)
Palnadu LRG 30	Kharif	170-180	20-25
	Rabi	120-130	
Suitable for all districts in A.P. Seeds has medium bold size with brown colour			
Maruthi ICP 8863	Kharif	155-160	20
Up straight growth it contains medium bold size seeds. It is resistant to wilt this can be grown on paddy field bunds.			
ST 1 or	Kharif	170-175	20-22
C11	Rabi	120-130	
It is suitable for Telengana Districts. The plant has medium height with extensive branching The flowers are yellow with red streak The seeds are long round shape with thick red colour.			
Abhaya	Kharif	160-163	20-22
ICPL332	Rabi	120-125	
Plants grow straight with excess pods. Seeds are medium bold with brown colour. It is resistant to pod borer attack			
Lakshmi	Rabi		
ICPL85063	kharif	160-180	18-20
The plant is bushy in appearance with excessive branching. It is resistant to wilt			
MRG 66	Kharif	180	22-24
The plant is bushy in appearance with excessive branching. It is resistant to wilt.			
HY3-C	Kharif	190-200	16-18
The flowers are red in colour. The pods are medium breadth with white colour seeds. Greend pods are used for preparing curries. It is suitable for Telengana area.			
Durga ICPL84031	Kharif	115-120	15
High yielding short duration variety. It is resistant to macrophomina wilt and also pod borer attack. It is suitable for kharif in north Telangana districts of A.P.			
PRG 100	Kharif	145-150	20
It is suitable for Chalka soils of Rayalaseema districts as a rainfed crop. It is resistant to wilt.			

Soils

- Pigeonpea requires light textured, well drained soil, though, it is grown on a wide range of soils.
- Soil should be neutral in pH (6.5-7.5).

Climate

- Pigeonpea is mainly grown in tropical and sub-tropical climates.
- It is highly susceptible even to light frost.
- It can tolerate heavy rains provided waterlogging does not take place.
- It has the capacity to tolerate moisture stress to a great extent because of the deep root system.

Spacing

- When pigeon pea is grown in the cool post rainy season in India, it matures sooner and do not grow tall than when it is sown at the beginning of the rainy season.
- Long duration varieties of pigeon pea are tall, spreading and occupy the field for about 250-270 days.
- These varieties are planted at wider row spacing of 90-120 cm and about 30 cm between the plants particularly under rain fed conditions.
- Under irrigated conditions Grow early maturing varieties are more popular as they fit well in double cropping systems with other crops.
- In case of April planted pigeon pea, a row spacing of 90-20 cm is recommended as the vegetative growth is much higher than June planted crop.
- Depending upon the size of seed and spacing, 15-25 kg/ha seed of pigeon pea is sufficient.
- To obtain satisfactory yields in the post rainy season the crop requires 12-30 plants/m2.
- Since soil moisture often becomes limiting factor is the post rainy season, yields tend to decline beyond a certain population.
- Maximum yield can be obtained at 12 plants m2 and any further increase in population led to decline in yield.
- Evidences are also available for no variation in yield from 33-45 plant m2 depending on soil type and its moisture holding capacity.

Sowing Time

- Pigeonpea is a traditional Kharif crop sown in June-July with onset of monsoon in various agro-climatic zones.
- Short duration varieties of pigeonpea are now becoming popular in the irrigated area.
- These varieties are harvested much earlier than the occurrence of frost/cyclones and can also be fitted well in to multiple cropping systems.
- Planting of early pigeonpea before the onset of monsoon in the month of June is recommended for higher yields
- Planting with onset of monsoon was the optimum because the ealier plantings emulated the reproductive phase during the period of heavy rainfall which ultimately caused drop of flowers and pods.
- Delay in planting reduces the yield of pigeonpea
- Delay in planting, caused reduction in the duration of crop, plant height, number of branches and pods.
- However, the impact on the protein content was low.

Method of Sowing

- Pigeonpea is generally broadcasted.
- Line sowing is superior over broadcasting. Broadcasting results in uneven plant population which ultimately results in low yield.
- In such areas where temporary water logging take place, planting on ridges is recommended..

Intercrop with Pigeon Pea

- Pigeonpea + Sorghum – Kharif
- Pigeopea + Pearl millet- Kharif
- Sorghum+ Pigeon pea –Rabi
- Pigeonpea+ Maize - Kharif

Land Preparation

- Pigeon pea being a deep rooted crop respond well to proper tilth.
- A deep ploughing by soil mold board plough followed by 2-3 discing and harrowing followed by planking is essential.
- Weeds should be removed.

Water Management

- Pigeon pea is mainly grown in the monsoon season under rain fed conditions.
- Being a deep- rooted crop, it is capable of extracting moisture from deeper layers in the soil.
- However, under long periods of moisture stress, it may respond to irrigation as well.

Irrigation

Drip Irrigation for Pigeon Pea

Inline drip line, turbo aqura or turbo line are suitable for Pigeon pea.

1. Laterals are spaced at the row spacing of the crop. 90, 100, and 120 cm.
2. Depending upon soil type dripper spacing is determined.

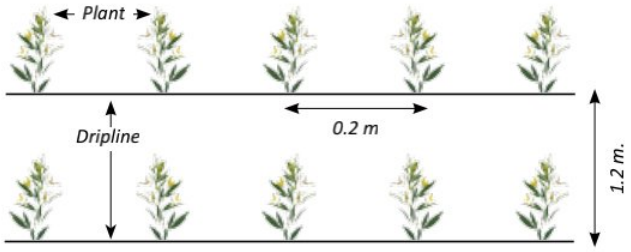
For sandy or murram type soils	30 cm
For medium soils	40 cm
For heavy (clayey) soils	60 cm.

3. Dripper discharge 4 lph

Water requrement of Pigeon Pea for Kharif and Rabi season.

Pigeon Pea kharif							
	E mm	ETP mm	kc	k p	WR mm	at 90 %Eff	l/ha/ day
MAY	6.70	4.6900	0.4000	0.5000	0.9380	1.0422	10422
JUNE	5.50	3.8500	0.9000	0.9000	3.1185	3.4650	34650
JULY	5.30	3.7100	1.1500	1.0000	4.2665	4.7406	47406
AUGUST	6.20	4.3400	0.8000	1.0000	3.4720	3.8578	38578
SEPT	4.70	3.2900	0.5500	0.8000	1.4476	1.6084	16084
Adjust Rainfall							
Pigeon Pea Rabi							
SEPT	4.70	3.2900	0.4000	0.5000	0.6580	0.7311	7311
OCT	4.00	2.8000	0.9000	0.9000	2.2680	2.5200	25200
NOV	3.60	2.5200	1.1500	1.0000	2.8980	3.2200	32200
DEC	3.40	2.3800	0.8000	1.0000	1.9040	2.1156	21156
JAN	4.10	2.8700	0.5500	0.8000	1.2628	1.4031	14031
Adjust Rainfall							

Layout of Dripline



Fertigation

Fertigation Schedule for Pigeon Pea		
Fertilizer recommendation		8:20:15/ac
At Planting	AllP	125kg SSP
	Rhizobium Culture	2 kg/ac
5 Days after germination	4 kg N	10 kg Urea
At first flower	4 kg N	10 kg Urea
	5 Kg K	8.5 kg MOP
20 days after first flower	5 Kg K	8.5 kg MOP
40 days after first flower	5 Kg K	8.5 kg MOP

Integrated pest and disease management is recommended.

IPM for Pigeonpea

1) The cultural practices, starting from selecting the disease-free and robust planting material.
2) Right sowing time.
3) Deep tilling to weeding out unwanted vegetation and soil-borne pests and pathogens
4) Crop hygiene, keeping clean field and practicing hygiene by workers will contribute significantly in controlling crop pests.
5) The pest surveillance and monitoring exercises based on frequent visits to the fields and sweeping with insect nets,
6) Observing the movement of the pests using pheromone traps, light traps and sticky traps, and deciding on a spraying schedule with botanical insecticides (neem- based products).
7) The need-based application of safe botanical insecticides not only cuts the costs, but also helps in reducing the pollutant load in the environment.
8) The use of biological agents to manage the pests is another important aspect of IPM. Spiders and preying mantises can be effectively used in managing pests.
9) Friendly birds are good custodians of crops, and they help manage the number of serious insect pests within the thresholds. By providing suitable perches the birds could be encouraged to visit the crop fields.
10) By growing ``antenna'' crops such as corn (maize) and sorghum (jowar or `cholam') have also helped in attracting the birds to crop fields as bio-control agents.
11) Castor and sunflower planted around the field of acts as insect traps.
12) Raise as intercrop in Sorghum and millet.
13) By raising companion crops along the main crops the pest could be managed well. While, the trap crops help in trapping the pests in them, other plants with strong aroma, such as fennel and garlic, help in repelling the pests.
14) The pests can be managed well by judiciously following the mixed-cropping pigeonpea (marigold or sorghum), alley cropping (marigold, softwood trees like sesbanea) and border cropping (marigold, Castor) with suitable crop varieties.
15) The light traps are mostly used for monitoring the pest movements in the fields.
16) Use NPV for caterpillar Control.

IPM for Disease control

1. The cultural practices, starting from selecting the disease-free and robust planting material.
2. Right sowing time.
3. Deep tilling to weeding out unwanted vegetation and soil-borne pests and pathogens
4. Crop hygiene, keeping clean field and practicing hygiene by workers will contribute significantly in controlling diseases.
5. Promote early maturing Pigeonpea varieties with resistance to sterility mosaic, Blight and wilt.
6. Follow rotation with or Sorghum or Millet.
7. Apply Trichoderma viride at the rate of 2kg in 50 kg FYM to the sopil before sowing.

Diseses of Pigeon pea and their control

Redgram Wilt *Fusarium udum*

Most destructive disease. Throughout the crop cycle the crop is susceptible.

Use Tolerant varieites like Maruti (ICP 8863), Lakshmi (ICP 85603), Durga (ICPL 84031) PRG 100, Mukta, Prabhat, Sharda. Crop rotation with Tobacco, Castor, or Sorghum. Soil solarization before planting. Seed treatment with Trichoderma viride+ 3 g thiram per kg seed. 2kg of the mixture mixed with FYM to be applied to the field.

Phytophthora blight *Phytophthora drechsleri*

A devastating disease. Young plants are killed. Galls develop on stems. Soil borne disease. Cloudy weather favour infection.

BDN 1, ICPL 150, !CPL 288, ICPL 304 and KPBR 80-1-4 are resistant. Seed treatment with 4g Trichoderma viride formulation + 6g Metalaxyl/kg seed. Follow up with a spray of Metalaxyl 2g/l.

Dry Root Rot *Rhizctonia bataticola Macrophomina phaseolina*

Serious problem of Late-sown crop. More Susceptible at Reproductive Stages.

LRG 66, ICPL 86005, ICPL 86020, ICPL 87105, ICPL 91028 are tolerant. Seed treatment with 4g Trichoderma viride formulation + 3g Thiram/kg seed. 2kg of the mixture mixed with 50 kg FYM to be applied to the field.

Powdery Mildew *Oidiopsis taurica*

White powdery growth on leaves and flowers. Defoliation when infection is severe. Cool climate congenial for disease.

Spray wettable sulphur @ 1g /l water

Sterility Mosaic *Sterility Mosaic Virus*

Serious problem in India. Patches of deep green plants that do not flower.

Eriophid vector spreads the disease. ICPL 87119, ICPL 227, Jagruti and Bahar tolerant. Spray Dicofol 3ml/l or sulphur 3g/l to control the vector.

Insect pests on pigeon pea

Gram Caterpillar *Helicoverpa armigera*

Throughout the year Peak attack in September to March-Feeds on all green tissue

A Combination of control measures Pheromone traps Use H-NPV virus solution Neem extract (1ml/l) Endosulphan or Pyrethroids (1-2ml/l) Shake the plant and collect all larvae from the ground and destroy.

Plume moth *Exelastis atomosa*

Peak attack November- March Larvae bore into buds.

Spray Endosuphan, Quinalphos, Carbaryl (1-2ml/l)

Green Pod Borer *Etiella zinckenella*

High infestation when temperature is high. Larvae feed on mature seed

Spray Endosuphan, Quinalphos, Carbaryl (1-2ml/l)

Spotted pod borer *Mauca tesulalis*

Major pest of the crop Larvae webs together leaves buds and pods. Bores into pods.

Spray Endosuphan, Quinalphos, Carbaryl (1-2ml/l)

Pod Fly *Melanagromyza obtusa*

Major pest of Pigeonpea Maggot feeds on developing grain. Complets life cycle in the seed chamber and flies out as adult through hole made on fruit wall.

Spray monocrotophos 1ml/l for larvae Spray endosulphan to control adults 2ml/l.

Blister beetle *Mylabris pustulata*

Adult feed on flowers.

Adults can not be killed by insecticides. Handpicking and killing in kersene mixed with water.

Jassids *Empoasca kerri*

Leaf infection. Reduced yield.

Single application of Dimethoate 1ml/l to reduce population.

Aphids *Aphis craccivora*

Infection high in cooler climate. Nymphs and adults colonise on young shoots and pods.Affects development pods and seeds.

Coccinellid predators control aphids. Apply dimethoate 1ml/l or phosphomidon 1ml/l.

Leaf Webber *Grapholita critica*

Minor pest.

No chemical application. Remove and destroy the webbed leaves.

Weed Management

- The growth of pigeon pea is quite slow during first 45-60 days after sowing. For short duration crop first 30 days in critical
- Two weedings, one at 25 days of another at 45 days after sowing, were found to be sufficient.
- Among herbicides, lasso @ 1.0 kg a.i./ha was found to be quite effective

Cultural methods

- Hand weeding 25 - 45 days after sowing is better control measure.
- Intercropping with sorghum and maize suppress weeds in long duration crops.
- With short season crops growing short stature crops such as cowpea, green gram , black gram, groundnut and soy bean serve as smoother crops to weed.

Harvesting

- Green pigeon pea pods are harvested for different purposes. Near cities where they can be readily marketable they are harvested for sale as vegetable.
- Fully developed, bright green seed is preferred, so pods should be harvested just before they start loosing their green colour, it is important to remember that the appearance of pods at their stage varies between cultivars.
- Dry seeds of Pigeon pea are harvested when the pods are fully ripe and have turned yellow but before the pods start shattering.
- Harvesting is usually done manually by using sickle to cut plants and vines, but occasionally by machines and is followed by drying and threshing.
- Harvested material in dried under the sun in the threshing yard for about a week, depending on the weather conditions.
- Threshing is done both manually and mechanically.
- In same places mechanical threshers are used.

Storage Practices

- Storage of food grains is an important aspect of Post Harvest Technology.
- Storage losses are considerably higher in pulses than in cereals.
- Pigeon pea in usually stored for long periods to ensure availability of whole seed at the time of sowing, and as a dhal to meet consumer requirement.

Benefits of drip irrigation for Pigeonpea

- Increases yield upto 100%
- Reduces water used for irrigation up to 55%
- Allows uniform high % germination
- Helps in early planting which is a pre-requisite for IPM
- Allows for a Summer crop (pest free environment)
- Early and uniform maturity
- Controls weed growth as water is applied only to the root zone in case of drip.
- Creates opportunity for high value rotation crops

Dos

- Ensure good drainage in the field.
- Adopt drip irrigation.
- Compulsorily apply organic manure as per recommendation
- Select high yielding, disease and pest tolerant variety suitable for each location.
- Strictly follow the irrigation schedule given by the engineer.
- Follow the drip system maintenance schedule given by the engineer.
- Compulsorily weed/ inter-cultivate, timely operation helps in crop growth.
- Follow the precautions while operating the drip system as explained by the engineer.
- Follow disease and pest control measures timely and effectively.
- Apply sprays in the evening or early morning only.

Don'ts:

- Don't over irrigate the crop at anytime.
- Don't spray the crop under hot sunlight.

Frequently asked questions (FAQ's)

1. Can I use drip method of irrigation for Pigeon pea ?
   Yes. Drip irrigation is suitable both as regular irrigation or as life saving irrigation.
4. Can I take an intercrop with drip irrigation?
   Yes. As per the practice existing in the area.

Crop yields on depend on Climate, Soil and Management and therefore can't be guaranteed by the company

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Oil Palm - Irrigation & Fertigation

Oil palm, *Elaeis guineensis* originated in the Guinea coast of West Africa. It is the highest oil producer among the perennial oil crops. It produces two types of oil. 1. Palm oil (extracted from the mesocarp of the fruit wall) and 2. palm kernel oil (from kernel).

In India AP and Karnataka have large areas under the crop. Growing oil palm is slowly picking up in Tamil Nadu.

Highest yields of oil palm are from in East and West Godavari and Krishna districts. The identified potential area in AP is about 4 lakh ha.

•Climate

- Oil Palm is a humid tropical crop. It requires a humidity of plus 80%.
- It grows well at 450- 900 m altitude.
- Requires evenly distributed rainfall of 150mm/month or 2500- 3000 mm/yr.
- Because of erratic rains in AP,irrigation is essential.
- A temperature range of 29-33 oC maximum and 22-24 oC minimum is ideal for oil palm.
- At least 5 hrs of bright sunlight is essential for the crop.
- Places prone to high wind velocity are not suitable for oil palm.

Soil

- Oil palm grows well in all types of soil.
- It grows better in well drained, deep, loamy alluvial soils rich in organic matter.
- Soil should have at least 1 m depth.
- Avoid alkaline, saline and water logged soils.

•Varieties

- Tenera is the ruling hybrid grown all over the world.
- Tenera has a thin shell, medium to high mesocarp content and high oil content.

Planting Season

- Best time for planting is June- December; i. e. during monsoon.
- If planting is done in summer provide adequate irrigation.
- Mulching the basin around the plant in summer is beneficial.

Planting Material

- 10-14 month old healthy seedlings with 1-1.3 m height and with 13 functional leaves with good girth at collar are best for planting.
- Seedlings up to 24 months age can be used for planting.

•Spacing and Plant population

- The spacing recommended is 9m x 9m x 9m triangular
- Plant population is 57 plants/acre

Planting

Pits of 0.6m x 0.6 m x 0.6 m are to be prepared.

- Take the pits prior to planting season.
- Apply 250 g DAP or 250 g of rock phosphate and 50 g phorate and mix with the soil at the base of the pit.
- Remove the polybag by making a longitudinal cut and place the seedling in the pit along with the soil.
- Fill the pit with soil and press firmly leaving the top portion so that the seedling bowl will be 25 cm below the ground level.
- Immediately after planting form basin and give irrigation.
- Provide stake support if the area is prone to wind.
- Take care that soil does not accumulate on the crown region which will result in crown rot.
- In low lying areas prone to water stagnation plant oil palm on mounts to avoid water logging of plants.

•Irrigation management

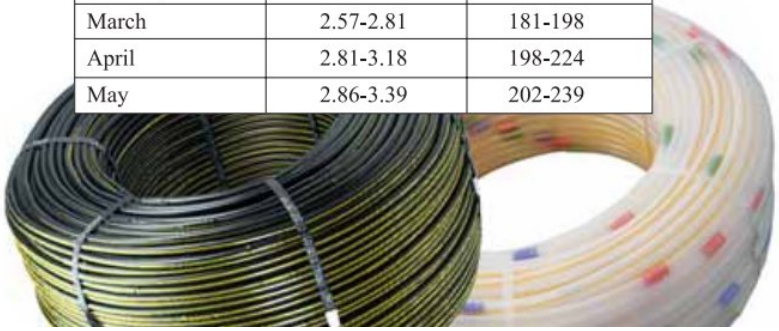
- Oil palm has a very high growth rate and its requirement of water is also high.
- Do not venture to cultivate this crop if water sources are not identified ahead.
- Under water stress or insufficient irrigation the rate of leaf production, sex ratio of flowers and abortion of inflorescence and eventually yield reduction occurs.
- Up to 3 year a plant requires 150 l per day and older plantations require upo 200-240 l/palm/day.

Micro irrigation for Oil Palm

•Frequent low volume irrigation is preferred for oil palm. Or else the high total volume of water required per day will result in leaching of nutrients from the root zone.

- A rate of water input matching the infiltration rate of soil would be ideal.
- Drip, minisprinkler or Jet irrigation is ideal .
- For drip irrigation 4 x 8 lph drippers for 5 hour duration is sufficient.
- Basin of each palm should be mulched to conserve moisture against evaporation.
- Research from Pedavegi (WG dist.) National Research Centre for Oil Palm showed that drip irrigation or jet irrigation resulted in maximum plant girth and number of leaves compared to conventional basin flooding.

Month	Water requirement	
	Mm/day	Lt/plant/day
June	2.05-2.44	145-172
July	1.69-2.14	119-151
August	1.64-2.23	115-157
September	1.96-2.21	138-156
October	1.84-2.20	130-155
November	1.80-2.09	127-147
December	1.55-1.95	109-137
January	1.74-1.99	123-140
February	2.12-2.33	150-164
March	2.57-2.81	181-198
April	2.81-3.18	198-224
May	2.86-3.39	202-239

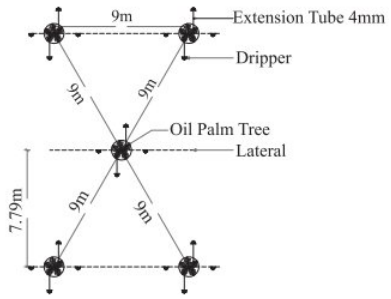


Drip system lay out

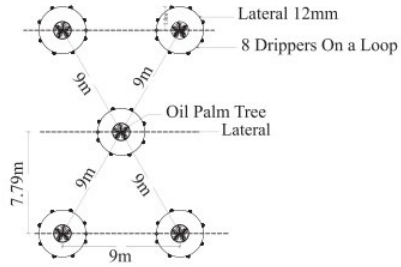
The online drip system is found to be more suitable for oil palm. The drip laterals are spaced at 7.79m row spacing. Each tree is provided with 4 drippers placed around the trunk using extension tubes from the lateral. The drippers are to be placed 1 m away from the trunk in case of mature trees, either on extension tubes or on a loop of polytube around the tree.

In case of Jets or Mini sprinklers two jets/mnisprinklers per palm are given attached to poly lateral at 1m away from the trunk on either side of the palm.

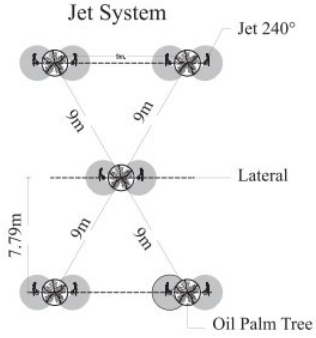
Drippers on extension tube



Drippers on a loop lateral



Jet System



Fertilizer requirement

Oil palm is a heavy feeder.

The recommended fertilizer doses for Oil Palm in AP are given below. Estimation of fertilizer requirement based on soil analysis will be more accurate.

Fertilizer recommendation for Oil Palm

Age	N	P	K	$MgSO_4$
1st year	400g/tree	200g/tree	400g/tree	125 g/tree
2nd year	800	400	800	250
3rd year onwards	1200	600	1200	500

- In very high yielding gardens 20% more of the above doses are recommended.
- Borax 100g/palm/yr is recommended in B deficient soils.
- First dose of fertilizer should be given 3 months after planting.
- 50-100 kg/palm/yr FYM or 100 kg green Manure to be applied from the first year onwards.
- A dose of 5 kg Neemcake is to be applied per palm per year.

•Method of Application

- If drip is adopted fertigation of N and K sources is possible.
- Or else broadcast the fertilizers around the clean weeded basin about 50 cm away from the trunk base and incorporate by forking in.
- If not fertigated, irrigate after forking in the broadcasted fertilizer.

Fertigation Schedule

- Two equal splits of fertilizer application is recommended; July-August and December- January
- Keeping the same application timings the following fertigation schedule is worked out.

1st year palm

Apply P as SSP (1250 g/tree) or Rock Phosphate (1000g/tree) to the tree basin in two splits, one in July and 2nd in December.

Fertilizer	Quantity g/tree	Rate of fertigation g/tree/wk	Duration
Urea	435 435	62 ,,	July 1st - Aug 3rd wk Dec 1st - Jan 3rd wk
MOP	334 334	48 ,,	July 1st - Aug 3rd wk Dec 1st - Jan 3rd wk
$MgSO_4$	62.5 62.5	16 16	July 1-4th wk Dec 1-4th wk

2nd year palm

Apply P as SSP (2750 g/tree) or Rock Phosphate (2000g/tree) to the tree basin in two splits, one in July and 2nd in December.

Fertilizer	Quantity g/tree	Rate of fertigation g/tree/wk	Duration
Urea	870 870	124 ,,	July 1st -Aug 3rd wk Dec 1st -Jan 3rd wk
MOP	666 666	95 ,,	July 1st - Aug 3rdwk Dec 1st - Jan 3rd wk
$MgSO_4$	125 125	16 16	July 1st - Aug 3rd wk Dec 1st - Jan 3rd wk

3rd year palm

Apply P as SSP (3750 g/tree) or Rock Phosphate (3000g/tree) to the tree basin in two splits, in July- August and two splits in December- January.

Fertilizer	Quantity g/tree	Rate of fertigation g/tree/wk	Duration
Urea	1305 1305	186 ,,	July 1st - Aug 3rdwk Dec 1st - Jan 3rd wk
MOP	1000 1000	142 ,,	July 1st - Aug 3rd wk Dec 1st - Jan 3rd wk
MgSO4	250 250	38 38	July 1st - Aug 3rd wk Dec 1st - Jan 3rd wk

Pruning

- Maximum number of green leaves should be retained on the palm.
- Only the lower dried and diseased leaves must be pruned.
- Give clean cut to the petiole as close to the stem as possible with a sharp chisel.
- Any damage to the petiole or stem will attract disease organisms.

Mulching

- Mulching of basin is compulsory to conserve moisture.
- Mulching can be done dried leaves, male flowers, coconut husk, empty bunches obtained from factory.
- In adult plantations all the cut leaves can be heaped in between two rows of oil palm which can act as a mulch.
- Flowering of Oil palm and management of fruiting
- Oil palm comes to flowering in 14-18 months after planting
- It produces male and female flowers separately on the same palm (monoecious).
- Male and female phases do occur naturally in consequent cycles in palm.
- Some trees may exhibit a phenomenon of producing more male inflorescences. This is not a serious situation as long as an average 10-12 female bunches appear a year.
- Excess male flowers occur due to the following reasons

1. Insufficient irrigation and infrequent irrigation
2. Non application of recommended doses of fertilizers.
3. Excessive removal of leaves

- 4. Ploughing close to the stem and thereby damage of roots.
- Practice ablation; removal of male and female flowers produced in the early stages of plantation
- Ablation helps in developing strong stem girth, vigour and extensive root system.
- Ablation can be extended from 14 th to 18th month after planting and extend upto 2-3 years depending upon growth and vigour.

Pollintion

- Oil palm is highly cross pollinated crop. Pollination is assisted by wind and insects.
- Wind pollination alone is not adequate.
- Good fruit set occurs after insect pollination. The insect Elaeidobius kamerunicus is a good pollinator.
- Releasing this insect after 30 months of planting is a good practice.
- If the plants are of low vigour, release the weevils after 3 years.

Intercropping in Oil Palm garden

- Oil palm is a wide spaced perennial crop with a long (3 year) juvenile period.
- Therefore intercropping is compatible.
- Vegetables, banana, turmeric, chillies, tobacco, pine apple, ginger, pulses and ground nut are compatible intercrops.
- While ploughing for intercrop, do not plough close to the palm base to avoid root injury.
- Water management of intercrop should not restrict oil palm's water requirements.

Cover cropping

- Cover crops are generally recommended for mature oil palm gardens.
- Pueraria phaseolodes, Calapagonium mucunoides, Centrosema pubescens, Mimosa invisa etc. are the good cover crop species.
- Cover crops are also can be taken after harvest of intercrops in early years.
- Cover crop should be sown in the entire field leaving the basin
- Cover crops are ploughed in situ.
- Cover crops help in soil and water conservation. And when incorporated into the soil will improve the organic matter content and nutrient status.

•Benefits of Drip irrigation for Oil Palm

- Increases yield upto 45%
- Reduces water used for irrigation up to 50%
- Increased fertilizer uptake by plants when fertigation is practiced and increased fertilizer use efficiency through fertigation.
- Reduces NO3-nitrogen leaching (thereby nitrate pollution) by 50% when fertigation is practised.
- Controls weed growth as water is applied only to the root zone.
- Allows for intercropping during the early years.

Pest and disease management

Most of the pests of Coconut are found to attack oil palm.

Spindle bug

Necrotic lesions and dry brown patches on leaves. Spindle fails to open

Keep phorate (2g) filled perforated poly sachets in the leaf axil

Tussock Caterpillar

Defoliation

Hand picking of caterpillars.Cut and burn damaged leaves.Spray monocrotophos (0.036%) or carbaryl (0.1%).

Root Grubs/Cockchafer beetles

Sudden death of young plants.

Fill the seedling bags with soil free from root grub. Apply 50 g phorate per seedling while planting sprouts.

Termites

Stunted growth of the plants

Give enough irrigation water.Apply Quinalphos (0.06%) or Chlorophyriphos (0.05%)

Wild Boar

Destruction of boll region

Keep scaring device.

Insect Pests of Adult palms.

Rhinoceros beetle

"V"Shaped gaps in the leaf silhouette. Hole at the leaf base. Chewed up fibre seen at the base.

Destruction of breeding sites. Maintain sanitation in the orchard. Extraction and killing of insect from the spindle portion using a metal hook. Trap adult with fermented castor cake. Use bioagents like Baculovirus oryctes. Use completely rotten FYM.

Red Palm weevil

Gradual wilting and drying of palms. Presence of few holes with a brown liquid oozing from the holes.

Removal of damaged or dead palms or rotten bunches from the orchard. Apply coal tar to the wounds and cuts on the stem to prevent egg laying.Trap adult beetles using pheromone baits. Maintain good sanitation. Root feeding of monocrotophos (10 ml/10 ml water).

Case worm

Holes on leaves. Defoliation. Cone shaped bags on the under surface of leaves.

Cut and burn badly infected leaves. Spray carbaryl (0.1%) on infested leaves. Root feeding of Monocrotophos (10 ml/10ml water).

Birds

Bird feeds on mesocarp of fruits

Cover fruit bunches with wire net. Use bird scare devices.

Rats

Damages young fruits. Exposed pericarp. Kills young plants

Follow IPM practices. Baiting with Zinc Phosphide, Use rat traps. Cover the base portion of the plant with wire mesh while planting.

Diseases of Oil palm and Control measures

Stem Wet Rot

Sudden death of spear leaves. Yellowing discoloration of remaining fronds. Death of leaves.

Provide drainage and avoid flooding of the field.Early detection of the disease and trunk surgery can save the tree. For early detection, a sharp iron rode may be pierced into the stem base of suspected trees, which gives out some liquid. If the liquid has putrified smell the palm should be subjected to trunk surgery. Trunk surgery is done to excise all affected fibrous tissues from inside the trunk. First the outer stem tissues and frond butts should be chiseled. The innermost disease tissues including yellowish lesions which are generally seen along with the border of healthy and diseased tissues also should be removed. After this a portective covering with carbendazim (1%) plus Monocrotophos (1ml) paste flowed by coal tar should be given to prevent the wound invading microorganisms and insects.

Bud Rot disease

Yellowing of the spear leaves which later turns brown. Basal tissue of the spear completely gets rotted. Rotten tissue emits a foul odour. Continuous rotting leads to destruction of meristem and death of palm. The disease becomes rampant during monsoon .Palms of all ages are prone to the disease.

If detected early, control is effective. The affected spear should be pulled out along with the decayed tissues. The affected tiisues in the crown should be removed and drenched with carbendazim or thiram (1%).For treating advance stage disease affected palms, first remove all the leaves surrounding the spear. The affected tissue and meristem should be removed layer by layer. Till fresh tissues are seen.The exposed fresh tissues of the apical bud should be cleaned and smeared with 1% Carbendazim solution. The exposed portion should be covered with dried leaves or perforated polythene sheet.Prophylatic measure:Where beetle damage is predominantly high, it should be checked by keeping 10g phorate granules in perforated polythene sheet.

Basal Stem Rot (Ganoderma)

Withering, yellowing and orange discoloration of the leaves followed by necrosis of older fronds. Rotting of the bole at the stem base. Infected palms appear suffering from malnutrition. Dry rotting of internal tissue at the base of the trunk. Roots become friable and disintegrate easily. There is little chance of recovery of affected palms. By the time symptoms are visible almost 50% of basal tissues get affected. Progress of disease can be checked by field sanitation. Isolate affected palms by taking trenches of 1m deep and 30 cm wide. Apply 5 kg neem cake per palm/yr.Disease affected but healthy palms should be treated with 10 ml Calixin (tridemorph) or 10g Aureofungin sol (in 100 ml water) per palm through root feeding. The suspected diseased palms should be uprooted and destroyed immediately as soon as they are noticed.

Bunch Rot

Affects fresh fruit bunches. During early stages of infection strands of mycelium can be seen spreading over the bunch surface. In later stages the mycelium grows over the fruit surface and penetrates into the mesocarp. The infected bunch becomes completely rotten and unfit for harvest. Sanitation: Before onset of monsoon, carry out crown cleaning, removal of dead inflorescence, bunch stalks, aborted bunches etc. Crowns of infected palms should be thoroughly cleaned and sprayed with 0.1% Carbendazim solution.

Dos

- Ensure good drainage in the field.
- Adopt drip or jets for irrigation.
- Prepare pits and fill it with the mixture as recommended.
- Compulsorily apply organic manure as per recommendation
- Select high yielding, disease and pest tolerant variety suitable for each location.
- Practice drip/jet irrigation from the beginning of the orchard.
- Irrigate with drip/jet strictly following the schedule given by the engineer.
- Follow the drip/jet system maintenance schedule given by the engineer.
- Compulsorily weed/ intercultivate, timely operation helps in crop growth.

- Follow fertigation schedule as given by the engineer.
- Follow the precautions while operating the drip system as explained by the engineer.
- Apply micronutrient as and when needed.
- Follow disease and pest control measures timely and effectively.
- Apply sprays in the evening or early morning only.

Don'ts

- Don't over irrigate the crop at anytime.
- For fertigation don't mix solid fertilizers and dissolve them together. Prepare individual solutions and mix them for application.
- Don't spray the crop under hot sunlight.
- Don't make a fire in the field with Drip system.
- Don't use the fertigation unit for bulky organic manure and fertilizers that are not soluble in water
- Don't add solid fertilizer from the bag directly to the fertilizer tank. Prepare solution separately and pour the solution to the fertilizer tank. Prepare solution only in plastic buckets.
- Don't use metal container.
- Don't stir the solution with naked unprotected hand. Use wooden spoon or stick.
- Don't heat the fertilizer solution to increase solubility.

Frequently asked questions (FAQ's)

1. Does oil palm require irrigation?

   Yes. Its requirement can only be met if rainfall is regular and 150 mm per month.It can not be grown in AP/Karnataka/TN without provision for irrigation.

2. Whether the meagre quantity of water supplied through drip/jet irrigation is enough?

   Irrigation rate in Drip/Jet method is estimated based on the ETP of the location and therefore it enough.

3. In drip/jet methods, water is applied to the surface at a very low rate. Whether this will cause root accumulation near the surface ?

   In palm, only the absorptive roots are located near the surface and get directed by moisture and nutrient availability. The anchor roots penetrate into deeper soil layers and provide stability for the tree.

4. Can I prefer Impact Sprinkler method of irrigation for oilpalm?

   No. it is not suitable as it spreads water in the inter-tree spaces and the trunk of the trees will obstruct the spray jet from the sprinklers and thus affect the uniformity of irrigation. Moreover wastage of water per irrigation will be high.

1. Can I take an intercrop with irrigation?

   Yes. Till the canopies of oil palm cover the interspace, intercropping is possible. But provide additional drip line for the intercrop.

Crop yields depend on climate, soil and management and therefore can t be guaranteed by the company.

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Precision Farming
COFFEE
With Jain Technology™

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Small Ideas. Big Revolutions.®

Precision Farming

Coffee

With Jain Technology™






Coffee plant is a woody perennial where the fruit yield depends on the balance between vegetative and reproductive growth. The coffee plant is believed to have originated in the Ethiopian High lands, in the county called Kaffa, hence the name. But the English word COFFEE is derived from the Italian CAFFE. In India Coffee was first grown in the 17th Century in the hills of Chickmaglur district. Even now, the coffee growing areas in India are restricted to a narrow belt in the States of Karnataka, Tamil Nadu and Kerala, on the Western Ghats and Manipur, Meghalaya, Mizorum, Nagaland, Orissa, Sikkim, Tripura and West Bengal on the Eastern Ghats.

Brazil is the highest coffee producer, 35% of global production. India produces only 4% of world coffee.

Wherever in the world coffee is grown it is within 1000 miles of the equator, including both tropical and sub-tropical climes.

Though the genus coffee has numerous species (Family Rubiaceae), only two, Arabica and Robusta are commercially significant. Arabica coffee grows best above 3000 feet altitude but is highly susceptible to pest and diseases. Robusta, is relatively drought resistant and is more resistant to pests. Robusta has high caffeine content, while Arabica has half caffeine content as of Robusta. Because of this trait, Robusta is used in most commercial coffee blends and in the production of instant coffee. Robusta grows in relatively lower altitudes.

India grows both Arabica (around 1/3 of production) and Robusta (around 2/3 of production) varieties of coffee. The total planted area of coffee covers around 380,000 hectares mainly in the traditional coffee growing states of Karnataka (58 %), Kerala (22 %) and Tamil Nadu (8 %). Non-traditional coffee growing areas are to be found in Andhra Pradesh, Orissa and North-East India. Major coffee growing districts include Kodagu and Chikmagalur in Karnataka and Wyanad in Kerala. The non- traditional areas grow some 15% of India's coffee.

The productivity of Arabica coffee is about 600 kg/ha and that of Robusta 1070 kg/ha (source: Coffee Board).

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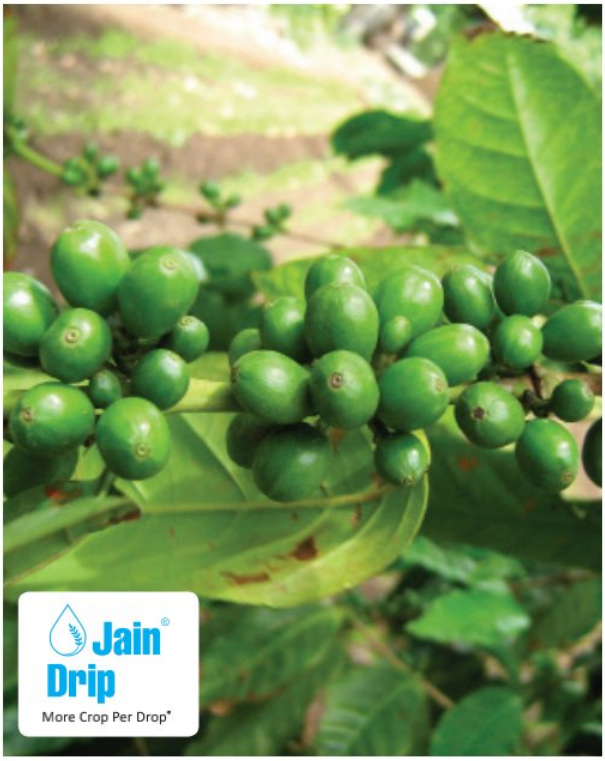


Coffee Industry in India

Coffee industry in India is 190 year old. Next to oil, coffee is the largest traded commodity in the world. This perennial crop takes long to establish as productive: 8 years for economic yield in case of Arabica and 10-12 years for Robusta. Most (98 %) of the 250,000 growers in India are small holders, less than 10 ha holdings. Coffee production is labor intensive; 70% of cost of production is labor.

Climatic effect

Coffee growth is affected by climatic and edaphic factors; light, temperature, rainfall, humidity nutrients and soil moisture and soil temperature.

Shade grown coffee

Indian coffee grows in a system with a 3-tier shade system. Planters take a lot of care in selecting the trees for each tier. The plantations are under the canopy of this shade trees.

The lower shade tier is usually a nitrogen fixing species like *Erythrina* or *Gyricedia*. Both these can harvest nitrogen and improve soil fertility. The secondary tier is of trees like Silver oak, white or red cedar , those shed leaves in monsoon and provide an effective shade during summer months. They keep the soil and ambient temperature low ; a requirement for coffee. The tertiary tier is of hardwood trees, mostly adapted forest species. The 3-tier system helps in filtering harmful UV radiation and the filtered sunlight helps in caramelizing sugars in the coffee bean and give it the unique taste of shade coffee . On an average, there are 300-350 shade trees in an acre of coffee making it as one of India's largest man made forest growing. Because of this deliberate forest maintenance the coffee cultivation in India is least mechanized.

Studies on growth of coffee have shown that annually there are two main phases of growth; phase I during March –July and phase II during August – October. The second phase is more pronounced. In a high production system the input management (water and fertilizer) has to take these growth phases into active consideration.

Soil and Climate

Coffee requires acidic pH soil with deep and friable profile.

Table 1 : Conditions suitable for growing both Arabica and Robusta coffee.

Soil and Climatic Factors for Coffee		
Factors	**Arabica**	**Robusta**
Soils	Deep, friable, rich in Organic matter , well drained and acidic (pH 6.0-6.5)	Same as Arabica
Slope	Gentle to Moderate	Gentle slopes to leveled fields
Elevation	1000-1500 m	500-1000 m
Aspect	North, East and North-East aspects	Same as Arabica
Temperature	15-25 oC, cool clime	20-30 oC hot humid clime
RH	70-80 %	80-90 %
Rainfall	1600-2500 mm	1000- 2000 mm
blossom showers	March-April (25-40 mm)	February-March (25-40 mm)
Backing showers	April-May (50-75 mm), Well distributed	March-April (50-75 mm), Well distributed

Liming of soils and maintenance of pH.

To grow healthy coffee plants and to realize better crop yield, it is essential to maintain the soil pH around 6.1. The various plant nutrients in the soil would then be available to coffee plants. The acidity also determines the nutrient assimilation/mineralization in the soil. Due to the continuous application of acid forming fertilizers like ammonium sulphate, ammonium chloride and DAP and due to the leaching of calcium and magnesium elements in the soil, the soils tend to become more acidic. Therefore, to monitor the soil pH, soils have to be tested compulsorily once in 2-3 years. When the soil pH goes above 6.2 or comes below 6.1, the soil pH needs to be corrected. Highly acidic soils are harmful for the useful soil micro-organism and in such soils coffee plant is always tend to be stunted in nature. If the soils are alkaline (above pH 7.0), most of the essential plant nutrients are not available to the plants.

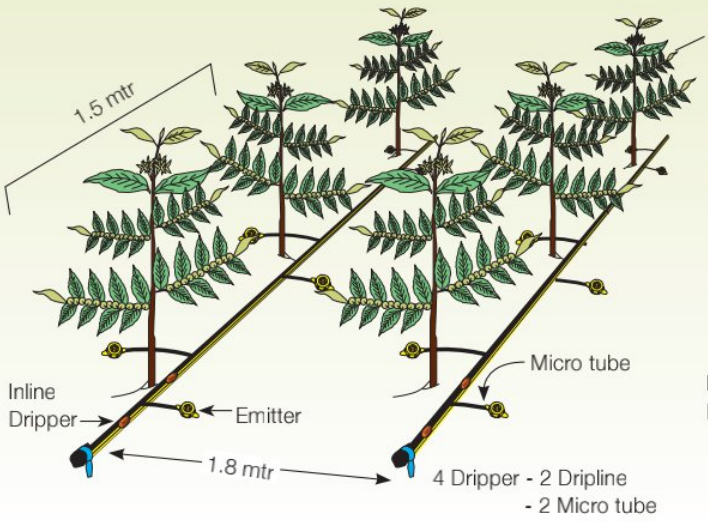
Whenever, the coffee soil pH falls below 6.1, it should be corrected by application of alkali forming soil amendments like agricultural lime(Calcium Carbonate), dolomite (Calcium and Magnesium Carbonates). Liming of the coffee soils can be done anytime of the year except during monsoon period. November to February months is the ideal period for lime application. One should take care that adequate moisture is present in the soil for the best use of applied lime. If the recommended dose of liming material is more than 3.5 metric ton per hectare, in such case the dose has to be split into two equal parts and applied in 2 years.

In the case of soil pH above 6.2, then pH can be corrected by the application of acid forming fertilizers.

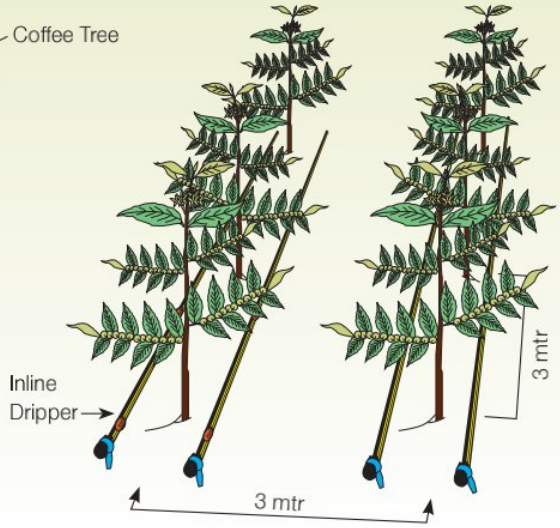
Water conservation in Coffee Plantations

Traditional coffee plantations are all in high rain fall zones of the country. However, the erratic monsoon rains make it imperative for planters to bring in irrigation technology for Coffee. Planters generally take up various run- off control measures which also restricts soil erosion. In addition to this the top soil and the rich organic matter (tree leaves etc.) maintain a spong like texture on the surface soil that would help in storing moisture in the rhizo -sphere and other lower strata. They also act like a mulch protecting escape of moisture.

Drip layout for Arabica Coffee



Drip layout for Robusta Coffee



But in recent years, the rain fall quantum has declined; infiltration rates into the soil decreased and factors like deforestation, soil compaction etc. has resulted in less soil storage of moisture. Water is increasingly becoming limited for coffee growth. Planters are finding it difficult to keep the Coffee plants growing without irrigation.

Coffee Irrigation

Because of drastic changes that occurred in the rain cycle over the years, irrigation is essential for coffee production.The Robusta area has been increasing ever since Arabica coffee began its decline due to increasing pest pressure. Robusta requires well timed systematic irrigation during the annual production cycle. In countries like India, Kenya, Ethiopia and Vietnam, coffee production thus depend upon irrigation for at least 4-6 months of the year. Countries in South and Central America, coffee is less depended on irrigation as their rain fall distributed throughout the year.

The irrigation requirement of coffee is very high; around 101 m3 water per acre per season.

The stages of Coffee when Irrigation is critical are:

- Period of Flowering
- Period of Berry expansion
- Bean filling stage

Benefits from Irrigation

- Enhances vegetative growth and increases the flower bunch points on the stem (Nodes)
- Increase bean yield
- Improves the soil ecology by enhancing microbial population
- Improves the arte of decomposition of soil organic material and thus maintains soil CN ratio
- Makes the soil micro climate ideal for coffee growth
- Improves nutrient up take by plants.
- In heavily water stressed situation helps the crop to survive and yield.

It is essential for Coffee plants to have adequate soil moisture continuously during the vegetative and fruit growth stages. It is also found that excessive water in the soil also is deleterious to coffee. In South Indian Plantations, this means that irrigation becomes essential after September till May except for about 40 days in January-February when Coffee requires a stress period for inducing flowering.

Suitable irrigation Systems for Coffee

Sprinklers and Rain guns have been adopted by large coffee estates for last two decades or so.

But as the technology got accepted several issues got to affect the increased adoption of Sprinklers. The main issues involved by these systems are;

- The concept of irrigation in Coffee plantations is to supply the water at proper time and in sufficient quantum. Because fruit set is fully depended on the timing and quantity of irrigation and uniformity of irrigation is critical.
- Sprinklers/Rainguns have large power requirements to operate.
- Shade trees act as obstruction to the pressurized water spray emanating from the nozzles resulting in non uniform water distribution.
- As water sources are fast depleting in plantations for want of adequate annual rain fall in the hills, large volumes of water required for an event of sprinkler irrigation are often not available in many estates.
- In this context drip irrigation is increasingly being adopted by Coffee Planters.
- Fertigation (application of fertilizer through irrigation water) is not possible through sprinklers but is part of drip irrigation system.

In this scenario drip irrigation method is found to be absolving many of the issues listed above. **Drip system with its,**

Lower energy requirement, higher water use efficiency, lack of any effect due to wind and above all allowing for fertigation, a more efficient fertilizer use, is the best method available.

Both in line and on line drippers are suitable. But for large gardens, inline drip lines are more practical.

For Arabica coffee single drip line per row of coffee is suitable.

For Robusta, there should be two drip laterals one on either side of the tree.

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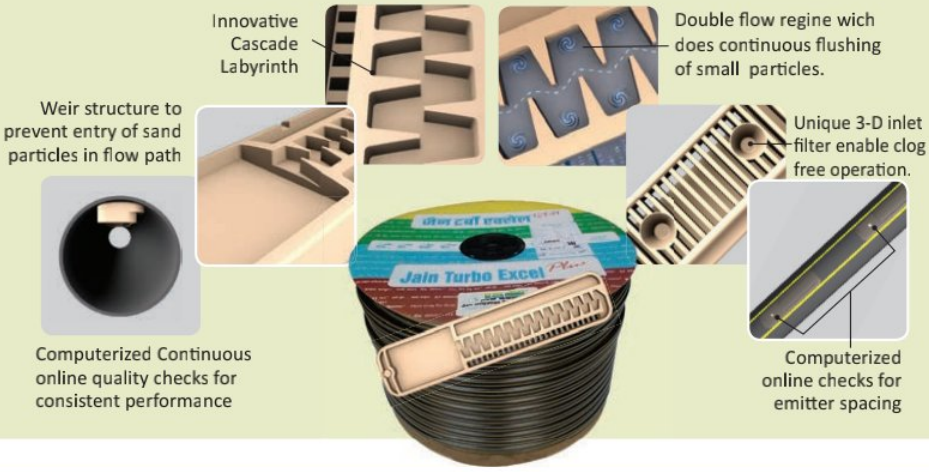
More Crop Per Drop®

ONE STOP SHOP for Your

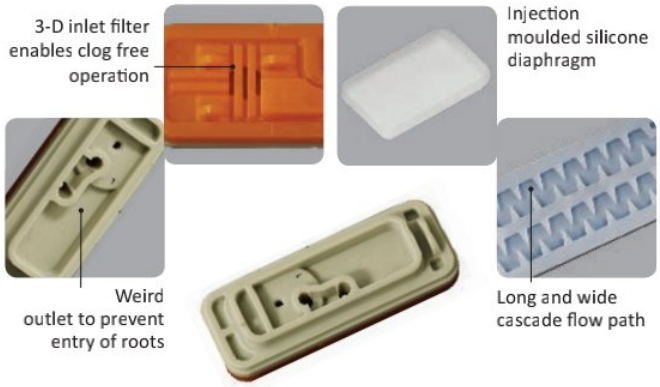
Jain Turbo Excel® and Jain Turbo Slim

- Five Star rated dripline from worlds reknowned institute IRSTEA (Cemagref), France.
- Available discharge rates - 0.85, 1.2, 1.6, 2.1, 4 lph @ 1kg/cm².
- 12, 16, 20, 25 mm nominal diameter.
- Dripper Spacing 15, 20, 30, 40, 50, 60, 75,90 cms.



Jain Turbo Top®

- Available discharge rates – 1.1 & 1.7 lph
- Injection moulded silicone rubber compensates with pressure and discharge gives uniform performance.
- Anti Syphone feature (optional) prevents suction of sand and silt particles inside the dripper.
- Cascade labyrinth gives strong, self-cleaning turbulence.
- Available in 16 & 20mm nominal diameter. (12, 16 & 20 mm in Thin Wall option)
- Suitable for surface as well as subsurface installations.

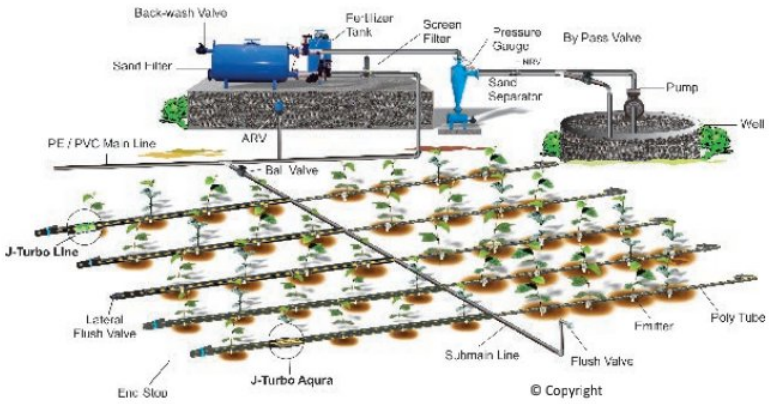


Why Jain Drip Irrigation ?

Water is not the only need of the plant. To uptake this water efficiently, it requires proper air-water balance within the root zone. Drip irrigation, with its low application rate, prevents the saturation of water within the root zone and continuously maintains field capacity. This provides a favorable condition for the growth of the plant. Drip irrigation also helps to use fertilizer efficiently. With drip irrigation water can be provided at frequent intervals which helps maintain required soil moisture level within the vicinity of the plant roots. Jain is the pioneer of drip irrigation. Ours is the only company in the world, which fulfills your entire irrigation system requirement under one roof.

Characteristics of drip irrigation

1. Water is applied at a low rate to maintain optimum air-water balance within the root zone.
2. Water is applied over a long period of time.
3. Water is applied to the plant and not to the land.
4. Water is applied at frequent intervals.
5. Water is applied via a low pressure network.



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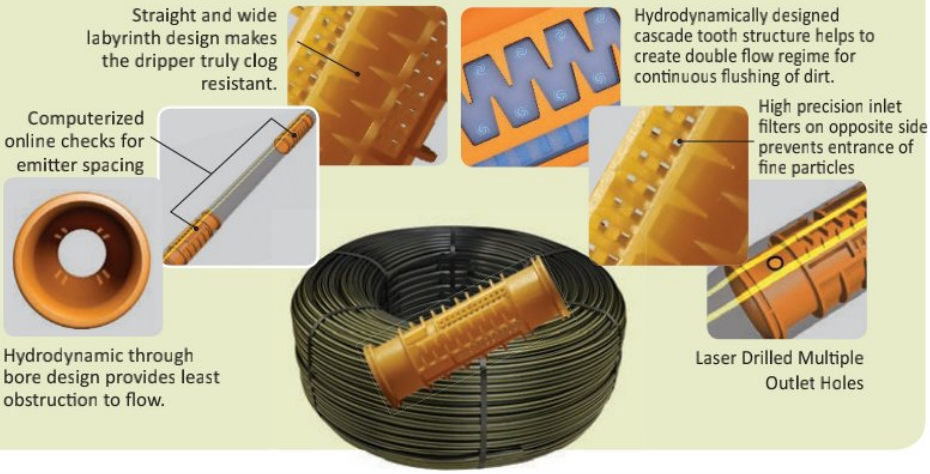
Micro Irrigation Needs

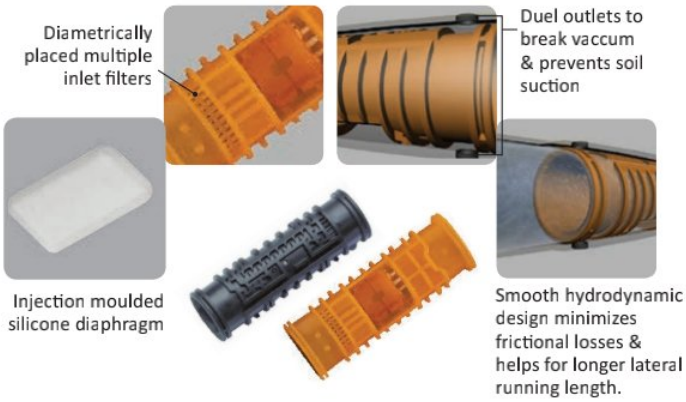
J-Turbo Line® Super

- Available discharge rates (at 1kg/cm²)
  - 12mm - 2.2, 4 lph
  - 16mm - 4, 8 lph
  - 20mm - 2.2, 4, 8 lph
- Availabe in 12, 16 & 20 mm nominal diameter.
- Suitable for surface as well as subsurface installations.



Turboline PC®

- Available discharge rates - 1.4, 1.8, 2.6 & 4.0 lph within pressure regulation range of 0.7 to 3 kg/cm².
- Injection moulded silicone rubber compensates with pressure and discharge gives uniform performance
- Application on undulating land/ Terrains/ Steep slopes.
- Available in 16 & 20 mm nominal diameter.
- Suitable for surface as well as sub-surface installation.
- Application where ever longer lateral length is necessary.
- Conforming to IS 13488, ISO 8261 Standard.



Largest Choice ! Customized Irrigation Solution

Online Dripper & Spray Heads

Jain Filtration Equipment

Jain Fertigation Equipment

Jain Rainport / Micro Sprinkler

Jain PVC/PE Pipes & Fittings

Automation Equipment

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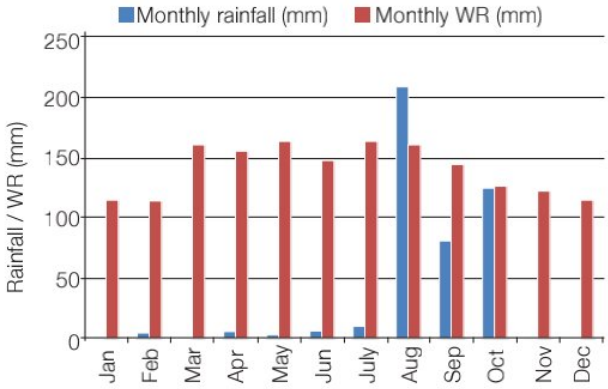
Water Requirement Of Coffee

Water requirement of Coffee is met by the monsoon rains in India. However , for a period of 6 plus months including the critical periods (March-May and September-December) rain fall is low and Crop water requirement has to be met by irrigation.

Fig. 1. Coffee water requirement (mm) from January to December and the rainfall (mm).@@



@@ Estimated WR for Wynad, in Western ghats.

Water requirement Mature yielding coffee

ET = E x 0.7 x 0.95 x 1 (mm)

- where E= Class Pan Evaporation
- 0.7 = Pan coefficient
- 0.95 = Crop factor for full leaf cover
- 1.0 = Canopy factor at full leaf cover

At peak

WR for Robusta at 3 x 3 m = 36 l/bush**

WR for Arabica at 1.8 x 1.5 m = 10.8 l/bush

** The WR changes with Pan Evaporation of the location.

Blossom Irrigation at 1 inch (as recommended)

Robusta = 222 l/bush***

Arabica = 67 l/bush

*** in drip irrigated gardens, continue dripping for 4-6 hours to completely soak the root system without allowing for run off.

Coffee fertigation

Coffee is a perennial with an annual cycle of flowering and fruiting. It also exhausts soil of nutrients. Coffee soils are highly organic due to the continuous decomposition of leaf matter available in their ecologies.

The processing of Coffee beans also returns large quantity of fruit skins and pulp obtained during the processing. For example, it is estimated that processing of 6000 kg fruits to get one ton of coffee beans, returns 15 kg N, 3.7 kg P, and 37 kg of K to the soil if it is properly composted and recycled.

However, use of only organic manure, dung or slurry or compost alone can not provide for high productivity of coffee.

According to the COFFEE GUIDE, 2000, published by Coffee Board, a ton of clean coffee of Arabica variety (6000 kg mature fruit) removes 40 kg N, 7 kg P and 45 kg K and a ton Robusta variety (5000 kg mature fruit) removes 45 kg N, 9 kg P & 58 kg K.

The COFFEE Guide , 2000, also recommends 20:20:20 kg NPK per acre for yields of 1 t per acre. For areas where yield exceeds 1.5 t/acre, the dose should be 30:30:30 kg/acre.

For every 100 kg clean coffee increase in yield a matching 10:7:10 kg of NPK /acre is to be added.

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Frequent Soil and leaf analysis for nutrient status is part of a coffee plantation management. The target leaf nutrient contents are given below.

Table 2: Target leaf nutrient content in Coffee for high production

LEAF NUTRIENT TARGETS FOR COFFEE			
N	2.6 -3.0 %	B	31-50 ppm
P	0.14 - 0.17 %	Zn	> 15 ppm
K	1.9 -2.5 %	Mn	< 200 ppm
Ca	1.2 -1.5 %	Aluminium	< 120 ppm
Fe	43- 60 ppm		

Table 3: Fertilizer Requirement for young bushes (up to 4th year)##

Coffee fertilizer requirement (young bush)				
Variety & age	NPK Dose	FERTILIZERS (g/plant/yr)		
		Urea	DAP	MOP
Arabica 1yr	20:10:20	35	22	33
2 yr	20:10:20	35	22	33
3 yr	25:15:25	41	33	42
4 yr	25:15:25	41	33	42
Robusta 1 yr	38:28:38	59	61	63
2 yr	38:28:38	59	61	63
3 yr	38:28:38	59	61	63
4 yr	40:30:40	61	65	67

##These yearly doses can be fertigated in May (50%) and August (50%).

Table 4: Fertilizer requirement for mature yielding coffee

Coffee –Arabica (5yr plus)				
Bearing bush Yield level (kg/acre)	Recommended NPK	FERTILIZERS (kg)		
		UREA	DAP	MOP
1000	120:90:120	180	196	200
500	70:50:70	104	119	116

Table 5: Fertilizer requirement for mature yielding coffee

Coffee –Robusta (5yr plus)				
Bearing bush Yield level (kg/acre)	Recommended NPK	FERTILIZERS (kg)		
		UREA	DAP	MOP
1000	120:90:130	180	196	200
500	70:50:80	104	119	134

However, in actual case, every planter uses his own fertilizer doses, mostly influenced by local fertilizer supplier and and a host of consultants who roam around the estates.

Because of the above, in this brochure, fertigation schedule is given as % of N P and K where any specific fertilizer quantity that a planter wants to apply can be accommodated. Jain Irrigation is also conducting experimental trials in collaboration with the Central Coffee Research Institute in Balehanoor, to standardize the doses and the schedule.

Table 6 : Fertigation schedule for mature yielding coffee##

	Months	N %	P %	K %
1	January	0	0	0
2	Feb 15th / March / April	25	40	15
3	May	15	30	15
	1st Fortnight of JUNE	20	0	15
4	July	0	0	0
5	2nd fort night of August	15	0	15
6	Sept /Oct /Nov/Dec	25	30	40
		100	100	100

Schedule is given in % nutrient, because the total quantum of fertilizer applied by planters vary from estate to estate. The same schedule is under experimentation in the fertigation experiments at CCRI

Bush management

Training

When the coffee plant reaches a height of 75 cm (Arabica) or 110 cm (Robusta) it is topped. This will allow for lateral spreading of the branches and increase the bearing area. Based on the soil fertility and plant vigour, a second topping is also practiced sometimes.

Pruning

Pruning of coffee is done immediately after harvest. Pruning involves ;

Centring : Removal of the vegetative growth up to 15 cm radius from the centre and up to the first node of all primary branches.

Desuckering : removal of orthotropic branches arising from the main stem.

Handling : Removal of small sprouts arising from the leaf axils which if allowed grow towards the inner side of the canopy and cause shade and become unproductive wood.

Nipping : growing tip of primary branches are nipped to allow secondary and tertiary branches.

Soil management

Digging: In a new clearing, the field is thoroughly dug to a depth of 35-40 cm towards the end of monsoon. Digging is discontinued once the coffee canopies have closed in.

Soil stirring: In established plantations, soil stirring is done towards the beginning of the dry period to control weeds and conserve moisture.

Trenching: Trenches or pits (50 cm wide and 25 cm deep) are dug or renovated in a staggered manner between rows of coffee along the contour during August- October.

Mulching: Mulching young coffee clearings helps to maintain soil temperature and conserve moisture. It also resists soil erosion.

Weed management

During the monsoon weeds are slashed back. A second weeding is done towards the end of monsoon.

Plant protection

Insect pests

1. White stem borer: Infected plants wilt and leaves become yellow. Control: Provide good shade; burn the infested plants; swab with heptachlor (50WP @ 2kg in 100 liter water).
2. Shoot hole borer: Infected plants dry up. Control: Prune and burn the affected branches.
3. Mealy bug: one of the serious pest; infection strts in few isolated bushes but spreads to others quickly. Control: Prune affected bushes; spray Folithion 50EC @ 300 ml OR Lebaycid 1000 @ 150 ml in 200 liter water.

Diseases

1. Leaf rust: Pale yellow spots on the lower surface of leaves; turn to orange yellow powdery mass; infected plants defoliate. Control: Spray Bordeaux mixture (0.5%) four times a year; pre-blossom, pre monsoon, mid monsoon, and post monsoon.
2. Black rot: Blackening and rotting of the affected leaves, twigs, berries. Control: Proper shade regulation, centering and handling of the affected bushes to prevent secondary spread, Spay 15 Bordeaux mixture.
3. Root diseases: Affected plants how gradual yellowing of leaves followed by defoliation and death of above ground parts. Control: Uprrot the affected plants and burn, dig trenches of 60 cm depth and 30 cm width to isolate the affected bushes, keep fallow for 6 months, apply organic manure 15 kg/pit.

Harvest

Coffee berries should be picked as and when they become ripe to get quality coffee. Arabica comes to harvest early, fruits taking 8-9 months for full development from flowering. Robusta takes 10-11 months.

The fruits are hand picked in India; the first picking consists of selective picking of ripe berries and is called fly picking. Thereafter there would be 4-5 main pickings at 10-15 days interval followed by the final harvest.

Shade vs Sun (open land) Coffee

The Arabica coffee, generally inhabits as the middle tier of the forest, halfway between the brushy ground cover and the taller trees. The coffee tree requires some but not too much direct sunlight; two hours a day seems ideal. The lacy leaves of the upper levels of the rain forest originally shaded the coffee tree. In many parts of the world, including Central America, Mexico, Colombia, Ethiopia, and other regions, Arabica coffee is traditionally grown in shade. However, in other parts of the world -- Hawaii, the Sumatra, Jamaica, and many other places -- coffee is not grown under shade because the weather is too rainy and wet and the coffee bushes need all the sun they can get. In Yemen and Brazil -- coffee is traditionally grown in sun (not under shade trees).

There is a tendency now of growers in regions where shade growing is traditional to replace shade-grown coffee groves with new hybrid trees that grow well in sun and bear quickly and heavily. This trend is slowly coming to the South India also. The crop husbandry of the sun grown coffee and the varieties those perform well in these conditions need to be researched and standardized. One thing , nevertheless clear, with shade trees disappearing from the Coffee environs more mechnization in Coffee growing is possible including the introduction of mechanical harvesters.

The Company

Jain Irrigation Systems Ltd. (JISL) derives its name from the pioneering work it did for the Micro Irrigation Industry in India. However, there is more to Jain Irrigation than Irrigation. Now Jain Irrigation is a diversified entity with turnover in excess of USD One Billion. We have a Pan-India & Global presence with 28 manufacturing bases spread over 4 continents. Our products are supplied to over 116 countries with able assistance from more than 6700 dealers and distributors worldwide.

Jain Piping Division is the largest producer of Thermoplastic piping systems for all conceivable applications with pipes ranging from 3 mm to 1600 mm in diameter and in pressure ratings ranging from 1.00 kgf/cm² to 16 kgf/cm² and above. JISL has a production capacity of over 5,00,000 M.T. per annum or 5000 km/day

JISL is the only manufacturer to own DSIR approved R&D setup with state-of-the-art facilities.

The pipes are manufactured confirming to IS, DIN, ISO, ASTM, TEC and other customised specifications.

The Piping Division includes Plumbing Systems, PE Pipes, PVC Pipes and Fittings catering to the urban and rural infrastructure needs of the country apart from irrigation needs of the farmers.

Micro-Irrigation Division manufactures a full range of precision-irrigation products, provides services from soil survey, engineering design to agronomic support and nurtures a sprawling 2300 acre Hi-Tech Agri Institute. It undertakes turnkey projects for total agricultural development. The division's pool of over 800 agri scientists, technologists and technicians are well equipped to render consultancy for complete or partial project planning and implementation e.g. Watershed or Wasteland and/or Crop Selection and Rotation.

Tissue Culture Division grows Grand Nain Banana plantlets and has established vast primary and secondary hardening facilities and R&D labs.

Agricultural and Fruit processing wastes are converted into Organic Manure. Neem-based pesticides are also formulated. Both are critical inputs for Organic Farming.

Agro Processed Products Division processes tropical fruits into Purees, Concentrates & Juices. The Dehydration facility dehydrates Onions & Vegetables.

Plastic sheet division's globally marketed products help conserve forests by providing alternatives to wood in the home building market.

Solar Energy Heating, Lighting Equipments, Solar Pump and Bio-Energy sources are new additions.

In a nutshell, the Corporation is the only 'one-stop-shop' encompassing manufacturing and marketing of hi-tech agricultural inputs and piping services as well as processing of agri produce. No wonder, it has distinguished itself as a leader in the domestic as well as global markets.

The corporate product range improves productivity and adds value to the agri-sector. Conservation of scarce Natural resources, protection and improvement of the environment emerge as a blessed outcome.

The Corporation has pioneered and raised a new Micro Irrigation industry in India and thereby helped harbinger a Second Green Revolution.

The reward has been over millions of smiling farmers and scores of customers in 116 countries.

Jain Drip — More Crop Per Drop®

JAIN — Jain Irrigation Systems Ltd. — *Small Ideas. Big Revolutions.®*

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Jain Drip · Jain Pipes · Jain PE Pipes · Jain Sprinklers · Jain Tissue-Culture · Jain Greenhouse · Jain Solar Pump · NUTRI CARE · NAANDANJAIN — A JAIN IRRIGATION COMPANY

Precision Farming
CASHEW
With Jain Technology™

Jain Irrigation Systems Ltd.
Small Ideas. Big Revolutions.®

More Crop per Drop | Jain Drip

Ultra High Density Cashew Plantation With JAIN Technology™

Cashew *(Anacardium occidentale),* a native of Brazil, was introduced in India during the later half of the 16th Century for the purpose of afforestation and soil conservation. Cashew has now emerged as a major foreign exchange earner next only to tea and coffee.

Commercial cultivation of cashew in India is taken up in eight states in India. It is also cultivated on small areas in other states of the country. India has an area of about 10.35 lakh ha under cashew with an estimated annual production of about 7.79 lakh tonnes of raw cashew nut. India is the largest producer, processor, consumer and exporter of cashew in the world. The current production accounts for 45% of the global production. Coastal states of the country are the main production centres. The important cashew growing states of India are Andhra Pradesh, Goa, Karnataka, Kerala, Maharashtra, Orissa and Tamil Nadu.

Cashew cultivation is taken up in small and marginal holdings and as more than 70% of the cashew area is under this category, cashew plays an important role in the development of small and marginal farmers.

Cashew is generally planted at a spacing of 8 m x 8m in square (156 trees/ha) or triangular pattern (180 trees/ha).In nutrient rich deep soils 10m x 10m is recommended in square (100 trees/ha) or triangular pattern (116 trees/ha). Jain Irrigation envisaged the idea of planting cashew in hedge- row fashion with close row to row and tree to tree spacing. In ultra-high density planting of cashew (UHDP) we planted cashew in close spacing in order to stretch the limits of potential yields, and considering the fact that yield per acre and return from Agri. / Horti. ventures are the bench-mark today for farm incomes rather than individual tree yields; we decided to maximize the yield per acre by going in for further closer spacing 3m x 2m accommodating 674 plants/acre.

Soil

The general notion is that "cashew is very modest in its soil requirements and can adapt itself to varying soil conditions without impairing productivity". But cashew performs much better on good fertile soils.

The best soils for cashew are deep, friable well drained sandy loams without a hard pan. Cashew also thrives on pure sandy soils although mineral deficiencies are more likely to occur. Water stagnation and flooding are not congenial for cashew.

Climate

Cashew is a tropical plant and thrives at high temperatures. Young plants are sensitive to frost. Areas where the with humidity temperatures range from 20 to 30 degree Celsius with an annual precipitation of 1000 - 2000 mm are ideal for cashew growing.

Heavy rainfall, evenly distributed throughout the year, is not favourable though the trees may grow and some times set fruit. It needs a climate with a well defined dry season of at least four months to produce the best yields. Coincidence of excessive rainfall and high relative humidity with flowering may result in flower/fruit drop and heavy incidence of fungal disease. Cashew is regarded as "essentially coastal tree" but that is not true. It also grows well at considerable distance from the coast.

The research in the field of crop improvement have identified elite materials with yield potential ranging between 20-25 kg per tree. Several varieties have been released by the different co-ordinating centres of ICAR. All the Agricultural Universities and Research Centres have established bud wood bank with the released varieties of respective centres, for further multiplication and distribution. However, yield per unit area remained very low. It is here that we thought of making a change; and that change is a package with do-able agronomy.

Common Varieties of Cashew

State	Major varieties
Andhra Pradesh	BPP-1, BPP-2, BPP-3, BPP-4, BPP-5, BPP-6, BPP 8 and VRI 2
Karnataka	Chintamani 1, Selection 1, Selection 2, Ullal 1, Ullal 2, Ullal 3, Ullal 4, UN 50, VRI 2, Bhaskara, Vengurla 1 and Vengurla 4.
Kerala	Anakkayam-1, Dhana, K22-1, Madakkathara 1 (E), Madakkathara 2 (L) and Priyanka (M), Vridhachalam-3, Kanaka, Dhanashree, Amrutha, Anagha, Akshaya, Sulabha, Damodar, Raghav
Madhya Pradesh	T No. 40 and Vengurla 4
Maharashtra and Goa	Vengurla 1, Vengurla 4, Vengurla 6, Vengurla 7 and Vengurla 8
Orissa	Bhubaneswar -1, Jagannath (BH-6), Balabhadra (BH-85) and VRI 2
Tamil Nadu	Vridhachalam-1,Vridhachalam-2,Vridhachalam-3,VRI 4,VRI(CW)H1
West Bengal	Jhargram-1, Jhargram-2
Goa	Goa-1 & Goa-2

Preparation of Land

Land with drainage and devoid of sub-surface hard rock or hard pan, is good for successful cultivation of cashew. The land should be ploughed thoroughly and levelled in case of agricultural lands. Pits of 1 m^3 are to be dug and allowed to wither.

Planting material

Cashew is a cross pollinated crop and exhibits wide variations in respect of nut, apple and yield of seedling progenies. Therefore, vegetative propagation has been advocated to mitigate this problem.

Air-layering has been quite successful but survival percentage seems to be low and it has been reported that the plantations raised from air-layers are more susceptible to drought and the life of such plantation is shorter as compared to that of grafted or seeding ones. The anchorage has also been observed to be poor, especially in cyclone prone areas. Number of other methods of propagation such as budding and grafting have been found successful with varying degrees of success.

Epicotyl grafting and softwood grafting are found to be successful because it is easy to produce large number of grafts in a short time. Softwood grafts are preferred for UHDP. 8-12 month old grafts are best for planting.

Ultra High Density Cashew Planting

In UHDP method cashew trees are planted at 3m x 2m spacing (674 trees /acre). We also recommend planting at 4m x 2m (500 trees/acre) 4m x 3m (337 trees/acre) or 5m x 4m (202 trees/acre) wherever labour availability for pruning operations is a challenge.

Pit size of 1m x 1m x1 m is dug and filled with 15 kg organic manure, 200 gm neem cake, 100 gm Single Super Phosphate, along with native soil.

The grafted plants obtained from the superior mother plant are usually planted after filling the pits at the onset of monsoon.

It is essential to provide stakes and temporary shade with the locally available materials wherever necessary to reduce the mortality rate and achieve quicker establishment.

If the monsoon rains are inadequate, irrigation is essential during the initial stages to ensure establishment.

Mulching with black polythen or weed mat is beneficial to increase the growth and yield of cashew.

Irrigation of Cashew

Cashew is generally grown as a rain-fed crop; but in UHD plantations, drip irrigation is an essential intervention. In drip- fertigated orchards, cashew is found to double the yield. Research at National Research Centre (NRC), Cashew has shown the benefits of irrigation in cashew production. However Cashew can not withstand water stagnation and logging. Critical period for irrigation is from flower initiation to fruit set.

Water requirement of UHDP Cashew

Table 1: Irrigation schedule for ultra-high density (UHDP) Cashew. Figures are in l/tree/day estimated for 3x 2 m tree spacing based on the evaporation of the location.

Month	Evaporation (mm)	1st yr	2nd yr	3rd yr	4th yr and onwards
Jan	4.6	0.63	2.53	5.69	10.12
Feb	5.9	0.80	3.21	7.21	12.82
March	7.29	1.00	4.00	8.99	15.98
April	6.69	0.89	3.55	7.99	14.21
May	7.54	0.94	3.76	8.45	15.03
June	7.45	1.01	4.05	9.12	16.21
July	7.47	1.03	4.11	9.24	16.43
Aug	7.84	1.09	4.35	9.78	17.39
Sept	7.78	0.96	3.84	8.64	15.35
Oct	4.74	0.55	2.21	4.97	8.83
Nov	3.84	0.59	2.35	5.28	9.39
Dec	3.9	0.58	2.33	5.25	9.33
Average	6.02	0.93	3.73	8.39	14.92

The quanta of irrigation will vary with age (crop factor), Canopy size (Canopy factor), location (Evaporation rate). Growers wanting to practice drip irrigation should get this schedule from Jain Irrigation Agronomist.

Drip system layout

- Online drip system is suitable for cashew.
- Drip laterals are spaced according to the tree spacing (3m).
- Each tree is provided with 4 (4 lph) drippers placed around the tree using extension tubes. In UHDP because of close plant to plant distance, inline drip line is also suitable with 4 lph emitters at 50 cm distance.
- For older trees (plus 5 year) two drip lines are to be placed one on either side of the trunk If necessary.
- The drip lines are to be placed 0.5 m away from the trunk.

Fertilizer application

Table 2: The nutritional requirements are given below :

Nutrient	g/tree/year		
	1 year	2 year	3 year & after
N	250	500	750
P_2O_5	108	217	325
K_2O	250	500	750

Fertigation

Table 3. Fertigation schedule(kg/acre/dose) for the 3 x 2m.

Year	Schedule	Urea Kg/ac	Phosphoric Acid Kg/ac	MOP Kg/ac
1	12 doses, weekly once (July-Sept)	1.1	0.5	0.3
	20 doses, weekly once (Jan-May)	1.3	0.5	0.3
2	12 doses, weekly once (July-Sept)	2.3	0.9	0.6
	20 doses, weekly once (Jan-May)	2.5	1.0	0.6
3	12 doses, weekly once (July-Sept)	3.4	1.4	0.9
	20 doses, weekly once (Jan-May)	3.8	1.5	1.0
4	12 doses, weekly once (June-Aug)	6.5	2.6	1.7
	4 doses, weekly once (Sept)	5.9	3.9	1.5
	12 doses, weekly once (Jan-March)	4.6	1.3	1.2
5	12 doses, weekly once (June-Aug)	8.1	3.3	2.1
	4 doses, weekly once (Sept)	7.3	4.9	1.9
	12 doses, weekly once (Jan-March)	5.7	1.6	1.5

Weeding

Timings of weeding are very important to minimise the cost. Weeding with a light digging should preferably be done before the end of rainy reason. Hoeing, cutting the weeds off underground , is more effective than slashing.

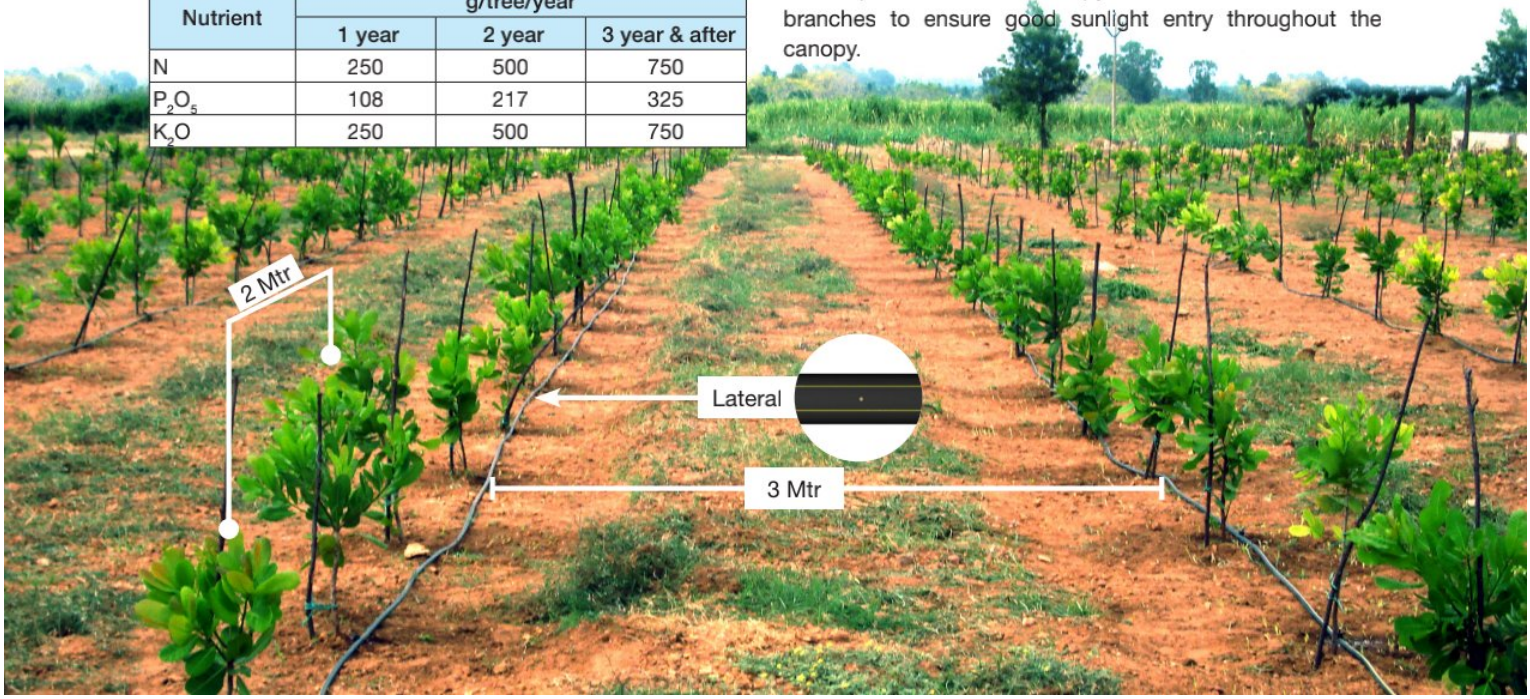
Chemical weeding may be considered as an alternative, where wages are high or where there is shortage of labour.

Canopy Management by Training and annual Pruning

The grafts planted have to be trained to get a single stem up to 45-50 cm from the ground. Primary branches to be initiated by heading back main stem at 45-50 cm height. After 3-4 month of first heading back primary branches to be cut after 30-40cm length from main stem to initiate secondary branches. After 2-4 months of growth secondary branches to be cut at 35-40 cm to initiate tertiary branches.

Annual pruning is done after harvest to remove excess growth, to keep tree within its provided space and to initiate more numbers of new shoots per unit area of canopy.

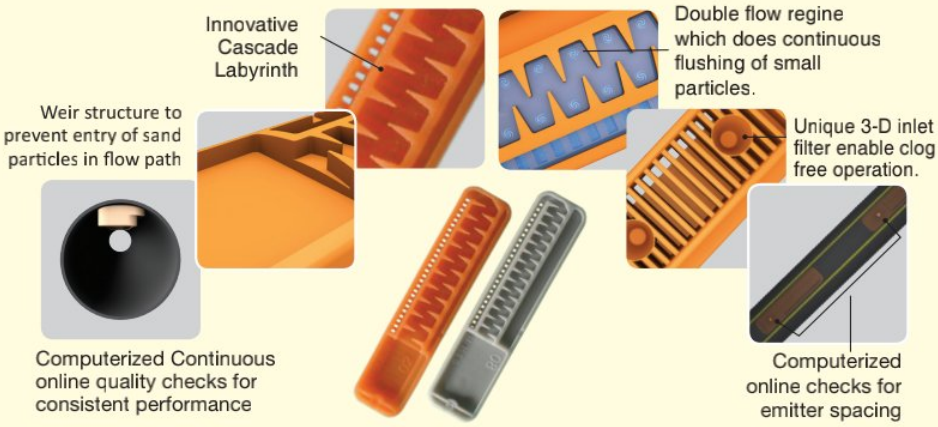
Pruning is done after harvest to initiate more numbers of shoots per unit area of canopy and to remove criss-cross branches to ensure good sunlight entry throughout the canopy.



ONE STOP SHOP for Your

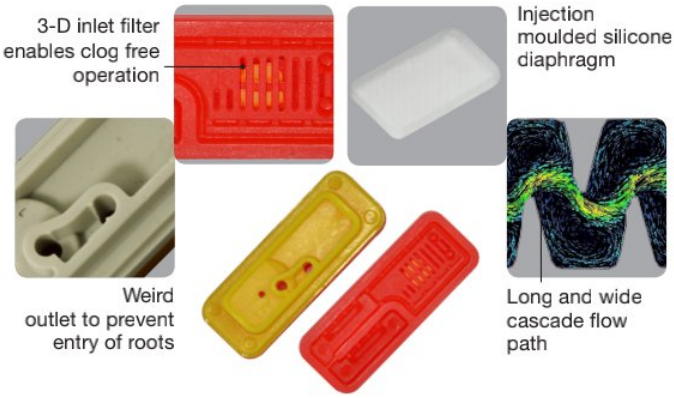
Jain Turbo Excel® - एक बेमिसाल आविष्कार!

- All our Drip Lines are Five Star rated from worlds reknowned institute IRSTEA (Cemagref), France.
- Available discharge rates - 0.85, 1.2, 1.6, 2.1, 4 lph @ 1kg/cm².
- 12, 16, 20, 25 mm nominal diameter.
- Dripper Spacing 15, 20, 30, 40, 50, 60, 75,90 cms.



Jain Turbo Top™ - सबसे आगे! सबसे टॉप!

- Available discharge rates – 1.1 & 1.6, 2.0, 2.2 lph
- Injection moulded silicone rubber compensates with pressure and discharge gives uniform performance.
- Anti Siphone feature (optional) prevents suction of sand and silt particles inside the dripper, used for Subsurface Irrigation.
- Cascade labyrinth gives strong, self-cleaning turbulence. Prevents Clogging.
- Available in 16 & 20mm nominal diameter. (12, 16 & 20 mm in Thin Wall option)
- Suitable for surface as well as subsurface installations.
- Operating pressure range 0.4 to 4 kg/cm².

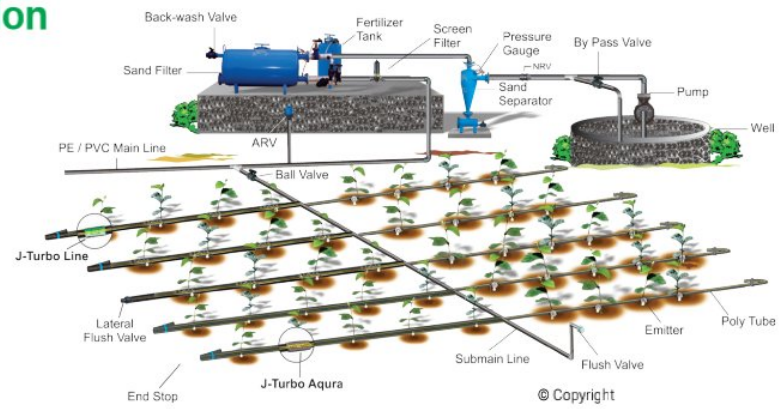


Why Jain Drip Irrigation ?

Water is not the only need of the plant. To uptake this water efficiently, it requires proper air-water balance within the root zone. Drip irrigation, with its low application rate, prevents the saturation of water within the root zone and continuously maintains field capacity. This provides a favorable condition for the growth of the plant. Drip irrigation also helps to use fertilizer efficiently. With drip irrigation water can be provided at frequent intervals which helps maintain required soil moisture level within the vicinity of the plant roots. Jain is the pioneer of drip irrigation. Ours is the only company in the world, which fulfills your entire irrigation system requirement under one roof.

Characteristics of drip irrigation

1) Water is applied at a low rate to maintain optimum air-water balance within the root zone.
2) Water is applied over a long period of time.
3) Water is applied to the plant and not to the land.
4) Water is applied at frequent intervals.
5) Water is applied via a low pressure network.

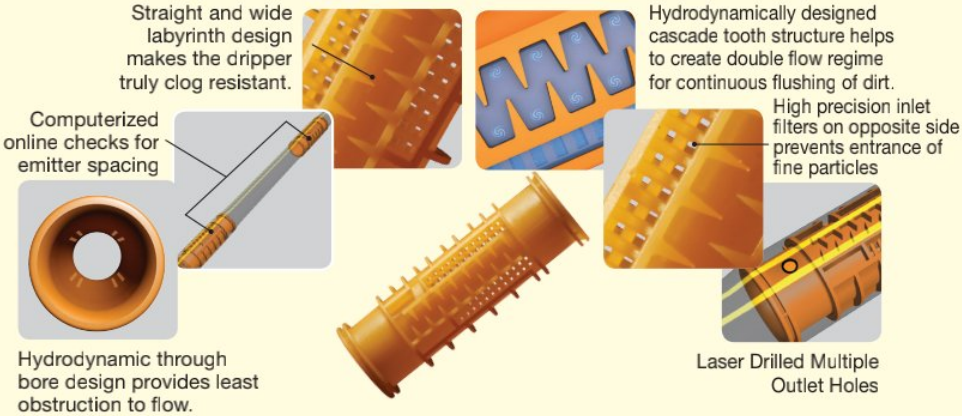


Jain Drip
More Crop Per Drop®

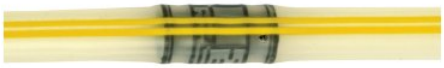
Micro Irrigation Needs

J-Turbo Line® Super - सर्वश्रेष्ठ कार्यक्षमता!

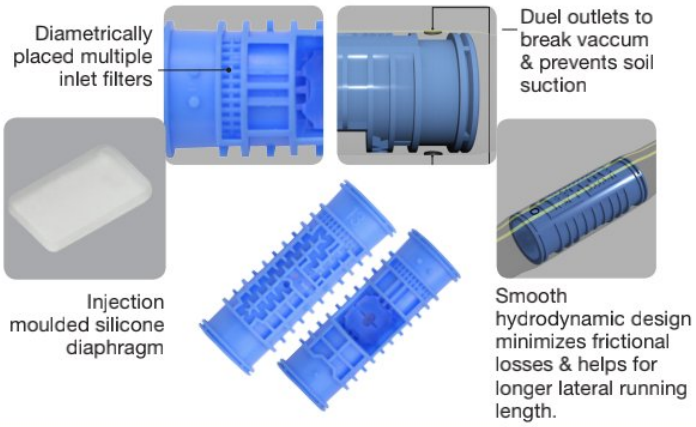
- Available discharge rates (at 1kg/cm²)
  12mm - 2.2, 4 lph
  16mm - 4, 8 lph
  20mm - 2.2, 4, 8 lph
- Availabe in 12, 16 & 20 mm nominal diameter.
- Suitable for surface as well as subsurface installations.



Turboline PC® - उच्च तकनीक – किफायती विकल्प!



- Available discharge rates - 16 mm =1.1, 1.6, 2.2 & 3.5. 20 mm = 0.9, 1.6, 2.2 & 3.8 lph within pressure regulation range of 0.7 to 3 kg/cm².
- Injection moulded silicone rubber compensates with pressure and discharge gives uniform performance
- Application on undulating land/ Terrains/ Steep slopes.
- Available in 16 & 20 mm nominal diameter.
- Suitable for surface as well as sub-surface installation.
- Application where ever longer lateral length is necessary.
- Conforming to IS 13488, ISO 9261 Standard.



Widest Choice ! Customized Irrigation Solutions

Online Dripper & Spray Heads

Jain Filtration Equipment

Jain Fertigation Equipment

Jain Rainport / Micro Sprinkler

Jain PVC/PE Pipes & Fittings

Automation Equipment

Jain® Drip
More Crop Per Drop®

Primary and secondary branches

Tertiary and Fruiting branches

Almost 95% branches facing the Sun

Management of insect Pests and Diseases

Insect Pests: Some 30 species of insects infests cashew. Out of these tea mosquito, flower thrips and stem and root borer and fruit and nut borer are the major pests, which are reported to cause around 30% loss to the yield.

Tea Mosquito

The nymphs and the adults of tea mosquito suck sap on the tender leaves, shoots and inflorescence and even young nuts and apples.Tea mosquito population builds up during the beginning of the rainy season, when the cashew tree is full of new flush.

Tea mosquito can be controlled by spraying quinalphos 0.05% (2 ml/lit) or profenofos 0.05% (1 ml/lit) or chloripyriphos (2.5 ml/lit) or thiamethoxam (0.2 gm/lit).

Spraying should be done thrice, first at the time of flushing, second at early flowering and third at the time of fruit set.

Thrips

Both nymphs and adults suck and scrape at the underside of the leaves, mainly along main veins, causing yellowish patches, latter turning grey, giving the leaves a silvery appearance. These thrips are more active during the dry season.

Spraying 0.05% monocrotophos or Dimethoate 1.6 ml/lit are very effective for controlling thrips.

Stem and Root Borers

The young white grubs bore into the fresh tissues of the bark of the trunk and roots and feed on the subsequent sub-epidermal tissues and make tunnels in irregular directions. Due to severe damage to the vascular tissue the sap flow is arrested and the stem is weakened. The characteristics symptoms of damage include the presence of small holes, in the collar region, gummosis, yellowing and shedding of the leaves and drying of the twigs. Complete control of this pest once the plant is infested is very difficult.

Prophylactic measures for its control can be adopted by swabbing the trunk up to 1 meter from the ground with coal tar + Kerosene mixture (1:2) or Neem oil 5 % (50 ml/lit) twice a year during March –April and November- December.

Uproot the dead trees in the field and destroy.

Swab the bark of the infested shoots and roots with Chlorpyriphos 20 EC (0.2 per cent @10 ml/lit),further drenching the same solution on the soil near root zone to minimize the reinfestation of this pest.

Fruit and nut Borers

The young caterpillar bores through the apple and nut causing deformity and /or loss of kernel weight.

Spraying of monocrotophos 0.05% concentration at flowering and fruit setting is recommended.

Diseases

Cashew crop does not have any serious disease problem, except the powdery mildew caused by fungus, which affects the young twigs and inflorescences and make it wither.

This disease generally appears when the weather becomes cloudy. Control can be obtained by dusting with 2% sulphur W.P.

Die Back

Symptoms like drying of twigs from the tip .Prune the affected shoots just below the affected portion and apply Bordeaux paste. Spray 1 % Bordeaux mixture or any copper fungicide like Blitox or Fytolan 0.25 % twice i.e. in May - June and again in October as a prophylactic measure.

Harvesting and Yield

Normally harvesting consists of reaping the nuts that have dropped to the ground after maturing. If the apples are also used for making jam, juice, syrup, fenni, etc., the fruit has to be harvested before it falls naturally.

In UHDP plantations, with the use of elite planting material coupled with a package of improved agronomic practices, and drip fertigation; an yield of 2-4 kg per tree (1.2 to 2.4/ acre) could be achieved.

Cashew varieties responded to Ultra high density and yielded very early. The crop also responded to fertigation resulting in 4 times yield compared to that in conventional soil applied fertilizer.

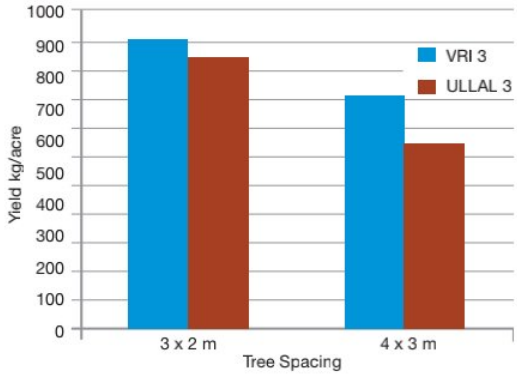


Fig 1. The very high yields of Cashew nut under 3x 2 m UHDP in two varieties

Pruning

UHDP Cashew at flowering and fruiting.

UHDP Cashew Fruits

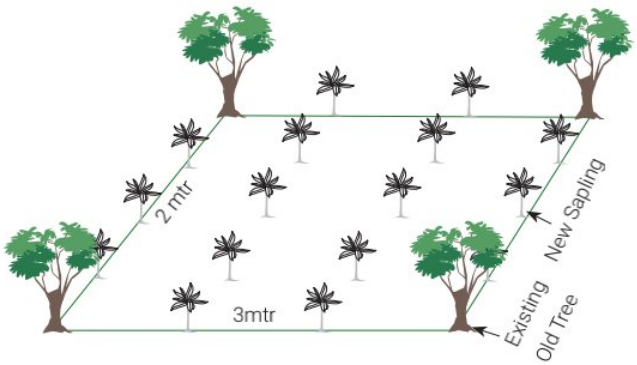
Table 4: yield of cashew kg/acre for two varieties from 2012 to 2016 in 3 x2 m UHD Plantation.

Year/ Variety	2012 (3rd yr)	2013	2014	2015	2016 (7th yr)
VRI 3	910	1004	1078	1045	1091
ULLAL 3	863	890	998	923	910

Top working and conversion of old pantation to UHDP

- Boosting cashew production 3-4 folds in a short span of time is perhaps possible only by top working the existing plantations and grafting with high yielding varieties.
- The rejuvenation of unhealthy cashew trees through top working involves beheading of trees, allowing juvenile shoots to start-out and taking up of in-situ grafting using procured scions of high yielding varieties.
- Trees are top worked during November to March and in situ grafting is done in February to June.
- It has been observed that the top worked trees within a period of two years have not only put forth a canopy of 3-4 m in diameter and 5-6 m in height (as that of 8-10 year old trees)
- An yield of 3 to 5 kg nuts per tree is obtained after top working in their first bearing itself.

UHD Cashew Converted from Old Traditional Orchad
Spacing app. 3m x 2 m



Marketing

Marketing of cashew is not a problem. The raw material production is considerably low (around 2.60 lakh tonnes) when compared to the processing capacity of our existing factories (around 4.5 lakh tonnes developed so far).

Benefits of UHDP Cashew

- Double the yield.
- Reduces water used for irrigation by up to 50%.
- Increased fertilizer uptake by plants when fertigation is practiced. Increased fertilizer use efficiency through fertigation.
- Consequently a reduction of up to 30% of applied fertilizer from the recommended dose is possible.
- Reduces NO3-nitrogen leaching (thereby nitrate pollution) by 50% when fertigation is practiced.
- Controls weed growth as water is applied only to the root zone.
- Allows for intercropping during the early years.

Benefits of UHDP cashew to farmer

- Very low gestation period.
- Early realization of income.
- Suitable for small, medium and semi-large farmers as its management is intensive and yields good quality fruits which can get better market price.
- It makes sensible bankable project to get financial support due to assured high early returns.

Dos

- Ensure good drainage in the field.
- Adopt drip method of irrigation.
- Prepare pits and fill it with the mixture as recommended.
- Compulsorily apply organic manure as per recommendation
- Select high yielding, disease and pest tolerant variety suitable for each location.
- Practice drip irrigation from the beginning of of the orchard.
- Irrigate with drip strictly following the schedule given by the engineer.
- Follow the drip system maintenance schedule given by the engineer.
- Compulsorily weed/ inter-cultivate, timely operation helps in crop growth.
- Follow fertigation schedule as given by the engineer.
- Follow the precautions while operating the drip system as explained by the engineer.
- Apply micronutrient as and when needed.
- Practice pruning and canopy management with a timely schedule
- Follow disease and pest control measures timely and effectively.
- Apply sprays in the evening or early morning only.

Table 5: Cost of establishing an UHDP cashew orchard

Particulars	Cashew	1st year	2nd year	3nd year	4th year	5th year
	Per Plant	Rs/Acre	Rs/Acre	Rs/Acre	Rs/Acre	Rs/Acre
Graft	35	23590	2360	0	0	0
Pit marking	2	1348	0	0	0	0
Pit Digging	23	15502	0	0	0	0
Organic manure shifting and pit filling	10	6740	0	0	0	0
Remarking	1.5	1011	0	0	0	0
Planting	3	2022	0	0	0	0
Staking	3	2022	0	0	0	0
Organic manure		10110	3370	3370	6740	6740
Weeding	4.5	3033	5055	5055	5392	4044
Training /Canopy of trees	0.25	337	674	2022	3370	3370
Fertilizers Total	-	722	1479	2313	3122	3842
Plant Protection	-	250	1000	2500	3000	3000
Labour costs (Spraying,staking,irri.maint.	-	2125	3000	4500	6000	6000
Interculture operations (Tractor)	-	600	600	600	750	750
Harvesting cost @Rs.10 per Kg	-	0	0	3000	6000	10000
Total Expenses	-	69412	17538	23360	34374	37746
Gross yield (kg /ac)	-	-	0	300	600	1000
Gross Income /ac @ Rs.125/ kg	-	-	-	37500	75000	125000

Don'ts

- Don't over irrigate the crop at anytime.
- For fertigation don't mix solid fertilizers and dissolve them together. Prepare individual solutions and mix them for application.
- Don't spray the crop under hot sunlight.
- Don't make a fire in the field with Drip system.
- Don't use the fertigation unit for bulky organic manure and fertilizers that are not soluble in water
- Don't add solid fertilizer from the bag directly to the fertilizer tank. Prepare solution separately and pour the solution to the fertilizer tank. Prepare solution only in plastic buckets. Don't use metal container.
- Don't stir the solution with naked unprotected hand. Use wooden spoon or stick.
- Don't heat the fertilizer solution to increase solubility.

Frequently asked questions (FAQ's)

1) Does Cashew require irrigation?
Normally cashew is rain-fed but the climatic and soil conditions where cashew is grown impose high Evapotranspiration demand. Drip irrigation is essential for higher productivity of cashew.

2) Whether the meagre quantity of water supplied through drip irrigation is enough?
Irrigation rate in Drip method is estimated based on the Evapotranspiration of the location and therefore it is enough. A wetting depth and wetted area of 40% is sufficient for Cashew production.

3) In drip method water is applied to the surface of the root system at a very low rate. Whether this will cause root accumulation near the surface and thereby the tree may fall in the long run?
In trees like cashew, only the absorptive roots are located near the surface and get directed by moisture and nutrient availability. The anchor roots penetrate into deeper soil layers and provide stability for the tree.

4. Can I prefer Impact Sprinkler method of irrigation for cashew?
Large Impact sprinklers are not suitable as it spreads water in the inter-tree spaces and the trunk of the trees will obstruct the spray jet from the sprinklers and thus affect the uniformity of irrigation. Moreover wastage of water per irrigation will be high. Sprinkler irrigation also will create the favorable environment for pests and diseases.

5. Can I take an intercrop with irrigation?
Yes. Till the canopies of cashew cover the inter-space intercropping is possible. But provide additional drip line for the intercrop. In old orchards intercropping is possible after top working for the next 2 years.

Jain Drip More Crop Per Drop® | JAIN Jain Irrigation Systems Ltd. Small Ideas. Big Revolutions.® | More Crop per Drop
Jains Mobile App
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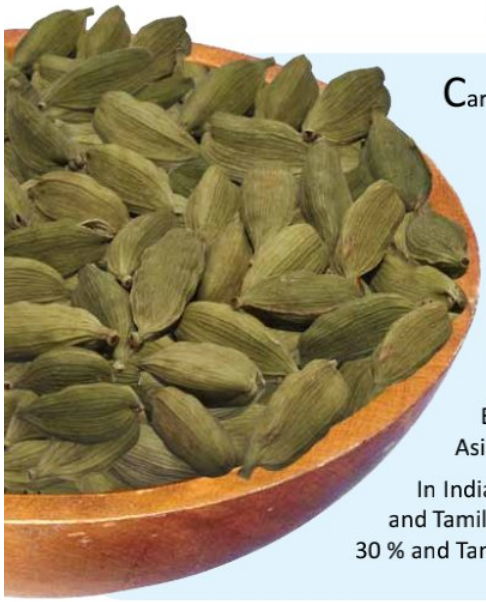
Toll Free: 1800 599 5000

Precision Farming
CARDAMOM
With Jain Technology™

Jain Irrigation Systems Ltd.
Small Ideas. Big Revolutions.®

HIGHTECH CULTIVATION OF CARDAMOM



Cardamom (Elettaria cardamomum Maton) known as the "Queen of Spices" originated in the Western Ghats of South India. It is one of the most highly priced and exotic spices in the world.

The total world production of this spice is around 35,000 MT per annum and the largest producing country is Guatemala followed by India. Tanzania, Sri Lanka, EL Salvador, Vietnam, Laos, Cambodia and Papua New Guinea are the other cardamom growing countries. Cardamom is used for flavoring various food preparations, confectionary, beverages and liquors. It is also used for medicinal purpose, both in Allopathy and Ayurveda systems. The major consuming countries of cardamom are the Middle Eastern countries, India, Pakistan, European countries, the U.S and Japan. Middle Eastern countries such as Saudi Arabia and the United Arab Emirates, and South-East Asian countries such as India account for more than 60 % of the world's consumption.

In India, Cardamom cultivation is confined mainly to the Western Ghats of Kerala, Karnataka and Tamil Nadu. Kerala accounts for 60% of the cultivation and production followed by Karnataka 30 % and Tamil Nadu 10 %. Idukki district in Kerala is the major cardamom producing area.

Habit

It is a perennial tropical herbaceous plant. Cardamom requires a wet humid rainfall regime. Hence, along with the year-to-year fluctuations in rainfall-both its quantum and distribution-the output and productivity of cardamom also shows considerable year-to-year fluctuations.

Climate

- Cardamom is usually cultivated in rain-fed conditions, under forest cover and is sensitive to micro-climatic conditions and moisture stress.
- Requires evenly distributed rainfall of 1500- 4000mm/ year.
- The optimum altitudinal range for growing cardamom is 600 to 1200 meters above MSL.
- A temperature range of 10-35°C is ideal for cardamom

Soil

- Cardamom grows well in forest loamy soils
- Soil pH: 4.2 to 6.8.
- Soil nutrient status: High in organic matter and nitrogen, low to medium in available phosphorus and medium to high in available potassium.

Varieties

Two varieties of cardamom plants are identified, and they are Elettaria cardamomum Maton, variety Major composed of wild indigenous types of Sri Lanka and Elettaria cardamomum Maton, variety Minor comprising of cultivars like, Mysore, Malabar and "Vazhukka".

These types are grown in different tracts and are mostly identified on the nature of panicles, size of plants and other morphological characters.

Cardamom varieties are highly location specific. High yielding varieties of cardamom released include ICRI 1, 2, 3; TDK 4 &11; PV 1, CCS 1 Mudugiri 1&2; NCC 200; MCC 12, 16 &40; RR1

Planting Material

Seedlings or suckers.

Nursery Management

Seedlings can be raised in nurseries.

Primary Nursery

- Sowing is done on beds of 1 m width, 20 cm height and 6 m length.
- Sowing time is September.
- Before sowing fumigate the beds with 2 % formalin to eliminate pathogens and other soil pests.
- Seeds collected from high yielding and disease free mother clumps should be washed and mixed with wood ash and dried in shade.
- Storage of seed will reduce germination rate.
- Seed treatment with acid or other chemicals improves germination.
- Best time for sowing is September and sowing in winter and during south west monsoon should be avoided.
- Seed rate is 30 to 50 g per 6x1 m bed.
- Sowing can be done in lines in rows at a distance of 10 cm.
- Irrigate with low impact micro sprinklers.

Secondary Nursery

- Seedlings of three to four leaf stages from the primary nursery beds can be transplanted in the secondary nursery at a distance of 20-25 cm.
- Irrigate with low impact micro sprinklers or Jain Acumisters.
- Planting in main field is done during last week of May or first week of June

Vegetative Propagation

- For vegetative propagation, rhizomes with not less than three shoots are used.
- Vegetatively propagated plants come to bearing one year earlier than the seedling-propagated plants.
- But this method has the disadvantage of spreading the 'katte' disease, which is of viral origin.
- This disease is not transmitted through seeds.
- Hence in areas where the disease is widespread, it would be safer to use seedlings for propagation.

Field Planting

- Trenches of 0.45 m width and 0.45 m deep and convenient length are to be taken at 1.8 m apart.
- Fill the trenches with equal quantity of humus rich top soil, sand and cattle manure

Cultivation Practices

For planting in new area

- Ground should be cleared or if it is replanting area, old plants should be removed.
- Shade regulation, Terracing and Preparation of pits should be done during summer months.

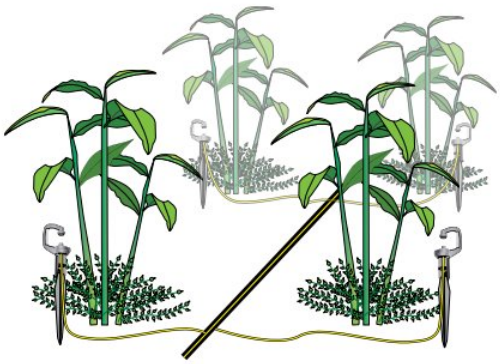
Major cultivation practices include

- Shade regulation,
- Field preparation,
- Planting,
- Weed control,
- Irrigation,
- Forking
- Mulching,
- Trashing &
- Earthing up.
- The plant to plant spacing recommended for Mysore and Vazhukka cultivars are 3x3 m or 2.4x2.4 m
- Recommended spacing for Karnataka region is 1.8 x 1.8 m or 1.2x1.8 m.
- Plant base should be mulched well with dried leaves to protect soil from erosion and conservation of moisture.
- Planting should be done diagonally to the slope.
- Irrigation during summer months ensures increase in yield by 50 %.

Micro Irrigation of Cardamom

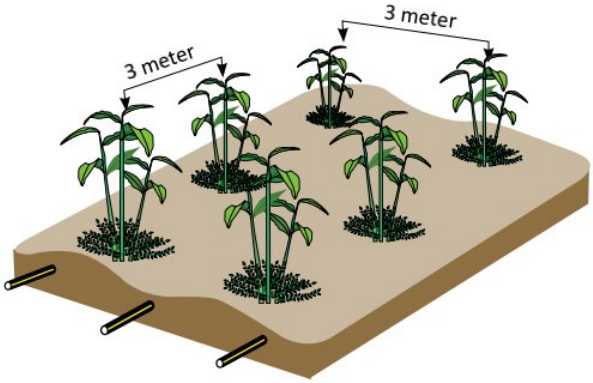
Cardamom requires irrigation even in wet tropical region receiving copious monsoon rain. The period from October to June first week is rainless and even during the monsoon (June- September) period irrigation is required during the breaks in the rainy season. Traditionally, Cardamom clumps (groups of plants originating from one seedling) were irrigated by pot irrigation or hose irrigation methods. Almost all of the cardamom is grown on slopes with plenty of shade trees amongst them furrow or channel irrigation method is impractical. Impact sprinkler irrigation, though practiced in some areas is found to be less efficient and does not give facility for fertigation and also enhances weed growth in the inter-clump spaces.

Mist irrigation using very fine misters (Jain Acumister)



Acumisters are installed on PVC risers (1m tall) and connected to the water carrying Lateral tubes through 8 mm micro tubes. Each clump will have one acumister placed at its centre (Photographs).

Subsurface drip irrigation; (Cardamom SDI)



Inline lateral tubes with drippers fitted at every 50 cm is placed at 20 cm below the soil surface on the sides of the clumps, as shown below in the drawing. The laterals are installed subsurface in order to facilitate the forking operation done in the inter-clump spaces. Drip lines on the surface will obstruct this important operation.

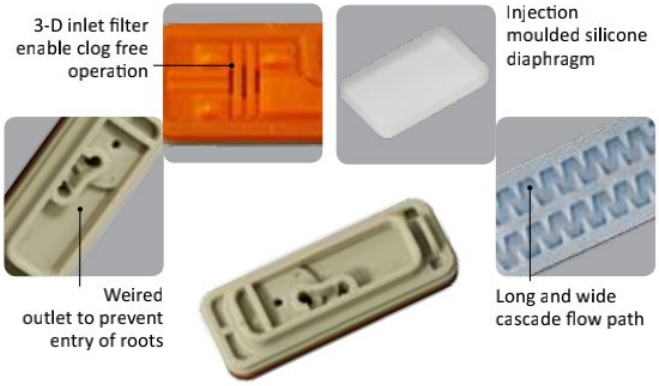
Jain Sprinklers
More Crop Per Drop®

J-Turbo Aqura®

- Available discharge rates - 0.8, 1.3, 1.6, 2.4 & 4 lph at 1 kg/cm².
- Clog resistant dripper
- Availabe in 12, 16 & 20 mm nominal diameter.
- Suitable for surface as well as subsurface installations.

Jain Turbo Top™

- Available discharge rates – 1 & 1.6 lph
- Injection moulded silicone rubber compensates with pressure and discharge gives uniform performance.
- Anti Syphone feature (optional) prevents suction of sand and silt particles inside the dripper.
- Cascade labyrinth gives strong, self-cleaning turbulence.
- Available in 16 & 20mm nominal diameter.
- Suitable for surface as well as subsurface installations.

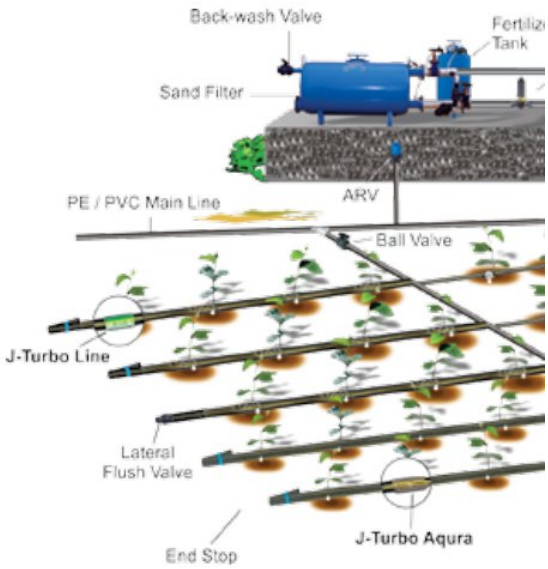


Why Jain Drip Irrigation ?

More Crop

Water is not the only need of the plant. To uptake this water efficiently, it requires proper air-water balance within the root zone. Drip irrigation, with its low application rate, prevents the saturation of water within the root zone and continuously maintains field capacity. This provides favorable condition for the growth of the plant. Drip irrigation also helps to use fertilizer efficiently. With drip irrigation water can be provided at frequent interval which helps to maintain required soil moisture level within the vicinity of the plant roots.

Jain is the pioneer of drip irrigation. Ours is the only company in the world, which fulfills your entire irrigation sytems requirement under one roof.



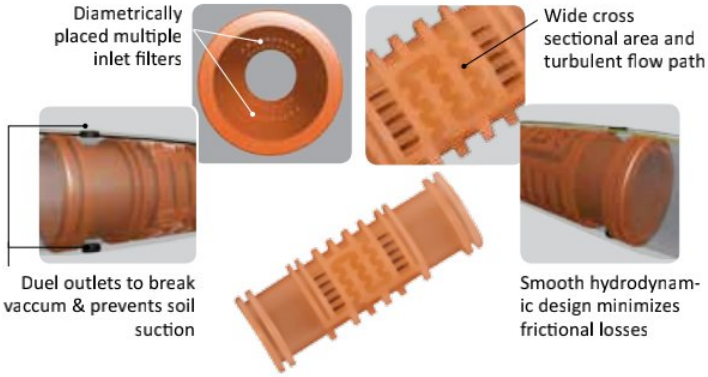
Characteristics of drip irrigation:

1. Water is applied at a low rate to maintain optimum air-water balance within the root zone.
2. Water is applied over a long period of time.
3. Water is applied to the plant and not to the land.
4. Water is applied every day equivalent to Evapotranspiration of the day.
5. Water is applied via a low pressure delivery system.

Jain® Drip
More Crop Per Drop®

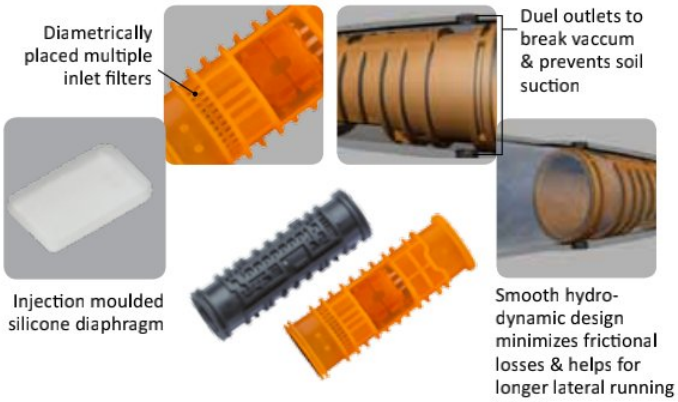
J-Turbo Line® & J-Turbo Line Deluxe

- Available discharge rates - 2.4, 4 lph at 1 kg/cm² Pressure.
- Cylindrical shape permits wide flow path cross section along with multiple inlet filter improves clog resistante.
- J-Turbo Line Deluxe model is provided with innovative, clog resistance cascade labyrinth.
- Available in 12,16 & 20 mm nominal diameter.
- Suitable for surface as well as subsurface installation.

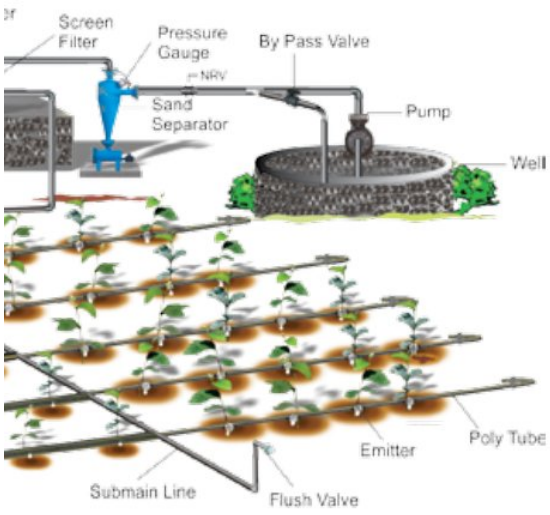


Turboline PC®

- Available discharge rates - 1.3, 1.6, 2.6 & 4.5 lph at 1 kg/cm² Pressure.
- Injection moulded silicone rubber compensates with pressure and discharge gives uniform performance
- Application on the undulating land/ Terrains/ Steep slopes.
- Applicatiion where ever longer lateral length is necessary.
- Available in 16 & 20 mm nominal diameter.
- Suitable for surface as well as subsurface installation.



Per Drop®



Advantages of Jain Drip Irrigation

- Increase in yield from 50 to 200%.
- Acts as a catalyst to achieve the highest potential yield of the crop.
- Improved quality, uniformity in grain size and fruit size.
- Early maturity of the crop. Early in the market, higher is the price.
- Minimized fertilizer loss due to localized application and reduced leaching.
- High water application efficiency – Water saving up to 70% .
- Reduction in manpower requirement.
- Saves Energy upto 50%.
- Control over weed growth and reduction in weedicide expenses.
- Improved disease control.
- Difficult and undulating terrain can be irrigated efficiently.
- Ideal for saline/alkaline soil conditions.
- No soil erosion.
- Technology for social justice & equity
- Efficient tool to overcome the challenges of water security, food security and energy security for the nation.

Jain® Drip
More Crop Per Drop®

In SDI irrigation and fertigation can be done with a minimum of one labour for the entire plantation.

Month	Pan E mm	l/ ha	l /clump/day
January	3.5	27222	27.2
February	4.1	31889	31.9
March	4.4	34222	34.2
April	3.7	28778	28.8
may	3	23333	23.3
June	3.3	25667	25.7
July	2.7	21000	21
Augest	2.4	18667	18.7
September	3.2	24889	24.9
October	3	23333	23.3
November	2.6	20222	20.2
Decmber	2.4	18667	18.7

** The above irrigation schedule is estimated for Idukki district. The quantum of irrigation will differ if pan E varies.

These estimates are for 5 yr plus clumps. For newly planted seedlings irrigation of 6 l /seedling is enough till the clump is established.

In the mist irrigation an average of 10-20 liter of misting is recommended daily depending on the diameter of the clump. This has to be given in two or three spurts in a day.

Fertigation

Fertigation is easily done in SDI either daily, alternate days or weekly doses; depending upon the readiness of the grower.

Preliminary studies have shown that 52 equal weekly doses of N and K has helped in improving yield of cardamom.

Fertigation schedule

Fertilizer recommendation	150 N: 150 P: 300 K (kg/ha) for full year.
Schedule of Fertigation	52 weekly doses
Fertilizer per dose per ha	4.21 kg UREA per ha/ week; 4.7 kg MAP per ha/week; 9.6 kg MOP per ha/week

Entire plantation and particularly the plant base are to be kept under mulch.

Plant base has to be mulched at a thickness of 5-10 cm.

Crop hygiene

Remove old tillers, dry leaves and leaf sheaths once in a year.

Disease Management

Nursery Diseases

Nursery Leaf Spot (Phyllosticta elettariae)

Mostly appear during February-April months. Small round or oval spots appeared as dull white in colour.

Treatment : Spray Difolatan or Foltaf (Captafol) 0.2 % or with Dithane M-45 (Mancozeb) or Indofil M 45 0.3 % .

Nursery Leaf Spot (Cercospora zingiberi)

Yellowish to reddish brown coloured rectangular patches seen on the lamina.

Treatment : spray Difolatan or Foltaf (Captafol) 0.2 % or with Dithane M-45 (Mancozeb) or Indofil M 45 0.3 %.

Nursery Leaf Rot

Development of water soaked lesions on the leaves which results in decay of affected areas

Treatment : Avoid excessive watering of seedlings. Spray 0.3 % Dithane (Mancozeb) twice at 15 days interval.

Damping off or Seedling Rot

It appears in germination nursery due to excessive soil moisture.

Treatment : Avoid overcrowding of seedlings. Provide adequate drainage facilities and remove affected seedlings

Clump Rot (Rhizome Rot)

This disease occurs in mature seedlings (6 to 18 months old) due to excess soil moisture. Uproot and destroy all the affected seedlings in the nursery

Treatment : Irrigate with micro sprinklers and scheduling of irrigation to avoid excess of soil moisture.

Drench the nursery beds with Copper oxychloride (COC, 0.3%) at the rate of 3 to 5 litres/m².

BENEFITS OF SDI in Cardamom

- Increase in yield by 55%
- Uniform, early and regular podding
- Uniform distribution of fertilizer and water
- Enhanced uniformity in podding and clump growth.
- Higher efficiency water and fertilizer use.
- Labour use for irrigation and fertilizer application reduced considerably.
- SDI does not obstruct Forking, weeding and other field operations.
- Rodent damage (by squirrels) is less
- Mechanical damage to irrigation system by labour or animal movement is avoided.

Jain Drip
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Plantation Diseasaes

'Katte'(Mosaic) Disease

Spindle shaped chlorotic flecks appear on the youngest leaf of affected tillers.Later develop in to discontinuous stripes of pale green and dark green areas, running parallel to the veins from the midrib of leaf margin.

Treatment : Avoid rhizome planting using materials taken from disease affected gardens.

Avoid raising nursery near katte affected areas.

Nilgiri Necrosis Disease / Viral & Systemic disease

Plants show alternate light green and whitish to yellowish streaks on the leaves in the form of mosaic.

Treatment : Plant sanitation by rouging of affected plants can control the disease

Kokke kandu disease (Cardamom vein clearing)

Systemic viral disease.

Mottling develops on the foliage and later shows severe vein clearing. Tillers are stunted.

Treatment : Plant sanitation is the only preventive measure.

'Azhukal' or Capsule Rot disease

Water soaked lesions appear on the young leaves and on capsules. Provide proper drainage & regulate thick shade by gentle topping of tree branches

Treatment : Treat with Bordeaux mixture 1 % (at the rate of 500 ml to 1 litre per plant) or Aliette 80 WP 0.3% (at the rate of 750 ml per plant)

Clump Rot or Rhizome Rot

Yellowing of leaves and decay of tillers occurs. Rhizomes become soft, dark brown coloured and results in total death of the plant

Treatment : Plant sanitation. Drenching of plant base with 2 to 3 litres of COC (0.25%)

Application of bio-agent Trichoderma after phytosanitation at the rate of 1 kg/100 kg of cowdung can control some extent of rhizome rot and azhukal disease

Capsule Canker and Capsule Brown Spots

Canker observed as glacy dicoloured eruptions on the capsule rind. Capsule brown spot appear as small round reddish brown lesions on the pericarp of the capsule.

Treatment : It can be controlled by spraying with 0.2 % Bavistin or 0.2 % Dithane M45

Leaf Blight

Drying of leaves occurs during October to February months

Treatment : It can be controlled by one or two rounds of spraying with 1% Bordeaux mixture or 0.3% Aliette or 0.4% Akomin.

Jain Sprinklers
More Crop Per Drop®

Insect Pest Management

Pests in Nursery

Shoot Borer

Appearance of excreted material at the mouth of the bore hole indicates the presence of larva in the shoot. Its caterpillars bore in to the shoots and feed on its core.

Treatment : The pest can be controlled by spraying insecticides within 15-20 days after the appearance of moths. Monocrotophos or Fenthion 0.075 %

Root Grubs

Grubs reduce the uptake of nutrients and leads to yellowing of leaves.

Treatment : Early stages of the grub can be controlled by applying Phorate or Sevidol @30 to 40 grams per clump.

Shoot Fly

Results in wilting and drying off of the terminal unopened leaves.

Treatment : Remove and destroy affected shoots at ground level. Apply Dimethoate or Quinalphos or Methylparathion at 0.05% conc.

Spotted Red Spider Mite

Spider mites spin web and colonise under the surface of leaves. They suck plant sap form leaves.

Treatment : Spray dicofol @ 200 ml/100 litre water or Sulphur 80 WP 250 gm./100 litre or Dimethoate @167 ml/100 litre or Phosalone 200 ml/100 litre on lower surface of leaves

Cutworm

It feed on leaves of seedlings and it pupates in soil.

Treatment : Spray Monocrotophos at the base of the seedlings

Nematodes

Necrosis of leaf tips and margins, narrowing of leaves, thickening of veins, reduction of intermodal length, appearance of leaves as rosette and reduction in plant growth.

Treatment : Apply Carbofuran @80 gm/6 m2 bed in primary nursery and @200 gm./6 m2 bed in secondary nursery.

During plantation, apply Carbofuran @60-80 gm. per plant or 20-40 gm. of Phorate with 300-500 gm of neem oil cake per plant

Insect Pests in Plantations

Cardamom Thrips

Insects cause damage to panicles, flowers and capsules.

It results in stunted growth; flower dropping and the injury produced on tender capsules.

Treatment : Remove collateral host plants of thrips. Remove dry drooping leaves, dry leaf sheaths, old panicles and other dry plant parts.

Shoot /Panicle/Capsule Borer

Flower production stopped and larvae feed on the seed

Treatment : Apply Monocrotophos or Fenthion 0.075 %.

Early Capsule Borer

These insects bore and feed flower buds, flowers and capsules.

Treatment : Spary Methylparathion or Monocrotophos 0.05%

Cardamom Whitefly

Black sooty mould develops on these and interrupts photosynthesis of the leaves.

Treatment : It can be controlled by spraying on lower surface of leaves a mixture of neem oil (500 ml) and Triton (500 ml) in 100 litre of water.

Apply Acephate 0.075% and Triazophos 0.04% .

Pollination

- Cardamom is a cross pollinated plant. Pollination is assisted by external agents like honey bees.
- Fruit setting increases in bee pollinated flowers
- For effective pollination, four bee colonies per hectare are required.

Yield

An average yield per picking of 278 kg/ha (cardamom is harvested 6-7 times a year) under drip fertigation (average yield in conventional irrigation and soil fertilization is only 180 kg/ha).

Dos

- Ensure good drainage in the field.
- Adopt Subsurface drip irrigation.
- Compulsorily apply organic manure as per recommendation
- Select high yielding, disease and pest tolerant variety.
- Strictly follow the irrigation schedule given by the engineer.
- Follow the drip system maintenance schedule given by the engineer.
- Compulsorily weed/ inter-cultivate, timely operation helps in crop growth.
- Follow fertigation schedule as given by the engineer.
- Apply micronutrient as and when needed.
- Follow disease and pest control measures timely and effectively.
- Apply sprays in the evening or early morning only.

Don'ts

- Don't over irrigate cardamom at any time.
- For fertigation don't mix solid fertilizers and dissolve them together. Prepare individual solutions and mix them for application.
- Don't make a fire in the field with Drip system.
- Don't use the fertigation unit for bulky organic manure and fertilizers that are not soluble in water
- Don't add solid fertilizer from the gunny bag directly to the fertilizer tank. Prepare solution separately and pour the solution to the fertilizer tank. Prepare solution only in plastic buckets. Don't use metal container.
- Don't stir the solution with naked unprotected hand. Use wooden spoon or stick.
- Don't heat the fertilizer solution to increase solubility.

Frequently asked questions (FAQ's)

1. Whether the meagre quantity of water supplied through drip irrigation is enough?

Irrigation rate in Drip method is estimated based on the Evapotranspiration of the location and therefore it is enough. With conventional hose irrigation water completely replaces the air in root zone thereby suffocating the plant. The last few days of the irrigation cycle the crop also suffers from water stress. The periodical water logging and stress affects growth and production of cardamom.

2. Can I prefer Sprinkler method of irrigation for Cardamom ?

No. it is not suitable as it spreads water over the canopy. Moreover wastage of water per irrigation will be high. Sprinkler irrigation will induce diseases because the excess humidity is ideal for fungal and bacterial growth. It also results in persistant weed growth.

3. How long the SDI lateral will remain in the field?

The laterals will remain functioning for 7-10 years with proper maintenance with care for avoiding mechanical damage. The head control (fiters and fertigation systems) will remain functional for 15 years.

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Precision Farming

APPLE

With Jain Technology™

Jain Irrigation Systems Ltd.

Small Ideas. Big Revolutions.®

Jain Plastic Park, Jalgaon

Hon. Padmashri Bhavarlalji Jain (Bhau)

Founder Architect, Jain Irrigation Systems Ltd., Jalgaon

Founder's Conviction: As a son-of-the-soil and first generation entrepreneur, Bhavarlal Jain has hands-on farming experience. He genuinely believes that agriculture is backbone of the Indian economy. He feels that the transformation of India into an industrial society will take many decades. In the meantime, for sustainability, self-reliance, and all round growth, the country has no alternative but to adopt science and technology for progress in agriculture. He says, *"I have a dream to change the way the Indian farmers do agriculture".*

Advances in other sectors, however phenomenal, cannot substitute agricultural development. This is the conviction with which the founder commenced his journey in 1963.

CORPORATE PHILOSOPHY

Mission

Leave this world better than you found it.

Vision

Establish leadership in whatever we do at home and abroad.

Credo

Serve and strive through strain and stress;
Do our noblest, that's success.

Goal

Achieve continued growth through sustained innovation for total customer satisfaction and fair return to all other stakeholders. Meet this objective by producing quality products at optimum cost and marketing them at reasonable prices.

Guiding Principle

Toil and sweat to manage our resources of men, material and money in an integrated, efficient and economic manner. Earn profit, keeping in view our commitment to social responsibility and environmental concerns.

Quality Perspective

Make quality a way of life.

Work Culture

Experience : 'Work is life, life is work.'

OUR COMMITMENT

Customer and Market

- Commit to total customer satisfaction.
- Build and maintain market leadership.

Quality Excellence

- Strive continually to reach and maintain quality in every aspect.

Safety and Health

- Secure safety and health of associates and other assets.

Environment and Society

- Protect, improve and develop the environment
- Cherish the symbiosis and nurture the creative partnership between society and the environment.

Development of Other Stakeholders

- Adopt transparency and fair practices for continuous sustainable growth.

THE CORPORATION

Jain Irrigation Systems Ltd is a diversified entity with turnover in excess of 5000 crores. We have a Pan-India presence with 28 manufacturing bases spread over 4 continents. Our products are supplied to 110 countries with able assistance from 6700 Dealers and distributors worldwide.

We are the second largest Micro-Irrigation company in the world. The Micro-irrigation Division manufactures the full range of precision-irrigation products; provides services from soil survey, engineering design to agronomic support; nurtures a sprawling 2000 acre Hi-Tech Agri Institute; a Farm Resource R&D, Demo, Training and Extension Centre and undertakes turnkey projects for agricultural and irrigation development in totality. Over 1000 agri and irrigation scientists, Engineers, technologists and technicians are engaged in offering consultancy for a complete or partial project planning and implementation e.g Watershed Development through Wasteland Transformation, including crop selection and rotation.

Jain Irrigation is also the largest Plastic pipe manufacturer in India covering a wide range of pipes and fittings. We annually process over 300,000 MT of various polymers. We extrude and injection mold PVC, PE, PP along with other engineering polymers like Polycarbonate, Polyamide, PBT,ABS etc. We are a 'Total Solution Provider' for various thermoplastic Piping systems that are used in transportation / conveyance of fluids, semi-solids , gases and cables.

The Tissue Culture Division produces Grande Naine Banana plantlets at full capacity and has established a matching primary and secondary hardening facilities as well as independent R & D and virology labs. Similarly a modern Bio-tech lab equipped with PCR based and other molecular markers, HPLC, AAS and GC, has been established to meet the needs of continuous genetic improvement and validation programme in cultivation of onion, banana, mango and some of the energy crops.

We also processes tropical fruits into purees, concentrates, juices and IQF products. The Dehydration Facility dehydrates Onions and Vegetables. The Spray Drying Unit processes gooseberry and other fruit purees into powders.

Agricultural and Fruit Processing waste is converted into Organic Manure. Plant-based pesticides are also formulated. Both are critical inputs for organic farming, a system we profess and practice.

Jain Irrigation is the only company in India which is not only a Pioneer manufacturer of hi-tech agricultural inputs but also a Total Agri-Service provider , houses R&D, Demo,Training and Extension Institute,is a large farm cultivator and an Agricul rural Consultancy organization. It is through such multi-dimensional activity profile, that Jain Irrigation nurtures the complete agri value chain and has become a 'one-stop hi-tech agri shop'.The reward has been over a million satisfied farmers and scores of happy customers globally.

Our other businesses include PVC and Polycarbonate sheets,Solar Water Heaters, Solar Lighting etc where the emphasis is on the conservation of scarce

natural resources like forest and energy. PVC sheets can replace wood as a substitute for building material and save our forests. Similarly Solar Water Heaters and Photovoltaic Lighting systems uses the abundant Solar Energy available free and saves the natural sources of energy like coal which is used to produce electricity.

Our unflinching efforts in pursuit of excellence appropriately blended with ongoing Research and Development efforts have earned the company highest R & D awards of the country and numerous other awards and recognition for our performance in Exports, Fair Business Practices, Quality Excellence etc.

Our obsession with quality has enabled us to reach export turnover of 490 crores from our India operations.

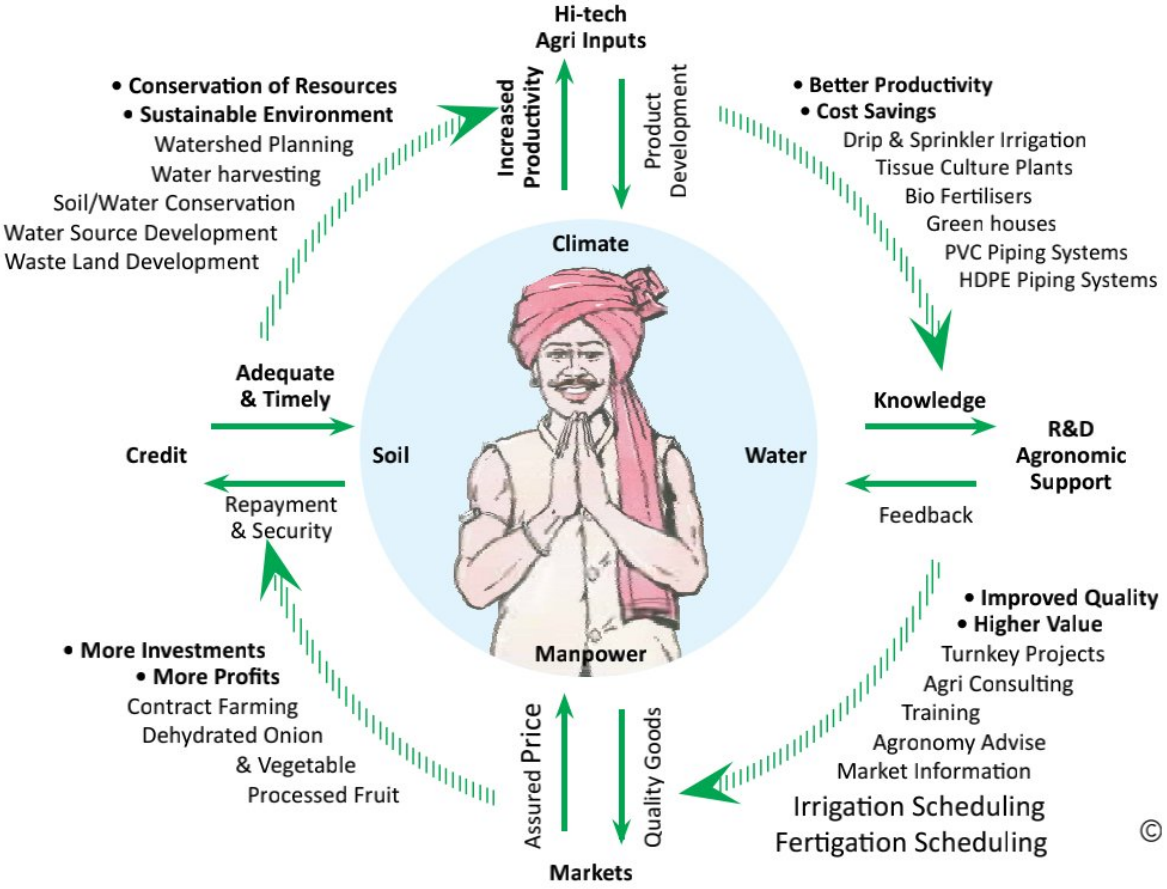
A lifetime commitment to introduce modern yet affordable and viable technologies in all our product offerings have compelled us to be creative and innovative.

ONE STOP AGRI SHOP

INDEX

Note: Crop yields depend on climate, soil and management and therefore can't be guaranteed by the company.

Jain Self Sustaining Agri Development Cycle



The organization, at its inception in 1963, started with trading of agricultural inputs – an activity which continued till 1978.

In the next three decades, we embarked on manufacturing and supplying a wide range of quality agri-inputs to enhance farm productivity, which includes water piping systems, on-farm irrigation systems, and superior bio-tech products.

Along with the supply of agri inputs, we also provide a host of hi-tech agri-services from land preparation to post-harvest management etc.

Today, we undertake infrastructural development in agriculture, and provide total solutions for water, soil, and crop management, and insight into farm cultivation and operations. We take up such jobs on turnkey basis which involves executing, operating, and managing the projects; in other words, we offer everything from concept to commissioning.

We undertake research in laboratory and fields to develop hi-tech agricultural technology and carry out demonstration, training, and extension work in order to take these technologies to the farming community at the grassroots level.

We are engaged in corporate farming, and also sponsor contract farming for fruits and vegetables which are in turn used as raw material for processing and other value addition.

We have the largest pool of agricultural scientists, technicians, and engineers in the private sector. The company is led by a professional management team. Our professionals are committed to our corporate mission. Our core strength is our global experience with local knowledge and feel.

1. INTRODUCTION

Apple cultivation in India started during Eighteen century and now it is an important crop of temperate region. Apple ranks 6th among fruit production in India. China is largest apple producer in the world with 43% share, however, India has only 3% share.

Table 1 : Apple area production & productivity in various countries and in India.

Country	Area (lakh ha)	Production (lakh t)	Productivity (in t/ha)
China	20.00	298.5	14.90
USA	01.41	43.58	30.70
Polland	01.70	28.31	16.50
Iran	01.74	27.18	15.60
Italey	00.55	22.05	40.40
Turkey	01.29	25.04	19.30
France	00.22	19.40	37.20
India	02.80	17.78	06.30
World	47.96	698.19	14.60
Jammu & Kashmir	01.28	13.12	10.27
Himachal Pradesh	00.98	05.10	05.20
Uttrakhand	00.32	01.30	04.06

Source: FAO Database & State directorate of Horticulture.

The table-1 indicates that apple productivity in India is much lower than other apple producing countries. Reason behind this, is that other countries have adopted new and improved methods of cultivation in recent years however, Indian growers are still using old techniques. Among Indian states productivity of J & K is higher than the other two states. It is mainly due to the best climate available in this state. In Jammu-Kashmir, there are regular

snowfalls and winter rains which provide sufficient moisture in the soil to protect the bloom from spring frosts, resulting in good fruit–set. Further, this zone being in inner Himalayas, the summers are cool and dry and there is plenty of sunlight available to the growing crop. If precise irrigation facilities are created, and a systematic approach to cultural practices is adhered-to, the yields and quality can be increased many fold.

The main handicaps are non-availability of 1)Irrigation, 2)Suitable cultivar which can produce sustainable yields under changing environment, 3) Nutrients for their efficient use during the growth stage when an apple tree demands, 4)Training and pruning, 5)Disease and pest management and 7) Protection of fruits from hailstorms.

1. During early days the snowfall in winters and rains during summers were regular, hence people did not realize need for irrigation. From last few decades neither snowfall nor rains occur at proper times – some years in excess, in other years, deficient. Looking to the topography of apple growing areas, water can be stored in tanks and can be used whenever neccessary through drip system for irrigation.
2. Cultivars have been developed which do well under fluctuating temperatures. These are to be popularized on priority basis.
3. Fertigation can be used for application of nutrients along with irrigation water. The nutrient can thus be made available to the trees when they require them most.
4. Although the system of training and pruning is recommended since long, however, it has not been used as an essential practice. Proper training and pruning gives strong framework to a tree and also enable the tree to yield a normal crop on a regular basis.
5. The first precaution to be taken up for management of diseases and pests is to maintain proper sanitary conditions in the orchard, provide conditions for aeration and sunlight upto the inner parts of the tree. Use of appropriate fungicides and insecticides at proper timings are very important for their control and to check their spread.
6. In some pockets, during summer, the hailstorms occur regularly which adversely affect the quality and production. Planting of apple orchards in these areas should be avoided and be put under temperate nuts like walnut, pecan nut etc.
7. Several orchards do not have sufficient number of pollenizer varieties.

2. ORIGIN AND DISTRIBUTION

Apple, *(Malus pumila L.)* belongs to the family Rosaceae and sub-family Pomoideae. It has originated in Asia in the regions of Asia Minor, the Caucasus and Soviet Central Asia. There are about 34 species in genus *Malus* known to occur all over the temperate and sub- temperate climates of the world. Humans have carried these several species to great distances from their centres of origin and has adapted them in new areas for their own horticultural production. Since evolution has been influenced by physical isolation in a range of environments, and further these isolations have occurred during comparatively recent evolutionary history, hybridization between species is still relatively easy. The 18 genera of sub-family Pomoideae have 17 pairs of chromosomes and are distinctly different from other genera of Rosaceae which have 7,8,or 9 pairs . Botanical and chemical observations suggest that the Pomoideae is of allopolyploid (amphidiploid) origin, produced by natural hybridization, possibly between Prunoideae (8 pair) and Spiraeodeae (9 pairs) followed by doubling.

The six most important apple producing countries are the Russia, USA, China, France, Italy and Turkey. These six combined produce more than half the world's crop. Apple contributes significantly to human nutrition and world food production. In USA apples are grown in about 34 States out of 48, but intensive cultivation is confined to few States which have suitable climate. In the United Kingdom where <1 per cent of the world's apples are produced, commercial apple production is carried out in few pockets and mainly in South eastern region where temperature is most favourable for regular production. Apple production in the UK is much greater in home orchards than it is in commercial orchards. It is estimated that about one– third of all nursery apple plants are sold to home gardeners.

3. SOIL

Deep loam soil is best for apples. Clay-loam soils having good drainage can also be used. In sandy-loam soils, apple trees are adversely affected by the stem diseases like Canker and Papery Bark and insects like stem and root borers. The soils rich in organic matter and, have a pH of around 6.5 and have good drainage are best for apple growing. The shallow soils with gravels can be made suitable by adding heavy quantities of farm yard manure/ compost or leaf moulds. On the whole , the soils on which natural forests of oak and deodar a flourish are ideal for apple orcharding.

4. SITE SELECTION

Apple being a temperate fruit, enters into dormancy from late autumn. It remains leaf less, in deep dormancy during winter months. Nevertheless, under the evolution process, this character has been provided by nature for the benefit of trees to save them from the chilling cold winters. Further, evolutionary processes have made low temperature a need of their life that we call as the "chilling requirement". Although during dormancy, there is no visible sign of growth, however, the processes of development remain active under low temperatures (at or < 7° C) i.e., chilling temperatures. The chilling requirement of apple buds varies between 1000-1500 hrs. Some varieties can be grown with low chilling hours up to 800hrs. The temperatures which are several degrees below zero degree are not effective to fulfill chilling requirement. These are, rather, dangerous to the shoots and buds. On completion of chilling requirement, in case there is a warm spell the buds put forth growth and because of being succulent they are liable to injury from the succeeding low temperature. Hence such areas are not suitable for apple growing. The best climate for apple is considered when there are at least 3-4 spells of good snowfalls and temperature, for most of the time, remains at or below 7° C between December and Feb-March. Depending upon the altitude and direction of slope, flowering occurs in April- May. The areas located > 2400 metre above msl (mean sea level) and facing North remain under snow for most of the period of the year hence at such altitudes , apple growing is possible on west, east or south facing slopes.

Constant chilling cold during winters, no frost during flowering, availability of sunlight for at least 8 hours daily and no hailstorms during summers and average minimum and maximum temperatures 10 and 30°C, respectively during the growing period are the ideal factors of climate for apple growing.

The hills of Noth-Eastern states and Nilgiri hills of South India, being warm, are not suitable for apple growing.

It is suggested to choose higher elevation sites close to the moderating effect of water flowing down in the perennial rivers. Large bodies of water take a long time to change in temperature both during summer and winter. The cooling effect of water in the spring delays the onset of bloom thereby reducing the risk of damage from spring frosts. In the autumn their effect reduces the on-set of cold temperatures and the damaging effect these can have on unharvested apples and on tree before they completely harden off. A higher elevation related to the valley is desirable because heavier cold air, in the spring will flow into the lower areas. This makes low areas frost prone resulting in poor tree performance with crop loss. A gentle slope is better than steep slope as the latter make orchard operations more difficult and is susceptible to soil erosion. Wind is another consideration and windy sites should be avoided. Strong winds can reduce the growth rate of trees, reduce bee activity during pollination, increase fruit drop and make spraying operation more difficult.

Considering all the parameters together, in India the best sites for apple orchards are the gentle slopes and wide valleys all along the perennial rivers in the states of Jammu-Kashmir, Himachal Pradesh and Uttarakhand.

Table 2: Comparative climate suitability for Apple cultivation in India

State	District	Areas based on climate		
		Most Suitable	Moderately suitable	Average
Jammu-Kashmir	Baramula	Rohana, Dangerpora, Sopore and Hajin.		
	Shopian	Sadipora, Pinjora, Kachidora, Jamnagar.		
	Kupwara, Kulgam, Srinagar, Pulwama, Budgam, Punch, Anantnag, Doda	Several places	-	-
	Rajauri, Bhadarwah	-	Several places	-
Himachal Pradesh	Shimla	Nankhadhi, Rohru	Kotgarh, Kotkhai, Thanadhar, Kumarsain, Chaupaal,	Mashobra, Kufri, Thiog, Shilaru
	Mandi		Nagwai, Sanaur, Sauri, Karsoag	Pandaar,
	Kullu	Rayson, Katrain, Naggar	Banjaar, Bhuntar, Parvati valley, Kullu, Fanjal valley, Sainj valley, Lag valley	Katola, Rajaun
	Kinnaur	Ribba, Purvani, Spillo, Nichaar, Kilba, Sangla and Ropa vallies, Telengi, Leo, Chango, Kalpa, Kothi	-	-
	Chamba		Tisa, Kilor- Kihaar, Bharmaur	Khajyar, Dalhousie, Salooni
	Sirmour			Nouhradhar, Habban, Deothi-Majhgoan, Dhamla, Haripur Dhar
	Lahaul	Chandra valley (from Khoksar to Tandi Bridge), All along Chenab river (from Tandi bridge to Udaipur)		
Uttara-khand	Uttarkashi	Harsil, Arakot, Bhutanu, Netwadh	Purola- Dharauli	Naugaon- Sauri
	Chamoli	Urgam Valley, Mallahari, Bampa, Gamshalli, Jumma	Auli- Barsari- Tapovan- Jelam upto Hemkund Sahib	Gualdam
	Rudraprayag		Tirjugi- Narayan	Gimtoli, Chirvatia
	Nainital		Ramgarh- Paharpani	Padampuri- Dhari
	Almora		Mornaula, Shaharphatak	Kausani
	Dehradun		Tuni-Koti-Kanasar-Chausal	Chakrata

5. SPECIES AND CULTIVARS

Altogether about 34 species have been reported in the genus *Malus*. The world's most important commercially produced apple cultivars belong to *M. pumila* . Though other species also have their own importance for example, almost all the scab- resistant cultivars have come from the crosses made between *M. pumila* X *M.floribunda*. Genes for disease resistance have also been obtained from *M. micromalus, M. baccata* and *M.sargentii.* Selections of *M.prunifolia* have been cultivated for their fruits in eastern Asia, and *M.micromalus* is grown commercially in China for processing and preservation in cans. A high level of resistance to powdery mildew is available in *M.sargentii* and *M.baccata* species. *M.prunifolia* is relatively more tolerant to calcareous soils than *M.baccata* but chlorosis due to iron deficiency associated with calcareous soils is common.

Few apple species are evergreen and grown only in sub-tropical regions, while at the other extreme, *M.baccata* survives readily in very cold regions but because of its low chilling requirement it breaks rest even when there is slight increase in temperature during spring season. The yielding capacity of *M.pumila* can further be improved by acquiring good cropping genes from *M.prunifolia, M.baccata, M.yunnanensis* or others.

Upto about 1960, the following cultivars were very common:

- Tydeman's Early Worcestor
- Lord Lambourne
- Early Shanburry
- Benoni
- Fanny
- Rome Beauty
- Winter Banana
- Jonathan

- King of the Pippin
- Cox's Orange Pippin
- King of the Tompkins County
- McIntosh
- Yellow Newton
- Baldwin
- Granny Smith
- Blenheim Orange
- Wagener
- Rymer (Maharaji)
- Ambri

Most of these are poor in colour and are either blended in taste or acidic.

Around 1970, cultivars of Delicious group came into existence which were preferred and planted in large scale because of their sweetness, red colour (except Golden Delicious) and attractive appearance. The Red Delicious, Royal Delicious and Rich-a-Red are still common but because of their sensitivity to changing environment, have now become poor performers and are showing un-sustainability in their production levels. There are now good prospects for cultivars like Vance Delicious, Star Crimson Delicious, Topred, Skyline Supreme Delicious and the spur cultivars like Red Spur, Gold Spur, Red Chief, Oregon Spur, Bright-N-Early, Silver Spur, Mac Spur, and Well Spur which on the whole have much better abilities to produce good yields under somewhat marginal climates. Moreover, their tree size is about two-thirds and fruits mature one to two weeks earlier than those of the Red and Royal Delicious. The cultivars Galla, Fuji and Red Fuji, recommended as pollenizers for most of the spur cultivars (unlike Golden Delicious and Jonathan- pollenizers for Red and Royal Delicious), produce much better quality fruits and hence can be planted in a proportionately greater number in the orchard for efficient pollination of the main cultivars.

There are cultivars such as Beacon, Sweet Sixteen, Heralson, State Fair and Keep Sake which can be grown in areas where the temperature during winter months remains as low as -20°C.

There are a group of cultivars which requires less hours of chilling for the normal flowering and fruit–set and hence, is suitable for cultivation in mild-temperate climate. Cultivars like Mollie's Delicious, Michal and Schlomith which produce good quality fruits as compared to their predecessors and have much better commercial value are recommended for growing in mild Climate.

The Scab disease is very common in many apple growing countries of the world, scab resistant cultivars like Prima, Priscilla, Sirprize, Florina, Macfree, Jonafree, Redfree and Freedom have been developed by transferring genes from the wild apple species.

Table 3 : Description of varieties and their suitability

Sr.	Variety	Main features	Suitable for
1	Tydeman's Early Worcestor	Fruits roundish, hard, red, blended taste, regular bearer, maturity 2nd fortnight July, good pollenizer for Delicious group.	H. P. and J &K
2	Lord Lambourne	Fruits roundish, green streaked, sweet, self-pollinated and a good pollenizer, maturity August 1st fortnight, regular bearer.	H.P. and J & K
3	Early Shanburry	Fruits small, red streaked, blended taste, maturity in July- August	Uttarakhand and J & K.
4	Fanny	Fruits medium, red blushed, blended taste, maturity in August	Uttarakhand
5	Red Delicious	Fruits conical, large, skin colour deep red streaks over yellow back ground, sweet, maturity in August-September	Uttarakhand, H.P. and J & K
6	Royal Delicious	Fruits large, conical, skin yellow covered with red streaks all over the surface, sweet, maturity in August-September	H.P. and J & K
7	Red Gold	Fruits round to slightly oblong, red blushed, waxy, glossy, heavy cropper, maturity in August-September	Uttarakhand, H. P and J & K
8	Golden Delicious	Fruits large, round, conical to oblong, golden yellow, sweet, maturity September-October	H.P and J and K
9	Rymer/ Maharaji	Fruits round, large, acidic, heavy cropper, long shelf-life, maturity in September- October.	Uttarakhand, H. P and J & K
10	Ambri	Fruits medium to large, yellow shining surface with red streaks, maturity in September- October	J & K
11	King of the Pippin	Fruits medium , skin yellow with light red streak, blended taste, maturity in September.	Uttarakhand and J & K
12	Oregon Spur II	Fruits medium, conical, skin colour deep red streaks over yellow background. Fruits mature about 10-15 days before Royal Delicious. It is suitable for mid hills and valley areas. Tree spur type.	H.P and Uttarakhand
13	Red Chief	Fruits medium, red streaked, maturity same as to Royal Delicious but colours 8-10 days earlier. Tree spur type.	H.P and Uttarakhand
14	Super Chief	Fruits medium, maturity slightly early than Royal Delicious. Tree spur type.	H.P and Uttarakhand
15	Gale Gala	Fruits medium, red over yellow background, maturity in August. Tree spur type.	H.P and Uttarakhand
16	Red Fuji	Fruits medium, round to conical, solid and aromatic, sweet, good shelf-life, maturity in September.	H.P, Uttarakhand and J & K

6. NURSERY MANAGEMENT

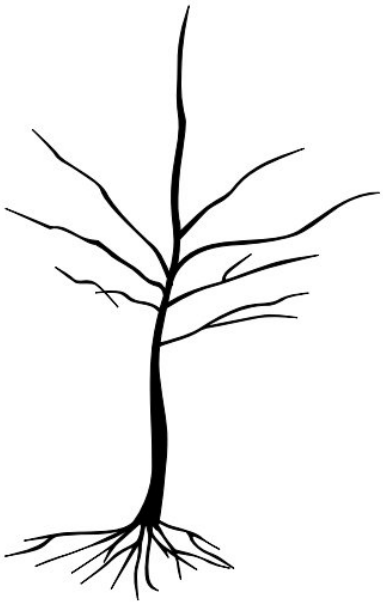
The seedlings of crab apple or of commercial cultivars and stooled plants of clonal varieties of year old are used as rootstock. Several types of clonal rootstocks are available which can be used for tree size control. The clonal rootstocks of Malling–Merton series are resistant to woolly aphid. Similarly, resistant rootstocks are also available for Collar Rot disease. In India, at present, the seedlings of crab apples or of commercial cultivars are used as rootstock for standard planting. Among the clonal rootstocks the M-106, M-111 and Merten-793 are recommended. The whip grafting is done in Feb-March about one month prior to bud break. These grafted plants are ready to be planted in the orchard during the next winter season. Budding is done in May-June and also in September-October.

In the high density planting, the role of clonal rootstocks is immense. The dwarfing rootstocks that are commercially available to fit this niche are M.9, Bud.9 and M.26.No perfect rootstock exists, and the limitations and strengths of each rootstock must be evaluated to select the rootstock that performs best in a specific situation. These rootstocks develop dwarf statured stions and also make the scion precocious. Malling 9 produces stions 1/3rd to 1/4th of the size of standard stions. It is very precocious and very productive rootstock. It has, however, brittle roots which break easily, hence anchorage is poor. This rootstock is tolerant to collar rot and does well on heavier soils where drainage is adequate. Many virus free M.9 sub-clones have been developed by heat treatment. More vigorous strains of M.9 are the Pajam 2 and RN29. The rootstock M.26 is more vigorous than M.9 and, therefore, a popular choice for re-plant sites. M.26 does well on slightly heavier textured soils if drainage is adequate. While moderately resistant to Collar Rot, it ,however, does not perform well on poorly drained soils. M.26 may be more suitable for cultivars such as Fuji, where M.9 is too weak. Bud.9 is one of the hardy Budagovsky rootstock series. It displays dwarfing similar to M.9, but is more winter hardy. It has greater resistance to Collar Rot than M.9. The P.2 is a Polish rootstock with

similar precocity and yield potential of M.9. Its winter hardiness is similar to B.9. It is resistant to Collar Rot and does not produce root suckers. Rootstock like Bud-9, Pajam-2 and RN-29 are in use in other countries and need testing in India before they are recommended on commercial scale.

Apple seeds require stratification for germination. Stratification is done by keeping seeds in moist sand either in open or in refrigerator during December to February for 2-3 months at 2 to 5°C temperature. At higher elevations (at or > 2100 metre above msl), direct sowing of seeds in the field under mulch in November is practiced which germinate naturally in early summer.

The rootstock plants should be about 80-100 cm in length and 1 to 1.25 cm thickness of the basal 1/3 rd length of the plant. Plants having more thickness, if used for graftage, success is poor. The weak plants, on the other side, are allowed to grow further and can be used for budding in May-June or Sept.-Oct.



A well feathered apple plant in the nursery

The seedling plants initially are free from viruses while plants of clonal rootstocks may have viruses, hence to ensure that these have no viruses, these should pass through tests before using them as rootstock. Similarly, the mother plants to be used for scion-wood should be true to type, productive having no viruses.

Stooling or mound layering is used for multiplication of clonal rootstocks. The young vigorous mother plants are first established for at least one year. These are planted in 20-30 cm. deep trenches at a distance of 1 metre. During the first growing season these trenches are filled-in 2 to 3 splits with the soil mixture consisting of 2 parts soil, one part each of sand and well decomposed FYM . These mother plants, once established, with proper care regularly produce new shoots for about 15 years. Every year during winter or about a month prior to start of main flush of growth, mother plants are cut down to a stump only about 8-10 cm high. This stump sends out vigorous shoots which are gradually earthed up during the growing season with soil, starting when these are about 12-15cm high, working the soil well in among the shoots. Repeat this earthing up when the shoots have made another 12-15 cm or so of growth, completing the operation within 3 to 5 months duration. When the growth has ceased during winter, fork away the soil out off the rooted shoots as close as possible to the original stump which is left exposed for few month to sprout again, thus restarting the cycle . Every year, thus rooted shoots are obtained from the

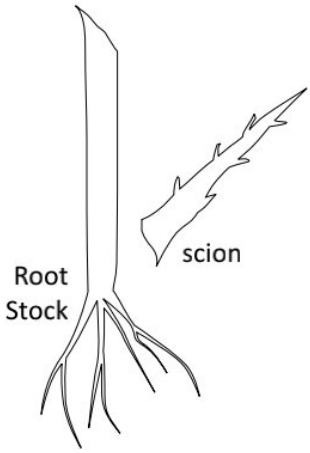
mother plants. These rooted shoots are either used immediately for grafting or planted in the nursery for budding purposes.

At high altitude (>2400 metre above msl) the growing period is short, hence establishment of nurseries in open is not economical as the desired growth needed is not available in one season both in rootstock and in stion. It is advised to have nurseries in polyhouses where the plants shall get longer growing period with optimum temperature for growth.

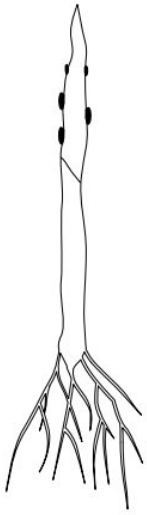
Tongue Grafting

Rootstock plant of one year age

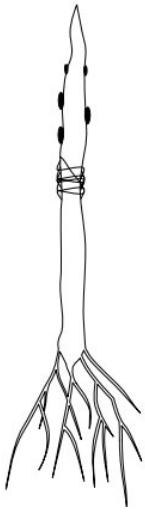
scion shoot from last year growth



Rootstock is cut, keeping 15-20 cm length. To the scion shoot similar type of slanting cut is given. On both the cut surfaces the tongue shaped cut are given



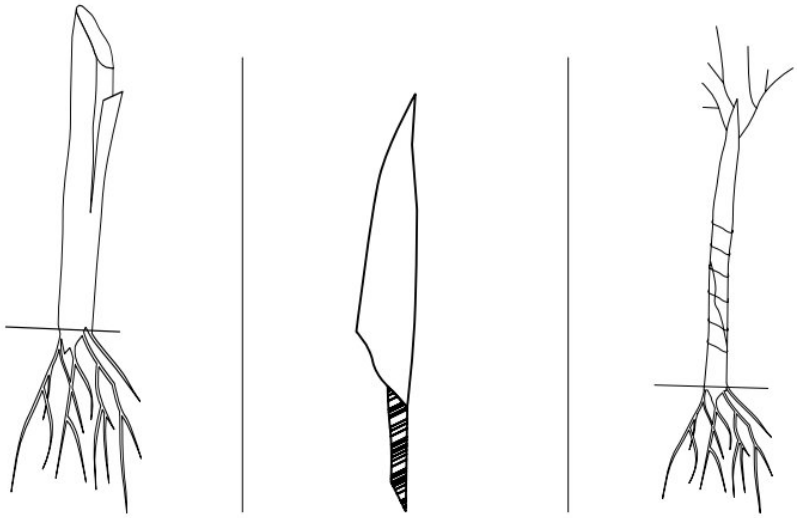
Joining of rootstock and scion shoot at cut surfaces through their tongues



Tying to Joining portions with polythene sheet for union to takes place.

The grafted plant after one year growth in nursery

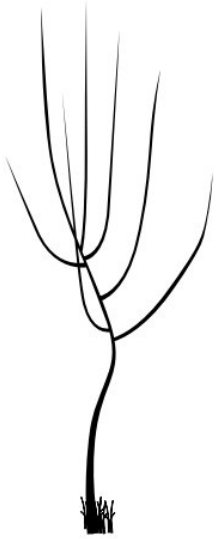
Cleft Grafting



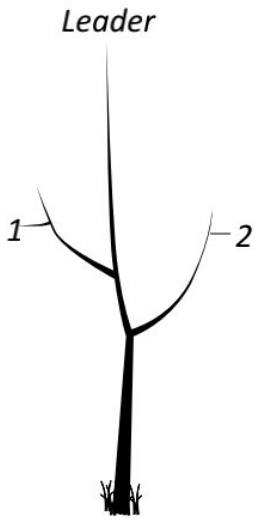
Rootstock *Scion* *Stion*

Selection of quality grafts for planting

Special care must be taken while buying plant. Quality should be given first preference over cost of plant as success of all efforts will depend on them. Grafts should be procured from good nursery which gives guarantee of variety and rootstock authenticity. Well developed plants with 60-100cm height having 3-4 branches and main stem thickness about 17-25mm should be preferred.



Nursery Plant ready for sale



Nursery plant after pruning before planting

7. ORCHARD ESTABLISHMENT

In case the fields have < 45 degree slope, it is advisable to make terraces of about 2 to 3 metre width and of convenient length with inward slope to protect them from erosion. The contour planting is preferred in fields having > 45 degree slope.

The rectangular planting system is followed wherein the distance between rows is kept more than that between plants. When seedlings or vigorous clonal rootstocks are used as rootstock and the scion cultivars are spur types, a 6 x 6 metre distance is recommended under normal soil conditions. When soils are less fertile and shallow, it may be reduced to 5 x 5 m.

Pits are dug 1 m. diameter and 1 m. depth. While digging the pits, the soil of upper half is placed at one side and of the lower half on another side. The pits should remain open during rainy season. These are appropriately filled during Sept-Oct using top soil along with 40-50 Kg well decomposed farm yard manure and 3 kg superphosphate with insecticide to control grubs etc. During filling of the pits, proper compression of the mixture is required and about 25-30 cm top portion of the pit may preferably be filled with the surface soil. The filling should be done upto 15-20 cm above the ground level. Prior to pit digging and also prior to planting, use of planting board is recommended to have plants at the right distance.

High Density Planting of Apple

Now a days most of the apple growing countries are using high density planting (HDP) system. In HDP row to row distance is 3-5 metre and plants in a row are spaced 1.5 to 2.0 metre. Thus 1000 to 2222 trees are accommodated in a hectare. Initially trees are supported with poles and trees are trained in slender spindle or vertical axis or trellis. In high density plantation system orchard start giving commercial yield in 3-4 years after planting and commercial life of orchard is considered to be 20 - 25 years. Table below has some examples of spacing with production capacity.

Planting distance (m)	Number of Plants (ha)	Production Capacity (T/ha)
4.0 x 3.0	333	30 - 45
4.0 x 2.0	1250	35 - 45
3.0 x 2.0	1666	35 - 50
3.0 x 1.5	2222	40 - 60

Advantages of High Density

a. Early commercial yield from third or fourth year onwards.

b. High yield per unit area, 25-30t/ha as compared to 10-12 t/ha in conventional planting.

c. Less pruning requirement in bearing orchards due to heavy bearing and tree architecture.

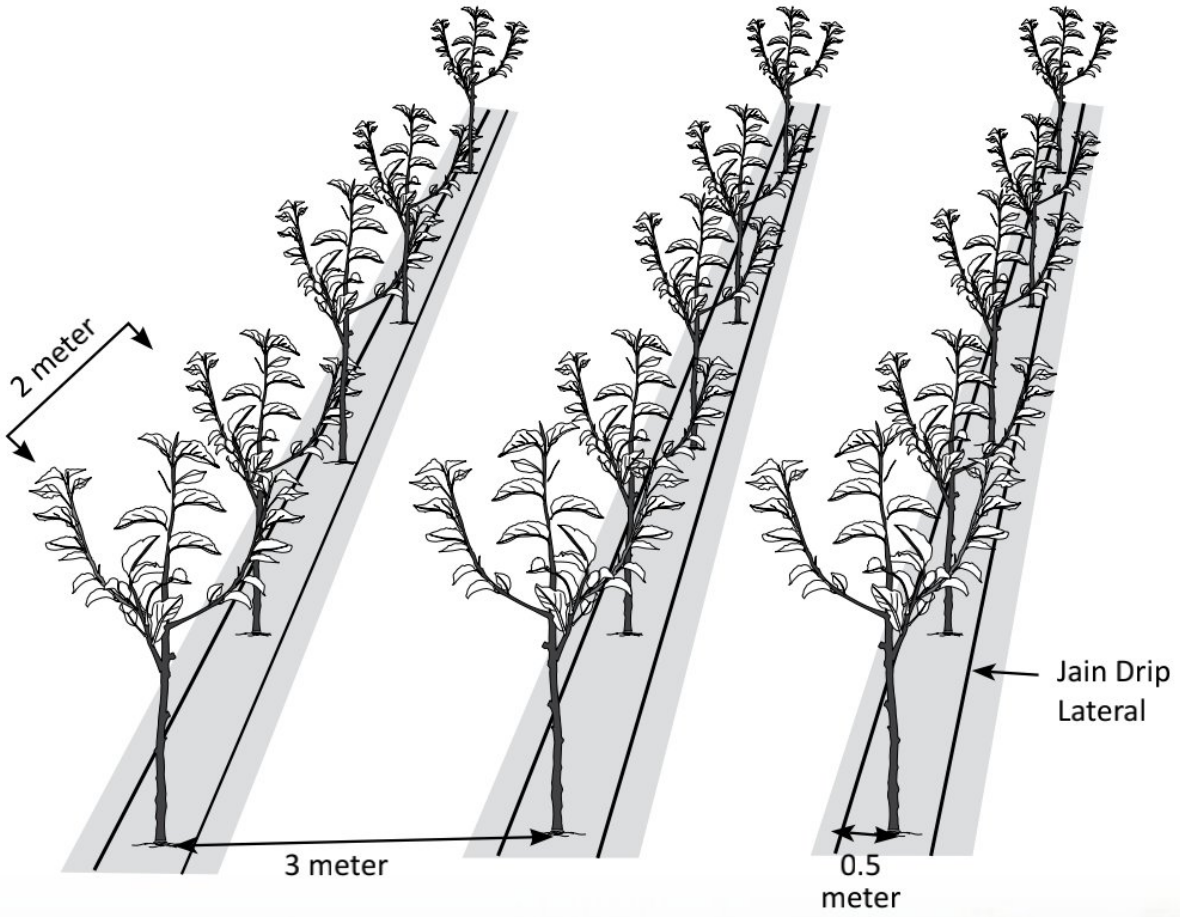
d. Easy pruning operation.

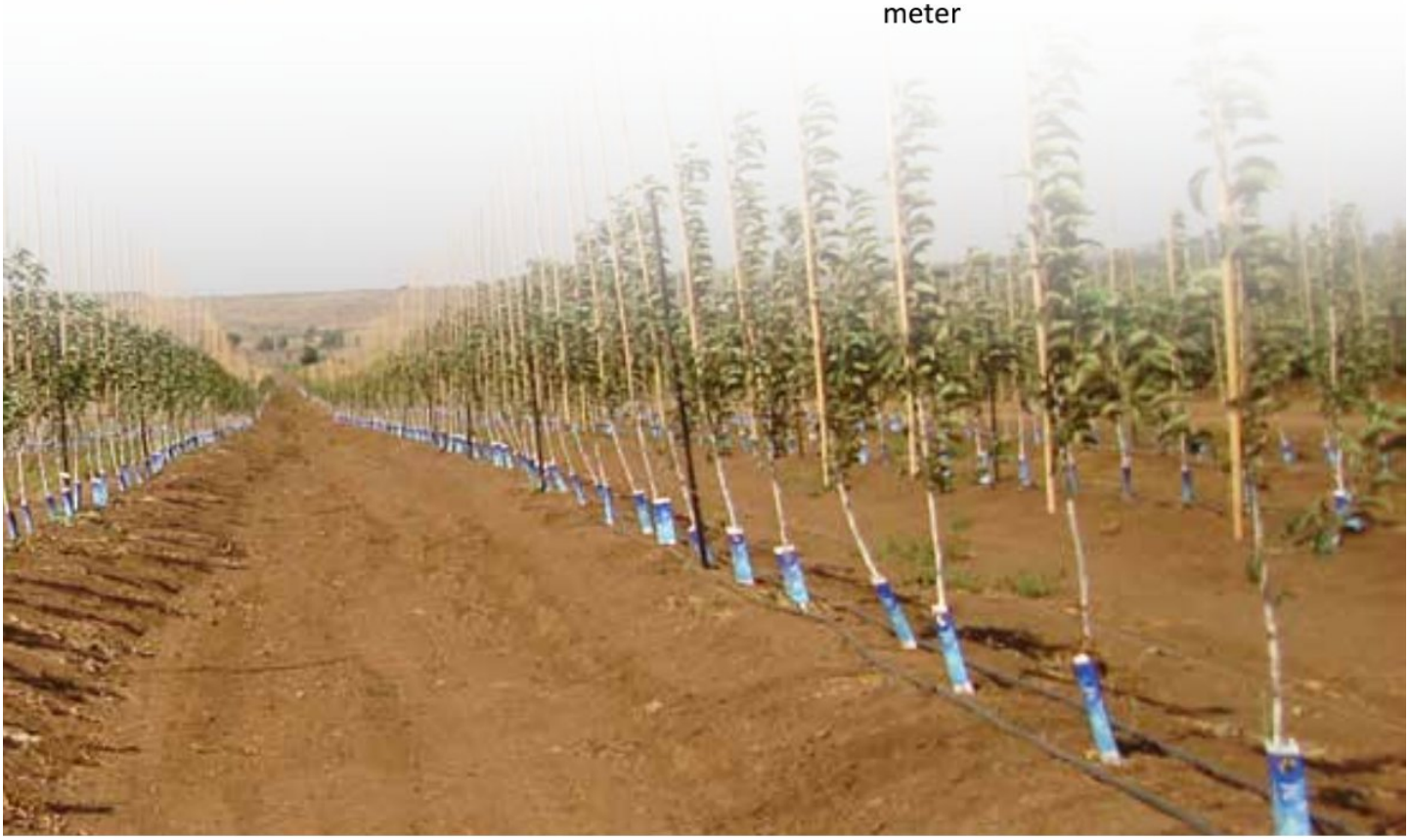
e. Uniform and high quality fruits.

f. Easy spraying, interculture and orchard management.

In high density plantings, trees are maintained 2.5 to 3 metre tall. The row to row distance is kept between 3 to 5 metre while trees within the row are planted at 1.5 to 2 metre distance . The root system , being very restricted, hence the pits are dug having 50-60 cm dimetria and 70-80 cm depth. The pits can be dug using big sized augers. The pits being small have almost half the quantities of FYM, super-phosphate, and chloropyriphos as that of the pits dug for widely spaced planting.

High Density Planting of Apple.
Plant to Plant Spacing 3 x 2 metre





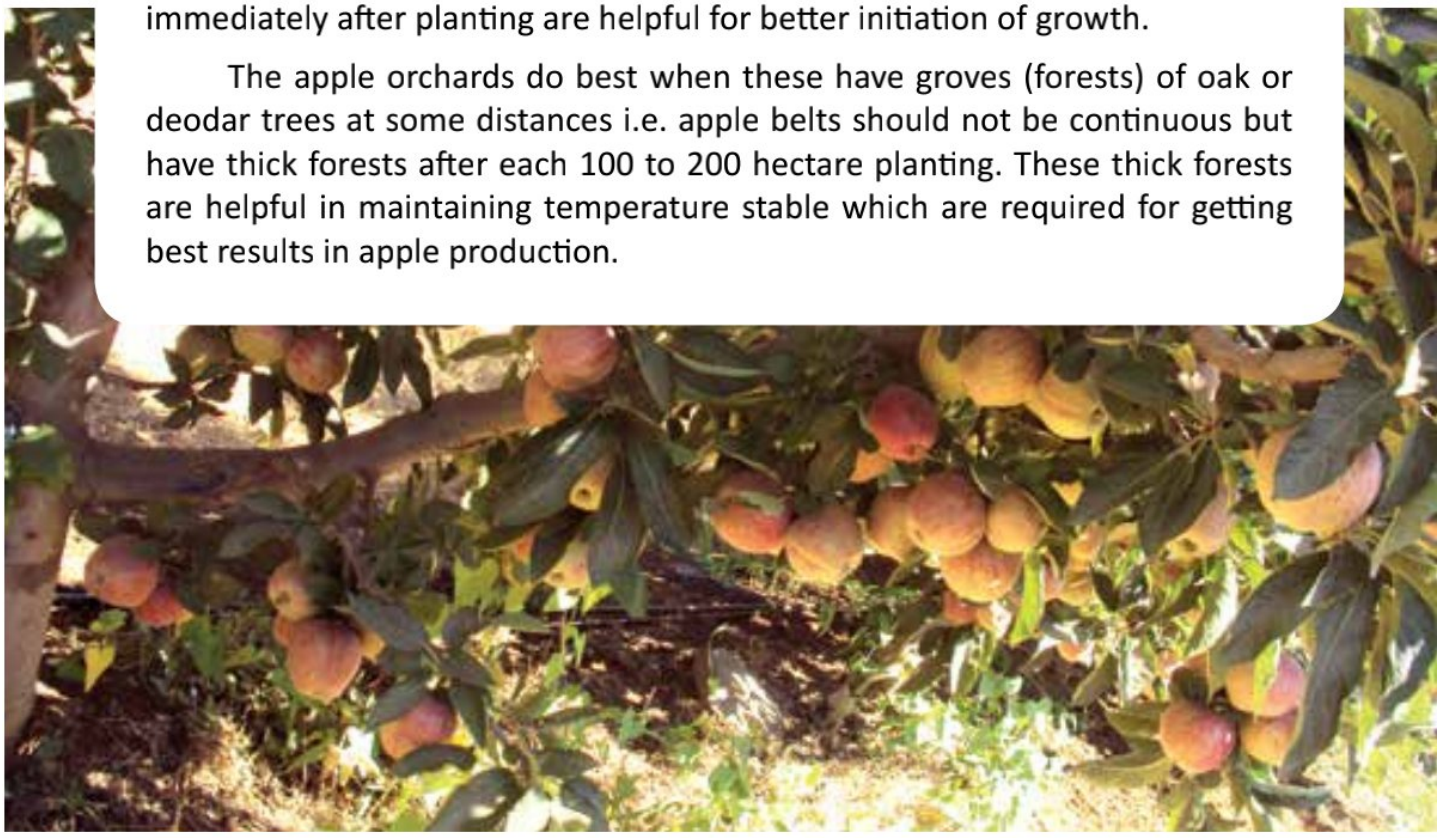
Well feathered two year old nursery plants are the ideal form that should be purchased where possible. These are better able to maximize canopy growth in the first two years of orchard establishment. The graft /bud union should be 8-10 cm above the ground after settling of soil occurs, and branches should not be closer than 60-70 cm to ground level. Branches should be well spaced up the main trunk, and the leader and side branches should be intact and not damaged. Ensure that there is sufficient root volume on each plant and these roots are healthy and free of root diseases.

In case the grafts are of one year age, the technique of bagging of the leader helps in the creation of laterals.

Planting is done from December to March. The roots are liable to injury from low temperatures; hence the plants are uprooted from the nursery as soon as possible after the leaf fall. The roots are covered with wet sphagnum moss and are further tightened with a sheet made up of jute. These are then sent to the desired destinations. On arrival at the respective places, these are put in shallow trenches and the roots are covered with soil where regular watering is practiced till their planting in the orchard.

In areas where the temperature during winter is around 0°C planting is completed by January. In winter the soil temperature remains few degrees above the air temperature, hence there will be growth of roots, though non-significant. This helps to nourish the plants on resumption of growth in the spring season. In areas where the temperature falls several degrees below 0°C, the best time for planting is March/ April. Watering and thick mulching immediately after planting are helpful for better initiation of growth.

The apple orchards do best when these have groves (forests) of oak or deodar trees at some distances i.e. apple belts should not be continuous but have thick forests after each 100 to 200 hectare planting. These thick forests are helpful in maintaining temperature stable which are required for getting best results in apple production.



8. SOIL MANAGEMENT

In standard planting where the trees are widely open, during early age when plants are young, there is plenty of vacant space available. This space can be used for growing of short duration crops particularly legumes and other vegetables. Hence there is regular cultivation of the orchard land initially for 5-6 years till the trees become large and the area is occupied by them. This regular cultivation facilitates the nitrification process hence better vegetative growth of trees is expected. In apple, fruits are borne on spurs which are formed on two year or older wood, therefore, once the trees have started fruiting, less vegetative growth is required which can be manipulated under semi-sod system of orchard soil management. In semi-sod system, the basin area of each tree is hoed and kept clean. Over rest of the area, natural grasses are allowed to grow but their growth is kept under control by mowing or cutting. Instead of natural grasses, cover crops can also be sown.

In high density planting, the trees are closely planted hence the area allotted is occupied within 3-4 year period and there is no scope for growing of short duration crops as intercrops. Cultivating to loosen soil around the base of the trees will promote growth. This cultivation should be at regular intervals before weed and grass competition gets well established. It should be shallow in depth so tree roots are not disturbed. It should be discontinued in July to avoid stimulating late tree growth that may be susceptible to winter injury. Weak weed growth under the trees by late summer can help trees harden off, and reduce soil erosion.

Soil fumigation, weed management & mulching

In many cases, tree growth of new orchards planted on old orchard land can be improved significantly with soil fumigation. Ideally, growers should conduct a bioassay before replanting an orchard site to assess the severity of replant problem and determine the value of soil fumigation. Growing a bio-fumigant crop such as *Brassicas* or mustard and ploughing in the soil to release

the active isothiocyanate compounds to fumigate the soil. Another method is to keep the site fallow for few years, adding organic matter either as composts or green manure crops or adding DAP fertilizers. Although these will improve the soil, they have not been proven to be as effective as fumigants or biofumigants in controlling replant disease pests and pathogens. Preferably apple orchard should not be established again on the same site from where the old apple orchard has been uprooted. It would be proper if other temperate fruits like plum or walnut be planted in cycles.

Weed competition can drastically reduce tree growth during the first few years and can cause a failure of the orchard to fill its allotted space which always results in diminished yield and profitability. Good weed control during the first 3-4 months of a growing season is the most critical period of the season. In later summer months if weed control is poorer it is not detrimental to the trees.

Placing a thick layer of dry grass or forest leaves on the soil basin of a tree is called mulching. For apple tree, the best time of putting mulch is from second fortnight of March to first fortnight of April after the snow has fully melted and the soil has become workable. After mixing of nitrogenous and potassic fertilizers into the soil, the area upto the tree spread is mulched with grasses/ leaves with 10-15 cm thick layer. It will help in conserving moisture significantly and also function as buffer for keeping the temperature of soil at normal levels. On rotting , it will add humus to the soil.

9. IRRIGATION AND FERTIGATION

Due to low frequency and uncertainty conditions of snowfalls and rains, the availability of water has become inadequate for normal growth and fruiting. Due to rainfed conditions or improper conventional irrigation practices, apple yield is affected greatly. Due to tough competition from imported apples in Indian market as well as competition and stringent quality expectation in export market, there is a great need of adoption of advanced irrigation and fertigation techniques.

What is drip irrigation ?

Drip Irrigation is the method of application of water and fertilizers directly near the root zone at frequent intervals and at low application rate so as to maintain proper air-water balance within the root zone of the crop. It is the pressurised irrigation system, water reaches to the farthest end under pressure and gives equal volume of water within the field area.

Characteristics of drip irrigation:

1. Water is applied at a low rate to maintain optimum air-water balance within the root zone.
2. Water is applied over a long period of time.
3. Water is applied to the plant and not to the land.
4. Water is applied at frequent intervals.
5. Water is applied via a low pressure delivery system

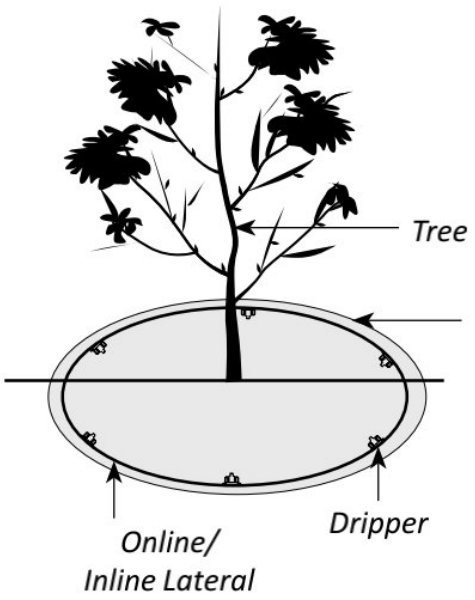
On resumption of growth after winter dormancy, apple trees should start getting irrigation. The flowering starts when the trees attain 4-5 years age. Drip Irrigation should commence two weeks after petal fall and continue till October. In case the water availability is limited, it should be used judiciously at critical stages of water requirement i.e., at (i) 20-25 days prior to flowering (ii) 1-2 weeks after petal fall (iii) 4-5 weeks after petal fall, and (iv) 3-4 weeks prior to fruit maturity. In such conditions drip irrigation plays vital role.

Advantages of drip irrigation system in apple

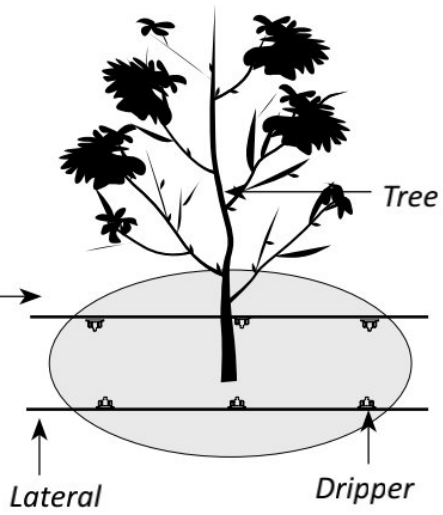
- With use of drip irrigation overall yield and quality of apple increases.
- During the prolonged gap of rainfall, drip irrigation is useful to avoid water stress, this timely survival irrigation also help to increase the yield.
- Drip irrigation promotes early maturity. Early harvest fetches higher price in the market and improves profitability.
- Drip irrigation increases the vegetative growth i.e., tree girth, tree height, shoot extension growth, tree spread, tree volume and leaf area.
- Drip irrigated apple exhibits higher flowering intensity and fruit set.
- With drip irrigation incidence of fruit drop reduces.
- Minimised fertilizer/nutrient loss due to localized application and reduced leaching.
- It is observed that use of drip irrigation accelerates assimilation and stimulates the formation of anthocyanin, which is responsible for red colour development.
- High water application efficiency. In hilly and undulating terrain, specially designed drippers can provide uniform discharge for change in static head.
- Reduction in manpower requirement. Operation of drip irrigation system involves least manpower.
- Energy saving. In hilly areas where sufficient elevation head is available, drip irrigation can be operated on gravity pressure without electricity.
- Control over weed growth, reduction in weedicide expenses and labour expenses.
- Improved disease control.
- Minimised soil erosion.

Layout of Drip Irrigation System

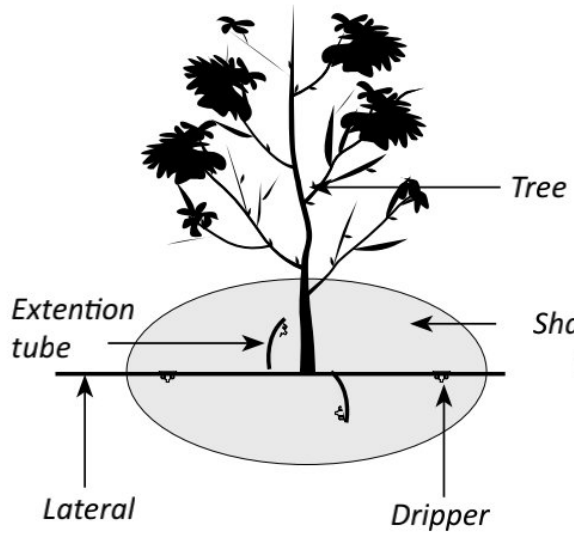
Loop Drip Irrigation



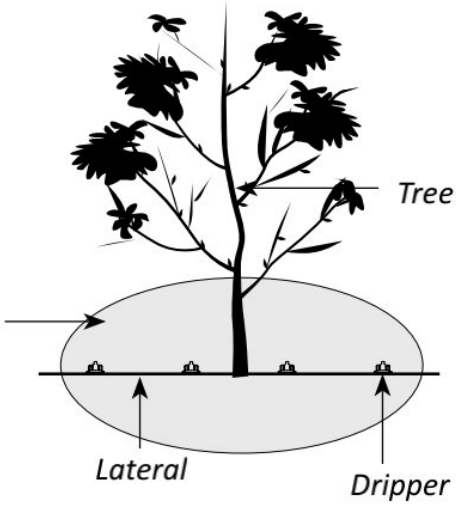
parallel Drip Irrigation



Online and Extenstion tube Drip Irrigation



For High Density Planting Drip Irrigation System



In water scarce areas for the purpose of drip irrigation, water can be stored in poly lined tanks from the water sources such as roof water harvesting, natural water springs, tube wells or by lifting water from rivers. If water is available near orchard from river, canals, etc., irrigation system can be directly connected from there. In cold regions, losses due to evaporation and transpiration are comparatively less as compared to warmer areas. The irrigation to plots can be designed accordingly during rainy season, if there is no rain for several days, irrigation has to be provided. On the basis of tree age, the approximate water requirement has been given in Table 4.

Table -4 (a): Approximate daily water requirement of apple trees under drip irrigation system. (Planting Distance 6x6 metre)

Age of tree (Year)	**Approximate daily water requirement in different months** (Litre/tree)*					
	April	May	June	July	August	September
1	1.0	1.5	3.0	4.0	4.0	3.0
2	2.5	5.0	10.0	13.0	14.5	11.0
3	3.0	6.0	12.5	17.0	19.0	14.0
4	6.5	13.0	26.0	35.0	38.0	29.0
5	10.0	20.0	40.0	55.0	60.0	45.0
6 and thereafter	14.5	29.0	58.0	79.0	86.0	65.0

Table 4 (b) : Approximate daily water requirement of apple trees under drip irrigation system. (Planting Distance 4 x 2.5 metre)

Age of tree (Year)	**Approximate daily water requirement in different months** (Litre/tree)*					
	April	May	June	July	August	September
1	1.0	1.5	3.0	4.0	4.0	3.0
2	2.5	5.0	10.0	13.0	14.5	11.0
3	3.0	6.0	12.5	17.0	19.0	14.0
4 & thereafter	6.5	13.0	26.0	35.0	38.0	29.0

- These values are for true temperate climate where winters are severe and are experiencing regular snowfalls. In summers, rains are scanty and precipitation is confined to few centimeters only.
- Area specific refinements are only possible through experiences or by using location specific climatic data and considering soil type. For intercrops like potato, french bean, tomato, cauliflower, cabbage etc., additional quantities of water will be required which can be estimated for each of these crops.

Online and inline system can be used for apple. It can be installed in loop type or using extension tubes.

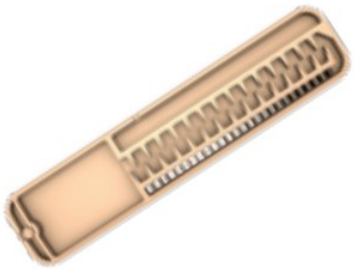
If the field is fairly flat (slope less than 2%), non pressure compensating dripper can be used. For slopes more than 2% or undulating terrain we have to use pressure compensating emitter. Following are the various options of drippers available,

Inline Emitter

There are several choices you have for selection of inline emitters,

1. Jain Turbo Excel®

- Available discharge rates - 0.85, 1.2, 1.6, 2.1, 4 lph @ 1kg/cm².
- 12, 16, 20, 25 mm nominal diameter.
- Dripper Spacing 15, 20, 30, 40, 50, 60, 75,90 cms.
- Suitable for surface as well as subsurface installations.
- Can be used for loop system



Jain Turbo Excel®

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2. Jain Turbo Line® Super

- Available discharge rates (at 1kg/cm²)

  12mm - 2.2, 4 lph

  16mm - 4, 8 lph

  20mm - 2.2, 4, 8 lph
- Availabe in 12, 16 & 20 mm nominal diameter.
- Suitable for surface as well as subsurface installations.
- Can be used for loop system

Jain Turbo Line® Super

3. Jain Turbo Top

- Available discharge rates – 1 & 1.6 lph
- Injection moulded silicone rubber compensates with pressure and discharge gives uniform performance.
- Anti Syphone feature (optional) prevents suction of sand and silt particles inside the dripper.
- Cascade labyrinth gives strong, self-cleaning turbulence.
- Available in 16 & 20mm nominal diametre.
- Suitable for surface as well as subsurface installations.
- Can be used for loop system

Jain Turbo Top

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4. Turboline PC

- Available discharge rates - 1.3, 1.6, 2.6, 4 & 4.5 lph at 1 kg/cm² Pressure.
- Injection moulded silicone rubber compensates with pressure and discharge gives uniform performance
- Application on the undulating land/ Terrains/ Steep slopes.
- Applicatiion where ever longer lateral length is necessary.
- Available in 16 & 20 mm nominal diametre.
- Suitable for surface as well as subsurface installation.
- Can be used for loop system

Turboline PC

Online Emiter

In online emitters, drippers are punched on to the tubing.

1. J-Turbo Key Plus

- Available discharge rates - 2,4, 8 and 14 lph at 1 kg/cm².
- Turbulent flow path with wide cross sectional area makes the dripper clog resistant.
- Narrow cross shaped inlet acts as a filter.
- Openable dripper - easy to clean.
- Extended outlet facilitates use of polyethylene extension tube, vinyl tube with multioutlet connector arrangement.

J-Turbo Key Plus

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2. J-SC PC Emitter

- Available discharge rates - 2,4 and 8 lph for the pressure compensating range of 0.8 to 3 kg/cm².
- Self cleaning design ensures flushing at start up, shut down & during operation.
- Hydraulically designed turbulent flow path emitter with wide cross sectional area and precision inlet filter that makes it a truly clog resistant'.
- Silicone rubber diaphragm ensures consistent performance for longer period.
- Application on the undulating land/ Terrains/ Steep slopes.
- Applicatiion where ever longer lateral length is necessary.
- Protected cross-shaped water inlet.
- Optional Anti-bug cap- prevents entrance of ants/bugs into the dripper.

J-SC PC Emitter

3. Click Tiff - HD

- Available discharge rates - 2,3,4, 8 and 12 lph for the pressure compensating range of 0.5 to 4 kg/cm².
- Strong turbulent flow in labyrinth with continual cleaning and flushing makes emitter a truly clog resistant.
- Silicone rubber diaphragm ensures consistent performance for longer period.
- Application on the undulating land/ Terrains/ Steep slopes.
- Applicatiion whereever longer lateral length is necessary.
- Protected cross-shaped water inlet.
- Can also be in PC (Pressure Compensation) & PCNL (Pressure Compensating Non Leakage) arrangement.
- Optional Anti-bug cap- prevents entrance of ants/bugs into the dripper.

Click Tiff

Apart from these drippers, micro sprinklers can also be used for irrigation of apple. Micro sprinklers can be installed above the tree as overhead micro sprinklers or underneath the tree. Where frost protection is necessary, micro sprinkler can be a better choice. It serves the purpose of irrigation, evaporative cooling and frost protection. Choices available with micro sprinklers are,

1. Aqua Master

- Innovative structure for improved durability, performance and insect protection.
- Unique water spreader for optimum distribution, maximum range and fine droplets.
- Can be used for under tree irrigation system or overhead above the apple tree if to be used for frost protection and irrigation.
- Uniform precipitation rate between 2 to 8 mm/hr.
- Uniform coverage over a wide range of spacing, flow rates and pressures.
- Special arrangement for rod attachment.
- Wide flow range 100 to 260 lph at an operating pressure of 1.5 kg/cm².
- Radius of throw from 4 m to 6 m.

Aqua Master

2. 501-U

- Special turbo hammer arrangement for uniform distribution.
- Can be used for under tree irrigation system or overhead above the apple tree if to be used for frost protection and irrigation.
- Uniform precipitation rate between 1.5 to 7 mm/hr.
- Wide flow range, 100 to 170 lph at an operating pressure of 1.5 kg/cm².
- Fine water droplets for delicate crops.

501-U

Apart from these Micro Sprinklers larger overhead Sprinkler like 233 B AF- Lal Topi can also be used for Irrigation and Frost protection purpose. For details please see Frost Protection Chapter.

In high density, all super dwarf and semi dwarf clonal rootstock have a limited root volume, most of the roots that feed are located in the top 30 cm of soil profile. The M.9 rootstock is much less tolerant to dry soils than the vigorous rootstocks like MM-111 or apple seedlings. Further, large highly feathered trees produce much more leaf area shortly after planting than un-feathered trees which creates a high water demand before the root system can re-grow sufficiently to support the trees. Frequent and early drip irrigation can help these trees produce good growth in the first year. Hence, it is recommended that growers should install drip irrigation system soon after planting to prevent water stress and maximize initial years tree growth.

Soil that have adequate moisture available throughout the growing season are likely to establish better trees, grow more fruit bearing shoots, initiate more and healthier fruit buds and produce larger, better keeping quality apples. Each mature apple tree on fully dwarfing rootstock may require 25-35 litres of water per day in May, June, July and August when applied with a drip irrigation system. Irrigation can influence the individual sizes of fruit in the orchard, and have a positive effect on the following year crop. A tree experiences stress of available moisture long before its leaves wilt. The ideal situation is to have a continual supply available all through the season so growth is not interrupted and the tree is not stressed. A level of 40-50 per cent

available soil moisture(A.S.M) is considered adequate for all soil types. With drip irrigation system the A.S.M under the emitters is maintained at 85-90 per cent. The A.S.M. can be determined by feel. Fine textured soils (silt and clay loams), which can be cupped in the hand and gently squeezed and moulded into the ball that holds together, probably contains upto 50 per cent A.S.M. A ball which is somewhat crumbly, although holds together with pressure, may contain only 30 to 40 per cent A.S.M. or less.

Frequent low doses of nitrogenous fertilizer delivered at least twice weekly through the drip system for the first 12 weeks of resuming growth will greatly improve tree growth during the first 2 years to speed development of the canopy. With high tree densities as with the Slender Spindle system and highly feathered trees, almost no lateral tree growth is required and only vertical extension growth is needed. Adoption of immediate fertigation of highly feathered trees will considerably improve tree growth and vastly improve yield potential during the initial years of orchard establishment. For moderate densities, trees must be grown vigorously for several years to fill the allotted space with canopy and relatively high nitrogen fertilization is desirable for 2-3 years after planting. However, excessive N fertilization can cause too much growth which results into delayed flowering, reduced yields, poor fruit quality and greater pruning.

After the development of canopy, the mature trees should be fed with low nitrogen fertilization to keep the trees “calm” with a balance between vegetative growth and fruiting. The soils which are rich in organic matter or have complex proteinacious substances in them produce 30 to 60 kg/ hectare of nitrogen annually through nitrification. This is almost half of the total amount needed by mature high density orchards. The 1/3rd of N requirement is given in April as active root growth starts before any obvious bud development in the tree canopy. The remaining 2/3rd of the N requirement is applied in equal amounts with subsequent irrigation in May and June, but not thereafter. Termination of N application in June is required to slow vegetative growth and promote hardening off for winter. Calcium nitrate is the preferred N source for fertigation of fruit trees because soil acidification occurs more slowly. The K is injected in equal amounts with each irrigation in July and August. The delayed application of K relative to N is to enhance fruit colour, winter hardiness , tree growth and disease resistance during the latter half of the growing season The drip lines must be flushed immediately after each fertigation to prevent plugging of the emitters.

Jain Fertigation Equipment

There are various equipment which can be used for fertilizer injection through drip irrigation system.

1. Fertilizer Tank

- Metalic powder coated tank operates on differential pressure.
- Operates even at low differential pressure.
- Available 30,60,90, 120 & 160 liters capacity.

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2. Venturi Injector

- Simple easy to use device.
- Available in ¾, 1, 1¼, 1½ & 2" BSP connection.
- Suction rate 40 lph to 1400 lph.
- Excellent chemical resistance to most of the chemical.

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3. Injector Pump

- Hydraulically operated pump, no electricity required.
- Can be used a precision injection of fertilizer.
- Low pressure loss.
- Suction rate from 50 lph to 150 lph.

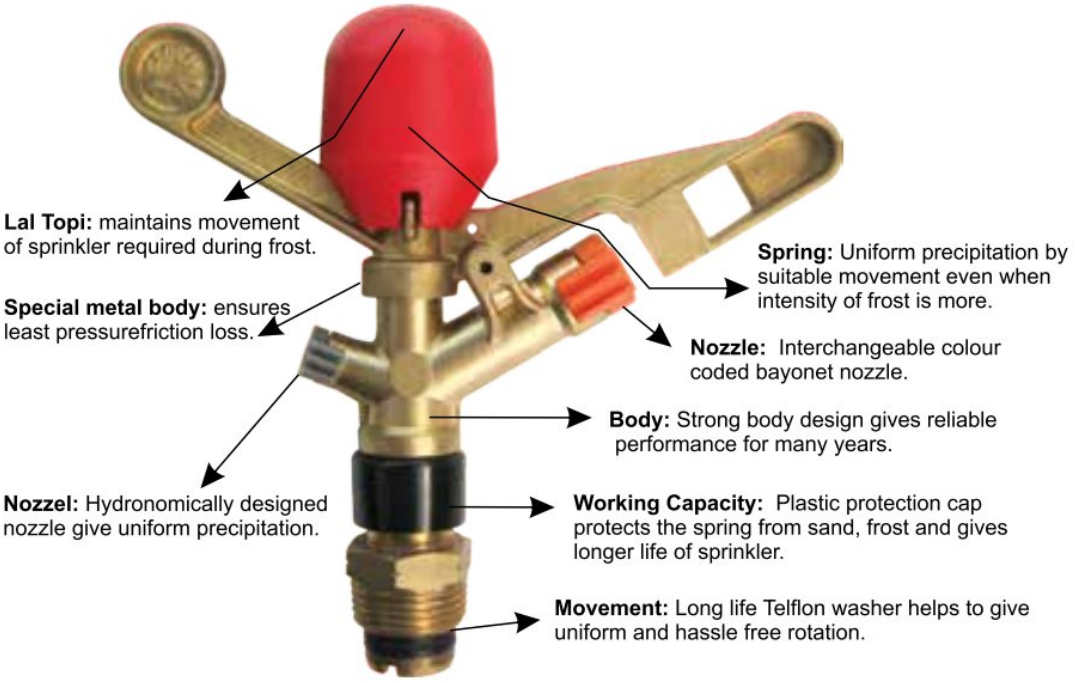
Jain Integrated Automation Systems

Automation of an irrigation system refers to operation of the system with no or minium manual intervention. The introduction of automation in irrigation system has increased application efficiency and drastically reduced labour requirment.

Advantages of Aumation Systems

- Conservation of Water and labour : Since the systems are automatic, they do not require operator.
- Systems & Operational flexibility : As desired, any valve can be controlled along with the pump.
- Increased efficiency of water and fertilizer use.
- Systems can be operated at night.
- Saving in energy, cost and water.

233 B AF - Lal Topi Sprinkler
Irrigation as also Frost Protection



Lal Topi Sprinkler - 233-B AF

- Superior technology from the world leader in sprinklers – NandanJain Irrigation.
- Sprinklers body manufactured with special metal ensures smooth inner surface. This reduce pressure friction loss compared to traditional sprinklers.
- Specially designed for frost protection. The top lal topi completely seals and protects the sprinkler from frost damage.
- In case of heavy frost fast, moving of sprinkled water removes frozen snow from the surface of plants.
- Does not allow temperature near plants to go below 0°C due to which frost does not settle on the crops and this way these are saved from frost damage.
- This is installed for irrigation and frost protection in apple, pear, walnut, cherry, litchi, almond, peach, plum, mango, kinnow mandarin and other fruits also.
- Lal topi sprinkler is capable for irrigation and frost protection in vegetable, medicinal and other crops.

Necessary for frost protection

- Suitable, movable speed of sprinkler
- Water distribution in suitable quantity
- Uniform precipitation rate

Jain Sprinklers More Crop Per Drop | NAANDANJAIN Irrigation

Principles of frost protection by Red Cap Sprinkler

- If snow and water is mixed below freezing point, temperature does not go below 0° C. until and unless whole water is freezed.
- Crops are not affected adversely from frost if temperature is lower than freezing point because for freezing of plant protoplasm the temperature should be below 0 degree c.

Nutrient requirement and fertigation schedule for standard planting

Age (in Yrs)	Nutrient Requirement / Plant								Fertigation schedule and quantities of chemicals /plant/dose								
	Period	N (g)	P (g)	K (g)	Ca (mg)	Mg (mg)	Zn,Fe, Cu,Mn (each) (mg)	B, Mo, each (mg)	No.of doses (1 in a week)	Urea (g)	Phosphoric Acid(ml)	Murate of Potash (g)	CaNO3 (mg)	MgSO4 (mg)	Zn, Fe, Cu,Mn (Sulph). (mg)	Boric Acid (mg)	Ammonium molybdate (mg)
1	March-August	60	60	60	300	250	200	200	24	5.4	2.7	4.2	62	52	42	50	16
2	March-August	120	120	120	300	250	500	200	24	10.9	5.4	8.3	62	52	105	50	16
3	March-August	180	180	180	500	500	500	500	24	16.3	8.1	12.5	104	104	105	125	40
4	March-August	240	240	240	2000	2000	1000	1000	24	21.7	10.8	16.7	416	416	210	250	80
5	March-August	300	300	300	4000	4000	2500	2500	24	27.2	13.5	20.8	832	832	525	625	200
6	April	120	216	0	0	2000	1700	800	4	65.2	60	0	0	2500	2125	1176	385
	May-June	240	144	120	0	0	0	0	8	65.2	20	25	0	0	0	0	0
	July-August	0	0	240	6000	4000	3300	1700	8	0	0	50	3750	2500	2063	1250	408
7	April	140	252	0	0	3330	1700	800	4	76.1	70	0	0	4162	2125	1176	385
	May-June	280	168	140	0	0	0	0	8	76.1	23	29.2	0	0	0	0	0
	July-August	0	0	280	10000	6670	3300	1700	8	0	0	58.3	6250	4168	2063	1250	408
8th and on-wards	April	160	288	0	0	3330	1700	800	4	87	80	0	0	4162	2125	1176	385
	May-June	320	192	160	0	0	0	0	8	87	27	33.3	0	0	0	0	0
	July-August	0	0	320	10000	6670	3300	1700	8	0	0	66.7	6250	4168	2063	1250	408

Note: 1. *Fertilizer schedule needs to be adjusted as per crop growth stages as months may vary with locations. April refers to before flowering and leafing stage, May-June refers to fruit growth and July-Aug. refers to fruit enlargement stage.*

2. *In place of Phosphoric acid, the mono-ammonium phosphate (MAP) can be used. Alternatively SSP or DAP can be applied in soil during Dec -Jan.*

Nutrient requirement and fertigation schedule for high density planting

Age (in Yrs)	Nutrient Requirement / Plant								Fertigation schedule and quantities of chemicals /plant/dose								
	Period	N (g)	P (g)	K (g)	Ca (mg)	Mg (mg)	Zn,Fe, Cu,Mn (each) (mg)	B, Mo, each (mg)	No.of doses (1 in a week)	Urea (g)	Phosphoric Acid(ml)	Murate of Potash (g)	CaNO3 (mg)	$MgSO_4$ (mg)	Zn, Fe, Cu Mn (Sulph). (mg)	Boric Acid (mg)	Ammonium molybdate (mg)
1	March-August	30	30	30	200	200	100	100	24	2.7	1.4	2.1	42	42	21	25	8
2	March-August	60	60	60	200	200	300	100	24	5.4	2.8	4.2	42	42	63	25	8
3	March-August	90	90	90	300	300	300	300	24	8.2	4.2	6.3	63	63	63	75	24
4	April	40	72	0	0	330	200	200	4	21.7	20	0	0	413	250	294	96
	May-June	80	48	40	0	0	0	0	8	21.7	6.6	8.3	0	0	0	0	0
	July-August	0	0	80	1000	670	300	300	8	0	0	16.7	625	419	180	220	72
5	April	50	90	0	0	670	400	400	4	27.2	25	0	0	838	500	588	192
	May-June	100	60	50	0	0	0	0	8	27.2	8.3	10.4	0	0	0	0	0
	July-August	0	0	100	2000	1330	800	800	8	0	0	20.8	1250	831	500	588	192
6	April	60	108	0	0	1000	800	400	4	32.6	30	0	0	1250	1000	588	192
	May-June	120	72	60	0	0	0	0	8	32.6	10	12.5	0	0	0	0	0
	July-August	0	0	120	3000	2000	1700	800	8	0	0	25	1875	1250	1063	588	192
7th & on-wards	April	70	126	0	0	1670	800	400	4	38	35	0	0	2088	1000	588	192
	May-June	140	84	70	0	0	0	0	8	38	11.6	14.6	0	0	0	0	0
	July-August	0	0	140	5000	3330	1700	800	8	0	0	29.2	3125	2080	1063	588	192

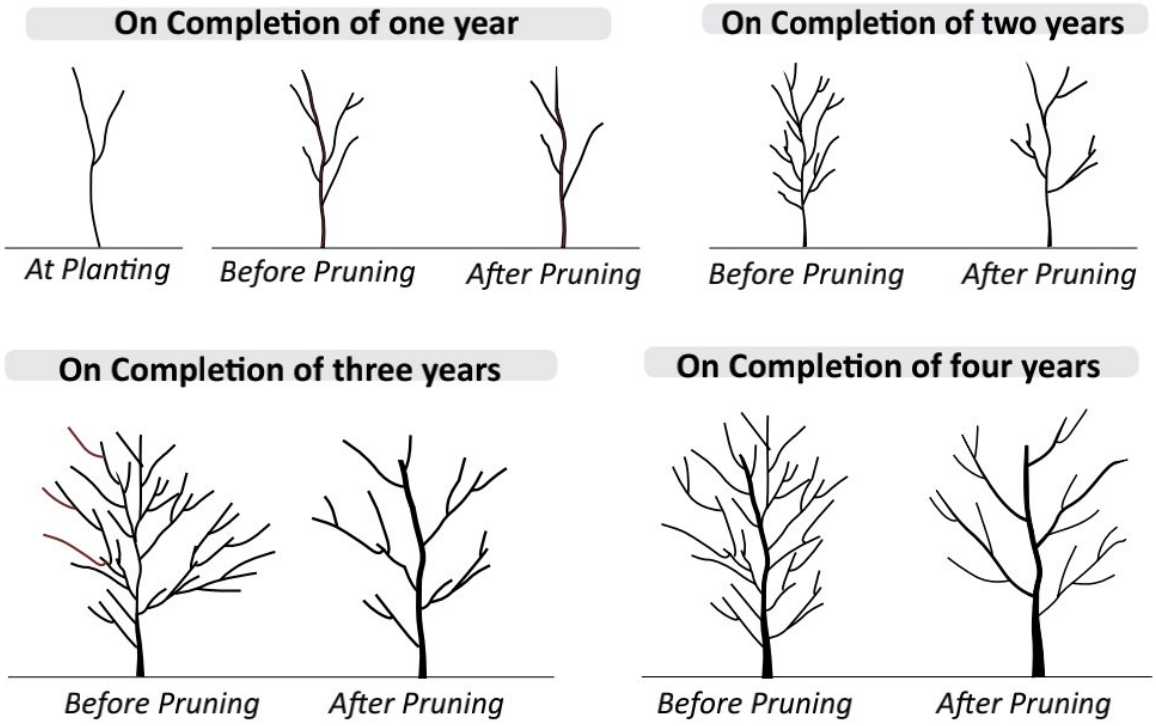
1. Fertilizer schedule needs to be adjusted as per crop growth stages as months may vary with locations. April refers to before flowering and leafing stage, May-June refers to fruit growth and July-Aug. refers to fruit enlargement stage.

2. In place of Phosphoric acid, the mono-ammonium phosphate (MAP) can be used. The alternatively SSP or DAP can be applied in soil during Dec -Jan.

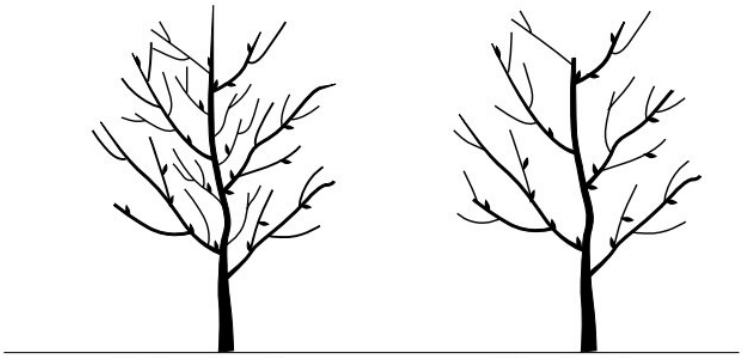
10. TRAINING AND PRUNING

Standard Planting

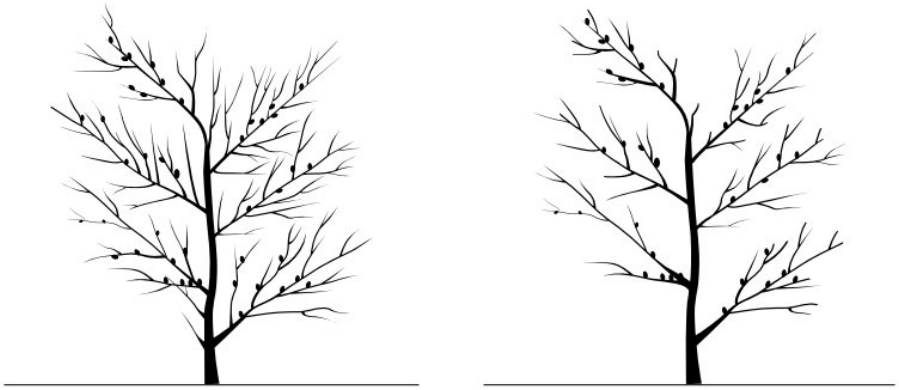
The widely spaced apple trees are trained to modified leader system. The shoot growing centrally is chosen as leader. The side shoots which are about 5-7 in number are selected over a period of 4-5 year. The first side shoot is retained at a height of 50-60 cm from the ground level, and thereafter, the difference between two adjoining branches should be in the range of 30-40 cm. The selected branches must have 45 to 60 degree angle to the leader shoot; secondly, these branches must have less vigorous growth than the leader branch; thirdly, these should be in different directions. On completion of selection of side branches, the growth of leader shoot is directed at 45° angle so as to modify it as a final and terminal side shoot. Over the years, the leader branch becomes trunk and side branches become scaffolds or limbs.



On Completion of five years



Pruning in bearing apple tree



Apple trees on vigorous rootstock start bearing fruit on attainment of about 4-5 years age. The objective of pruning of a bearing tree is to provide sunlight in the inner parts of a tree and lower the speed of vegetative growth. First of all, dried and diseased branches/portions are removed. Secondly, heading back of scaffold branches is performed upto strong laterals. Generally the heading back cuts on scaffold branches are made by removing top 2–4 side branches below upto a strong lateral. As one goes down, it invigorates to sprout the dormant buds further down on the scaffold. Hence, the severity of heading back cut is dependent on the requirement of vegetative growth during the following year. In this context the practical experience of the pruner is helpful to decide as to how deep should be the heading back. During pruning, the branches bearing old spurs and the branches which are weak and crowding are removed.

High Density Planting

Without putting if and buts, the ideal tree shape for close (high density) planting is a narrow cone. The tree will have a single trunk with fruiting units arranged evenly from 60-80 cm height to the top. There are three most common training systems as : (1) Slender Spindle (2) Vertical Axis and (3) Trellis.

1) Slender Spindle

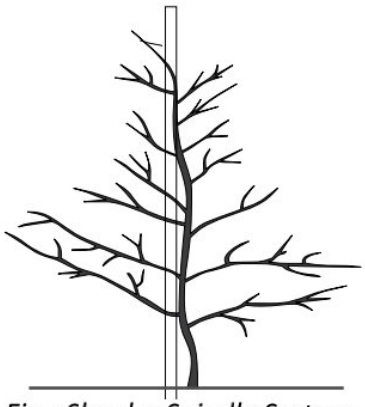


Fig.: Slender Spindle System

It consists of an individual support post at every tree . The post should be 2.5 to 3 metre in length and of pressure treated wood, concrete or metal to ensure it lasts the life of the orchard(Approx. 20-25 years) . A diameter of 5 to 6 cm is preferred. The depth of the post in the ground should be 60 to 90 cm for stability leaving rest of the portion above ground. The leader must be manipulated in some manner to ensure continuous branching. The main characteristics of this system are :

i) Height controlled at about 2.5 metre .

ii) Maximum width of tree spread is 2 metre.

iii) Lateral branches continuously along the central leader

iv) One or two permanent whorls of laterals can be established in the lower portion of the tree .

v) Leader management for profuse lateral branching is important to generate fruiting wood production and to increase the number of growing point to control vigour.

vi) Lateral shoot positioning is important to control vigour and encourage fruiting. This positioning is also necessary to stimulate secondary branching.

vii) Trees must have a permanent support system for the total height of the trees to attach the leader to every 40- 45 cm. This support holds trees stable in soil and supports the fruit load.

2) Vertical Axis

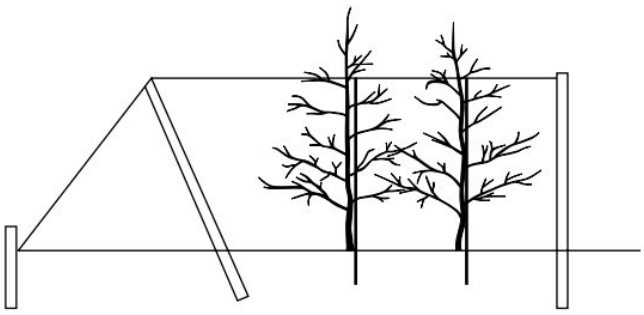


Fig.: Vertical Axis System

A strong un-headed leader is encouraged to grow until it reaches to about 3.5 to 4 metre from the ground i.e., the trees are taller than Slender Spindle system . This is the main feature that distinguishes it from Slender Spindle system. This central axis forms a short shaft around which lateral branches radiate to form a narrow cylinder of fruit bearing wood. The diameter of the branches should gradually decrease to the top of the tree, and these should always be smaller than the trunk where located. There should be lessening in the length of the laterals from the bottom to the top, this result in a slender conical shaped trees. The distance between

the branches should be less towards the top of the tree in order to allow for maximum light penetration.

This system basically consists of one or more high tensile steel wire (s) drawn tight and supported 2-3 metre above the ground by a series of in - line posts spaced 9 to 15 metre apart. The closer the spacing for the inline posts, the higher the degree of stability of the support system under strong wind or high crop load conditions. Individual trees in the row are supported by vertical leader supports that reach up to the top support wire.

3. Trellis

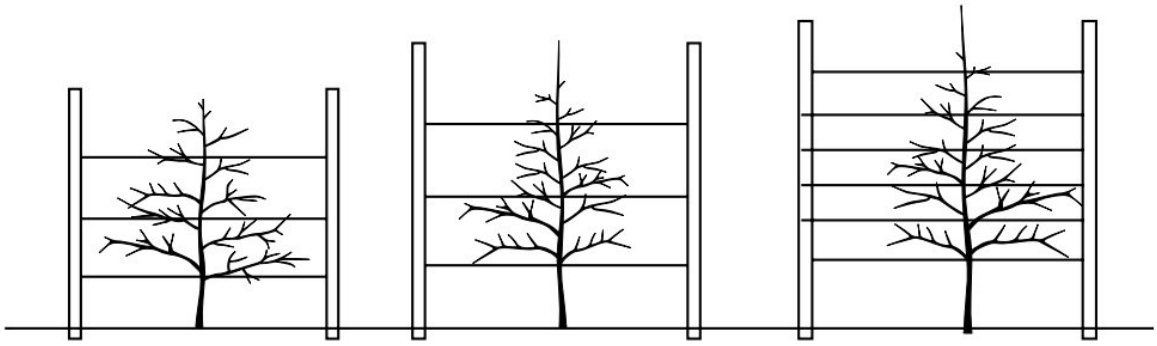


Fig : Trellis System

There is positioning of laterals along the supporting wires. The trees at planting are normally headed 15 cm above the bottom wire. Shoot growth is allowed to proceed un-manipulated until mid July. Upright shoots and water sprouts are removed during August to minimize re-growth and vigour. Completion of every layer is important in a Trellis system. Do not allow a strong leader to reach the top of the trellis too fast. Unlike the Vertical Axis there is no support alongside each individual tree. Instead, branches are trained horizontally along the wires.

The lowest two wires should be installed when trees are planted, to allow them to be supported immediately. Usually the first wire is 50-100 cm from the ground. From this point upwards the wires are required at 0.5 to 1 metre distance. Wires should be added as the trees grow. Placing wires on alternate sides of the tree trunks provide additional support. Tree trunks are attached to the wires either by flexible ties or staples.

In India, the apple orchards are planted/ being planted on slopy fields hence, Slender Spindle system is better suited over other two systems. In case of gentle slopes the Vertical Axis or Trellis can also be considered.

Under high density system pruning requirement is much lower once orchard comes under production than the conventional planting. Only light pruning is required to thin out water sprouts and some time renewal pruning for damaged branches to develop new ones.

Pruning

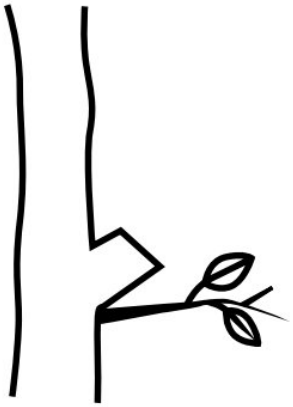


Fig : Renewal Pruning Cut (Angled or sloped cut)

The appropriate pruning approach is to annually remove 1-2 large upper branches completely during winter and develop younger replacement branches. The removal of entire branches in the upper portion of high density apple trees helps to open channels for light penetration which maintains fruit production and quality in the bottom of the canopy. This renewal pruning is the single most important pruning concept for mature high density orchards to contain the canopy and maintain a concrete shape. To assure the development of a replacement branch, the large branch should be removed with an angled or shaped cut so that a small stub of the lower portion of the branch remains. From this stub a flat weak replacement branch often grows. This type of pruning does not stimulate vigorous re-growth.

Once branches have become horizontal or hanging under the weight of crop, these can be shortened by heading back cuts without adverse effects since the terminal bud no longer exerts significant control over the branch, However, if the overall vigour of the mature tree remains high, leaving the hanging branches long will help increase cropping and reduce the vigour of the tree. After a number of years, if the hanging branches begin to shade the bottom half of the tree these should be removed with a renewal cut and a replacement branch developed.

Time of Pruning

Pruning can be started few days after the tree enters into dormancy and is completed at least one month prior to resumption of growth in Spring. In areas where the winter season is moderate, the pruning operations should be completed early in the season. It gives sufficient time for healing of wounds made during pruning. Contrary to this, in areas where the minimum temperatures remain several degrees below freezing point, the pruning should be delayed until the danger from severe cold is over because there are chances of drying of succulent branches due to severe cold. In other words, early pruning under extremely cold conditions can lead to severe losses to branches and fruiting wood. Late pruning under similar climatic conditions removes winter injured shoots before any further pruning is done. For example, in the areas like Kullu-Manali of Himachal Pradesh and Ramgarh-Mornaulla areas of Uttarakhand, pruning should be done in December-January while in areas like Lahaul-Spiti and Harsil, it may be delayed and preferably be done during March.

11. PROVISION OF POLLENIZERS AND POLLINATORS

Apple, because of being self- incompatible, needs cross pollination. To provide pollen to the main cultivar, a provision is made of the pollen donor cultivars i.e., pollenizers. These pollenizers must be compatible and should also have synchronization in flowering. For Delicious group of cultivars, Golden Delicious, Red Gold, Lord Lambourne and Tydeman's Early Worcester; and for spur cultivars, the Gala and Fuji are the good pollenizers, respectively. The number of these pollenizer plants may be 10-20 per cent of the main cultivars and should be well scattered over the orchard. In areas where the climate is not static during flowering, the number of pollenizers may be increased to 30 per cent. It will also be a good practice to have apple seedling plants on the boundaries of the orchard. These will serve dual purpose, one as wind break and another as pollenizer.

New research shows that Bumble Bees are more effective pollinator than honey bees as they are able to work under lower temperature (up to 10^0C) when honey bees don't work. Bumble bees are now available commercially.

The apple pollen being heavy are carried by honey bees from one flower to another flower. The foraging nature of honey bees is very peculiar. When these are placed in the orchard when there are no flowers, they will go to near by trees or forest area for foraging and shall continue to do so even when flowering in apple orchard has occurred. Looking to this nature of honey bees, it is recommended to place/ transfer honey bee hives in the orchard only when at least 25 per cent flowering has occurred in the orchard. They will remain inside the orchard for their food as it will be a new area for them. Three strong colonies of honey bees are required for the effective pollination of one hectare of an apple orchard.

In square or hexagonal systems of planting, the honeybee flights are zigzag and in one flight, a honey bee generally visits three adjoining trees. Hence, the planting plan should be made in such a way that out of three trees, there should at least be one tree of the pollenizer cultivar. In case of rectangular system, the honey bee flights are straight hence, after about 18-20 metre distance there should be a tree of pollenizer cultivar. Honey bees prefer the fragrance of flowers therefore, sprays of any chemical should be avoided during flowering.

12. USE OF GROWTH REGULATORS

To Control fruit drop: The fruit drops may occur as; (1)early drop due to unpollinated or unfertilized blossoms, (2) June drop due to either moisture stress or over load of fruits, and (3) pre-harvest drop.

The problem of fruit drops is more common in early maturing cultivars. Spraying of Naphthalene Acetic Acid (NAA) @ 10 mg/litre (Planofix is the commercial formulation of NAA of which 1 ml is dissolved in 4.5 litre water to achieve the required concentration) is most effective. The spray is done about a week before the expected drop.

To improve fruit set: There is a problem of normal fruit setting in climatically marginal areas. Formulations like Miraculan (0.75 ml/litre) or Paras or other similar compounds (0.6 ml/litre) or other similar compound or Biozyme/ Protozyme (2 ml/litre) can be sprayed twice at (a) pink bud stage, and (b) immediately after petal fall.

To improve surface colour and enhancement of maturity: Apple surface colour development is greatly hampered in areas where temperatures during summers are high. Similarly, at high altitudes, the maturity is comparatively late. Application of ethrel @ 2.5 ml/l if sprayed about 10-12 days prior to harvesting date greatly improves colour and also enhances maturity. The application of ethrel is recommended at the stage when maximum fruit size has been attained and about 30 % red colouration has developed. Planofix (1ml in 4.5 litres) should be added to ethrel to arrest the excessive fruit drop caused by ethrel. Further, ethrel treated fruits are not suitable for storage as they have poor shelf life.

In old orchards of standard planting system use of paclobutrazol is also helpful in improving fruiting and reducing alternate bearing.

13. FROST PROTECTION

When the temperature during night drops below 4°C the water particles in the air are crystallized and are deposited on plant parts and also on all the exposed surfaces. It is called White frost. When there is very low humidity in the air and temperature drops to below 4°C during night, the frost occurs without deposition of any ice particles. It is called Black frost.

The occurrence of frost is a common phenomenon in subtropical and temperate zones of the earth. The temperate zone fruit trees remain in deep dormancy from December to February or upto March (>2400 metre above msl in Himalayas). The temperate fruit trees are benefited from these frosts by getting chilling temperature and completing their chilling requirement. The harm from frosts to apple starts after their chilling requirement is met and when they are able to resume growth. In case the frosts occur during the period of bud swelling to petal fall, it is very harmful, and many a times crop failures occur significantly.

Several devices have been developed to protect the bloom from frost such as giving irrigation to the orchard few days before bud swell, mixing of warm air settled above at about 100 metre height from ground, putting electric / solar heater during mid night for few hours and putting of caps on individual plants of small stature. Giving irrigation prior to bud swell stage is helpful as the water on freezing releases latent heat which raises temperature up to few degrees of the microclimate.

The small stature plants can be protected from frost by putting caps over them in the evening and removing with the sunrise. The science here involve during day time plant body gets warm and in the night gets cool. In case it is covered with caps (inorganic or organic) in the evening the heat released by the plant body remains all around the plant which is capable to protect it from frost.

Easy and convenient method to protect plants from frost damage is to sprinkle water above the canopy during frost hours.

Principle of Overhead Sprinkler Frost Protection

The principle of this method based on three factors,

1. When water freezes its latent heat is released. This latent heat keeps the temperature of the plant from dropping below freezing point.
2. A mixture of ice and water exposed to below freezing point remains at 0 degree Celsius until all the water is frozen.
3. Plants do not suffer frost damage until the temperature drops slightly below 0° C because the freezing point of plants liquid is below that of water.

Continuous sprinkling of water above the canopy during the frost allows plant tissue to take specific heat from water to protect them self from falling temperature below critical limit and prevent nucleation of plant cell fluids.

Key considerations

Successful protection of crops from frost damage using sprinklers depends on two crucial factors:

A. The rotation speed of the sprinkler.

B. Rate and uniformity of water application.

A. The rotation speed of the sprinkler

Effective protection from frost damage relies on the continuous release of latent heat as the water freezes. If the rotational speed of the sprinkler is too low there will be enough time for complete freezing to take place before the sprinkler has a chance to apply more water to allow the heat release process to start again.

B. Rate of uniformity of water application

The volume of water in relation to area has been found to be one of the most important considerations when designing for frost protection. The application rate is calculated after considering factor such as air temperature, wind conditions, humidity levels and critical temperature of crop. Table refers required minimum precipitation rates.

Approx. Minimum temperature ^{0} C	-3.3 to -3.9	-4.4 to -5.0	-5.3 to -5.8	-5.8 to -6.7	-6.9 to -7.8
Min. precipitation Rate, mm/hr	2.5	3.0	3.8	4.6	6.4

Extreme care shall be taken while selecting the sprinkler and sprinkler spacing for frost protection application. Frost protection system can not be

operated section by section. Entire system has to be started at the same time. Sufficient water availability in the reservoir is a must. As temperature plays very important role in frost protection system, it is recommended to have automatically operated system based on temperature sensor. Ensure that the electricity shall be available continuously throughout the freezing period when sprinklers are operated. It is recommended to have sufficient electrical back up for this system.

Jain's "LAL TOPI" sprinklers are specially designed for this purpose. These sprinklers can be installed above the canopy and operated during frost hours.

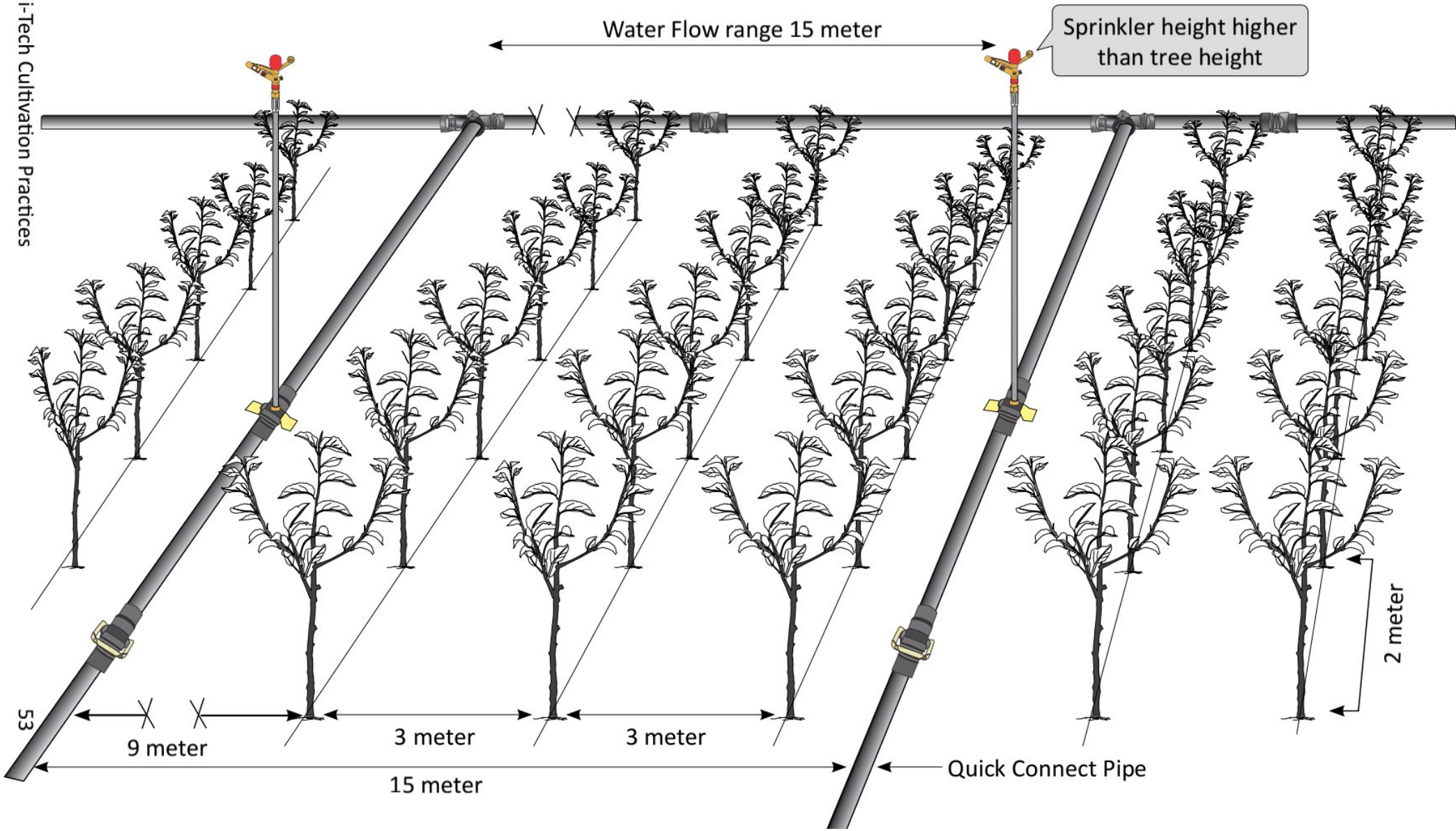
Jain Lal Topi - 233 B AF - Anti Frost Sprinkler

Apart from "Lal Topi - 233 B AF " sprinklers, we can also use micro sprinklers for frost protection system.

- Superior technology from the world leader in sprinklers – NandanJain Irrigation.
- Nozzles manufactured with high quality special plastic materials provide resistance to corrosion, chemical and UV radiation as well as uniform water distribution for many years. .
- Sprinklers body manufactured with special metal ensures smooth inner surface. This reduces pressure friction loss compared to traditional sprinklers.
- Specially designed for frost protection. The top lal topi completely seals and protects the sprinkler from frost damage.
- Facility for changing different control nozzles in the same sprinkler available according to crops and intensity of frost.
- Suitable flow rate for effective irrigation along with protection from frost available.
- Irrigation in a circle up to 26.5 to 37.5 metres distance.
- Conforming to Indian Standard IS : 12232 approved by BIS.

Apart from Lal Topi - 233 B AF Sprinkler other sprinkler products which can be used for frost protection purpose are : Aqua Master 2005 and 501 U.

Jain Lal Topi - 233 B AF - Anti Frost Sprinkler Layout



14. DISEASES

Canker and Papery Bark

Canker and Papery Bark are the two diseases prevalent in all the three apple growing states. These are stem diseases which appear on shoots, scaffolds and also on trunk. In case of Canker, there are depressions which have pink coloured pustules. In Papery Bark, the bark becomes papery. There is death of cells in the affected portions. Initially phloem is affected and later on incidence may be upto wood. The affected shoots are removed, the affected bark and even the wood on scaffolds and on the trunk are scrapped, and the cut and scrapped portions are pasted with Chaubatia paste (Copper Carbonate:lead Oxide:Linseed Oil 1:1:1.25) during pruning in winters for their control. The whole orchard is sprayed with copper fungicide during dormancy and also in the rainy season.

Root Rot

The Root Rot is more common in poorly drained soils, hence, water stagnation either above or in subsoil is to be avoided. The drenching of soil either with copper oxychloride or mancozeb is helpful in controlling the disease. Keeping the soil pH near to neutral level is also a measure to check the spread of the disease.

Apple Scab

The Apple Scab is found in some pockets of the apple growing areas. Typical Scab symptoms appear on foliage and fruits. Light brown or olive green spots which soon turn musty black appear on either or both sides of the young leaves. Severe spotting leads to premature leaf-fall. Severe early infection results in the formation of illshaped knotty fruits. Fruits which get affected in late summer develop small, rough black circular lesions on the skin. Following spray schedule is recommended:

i) In dormancy at silver tip to green tip stage.
ii) At pink bud stage.
iii) At petal fall stage.
iv) When Fruits attain pea and walnut size.
v) When fruits have attained full size.
vi) 20-25 days before harvest.

In these sprays, the fungicides like Mancozeb, Fenarilmol, Bitertanol, Captan, Sulphur, Chlorothalonil and Carbendazim are used interchangeably but following precautions are taken: (a) Carbendazim should not be sprayed in two consecutive sprays. (b) Chlorothalonil should be applied only at silver tip or green tip stage and not after wards as it causes rusting on fruits.

Table 5 : List of fungicides recommended for Apple

Sr.	Name of Fungicide	Recommended Concentration	Waiting Period
1	Aureofungin	2g/lit	-
2	Carbendazim	0.25g/lit	40 days
3	Captan	1.2g/lit	8 days
4	Chlorothalonil	2g/lit	45 days
5	Dinocab	0.3g/lit	21 days
6	Diathion	0.75g/lit	21 days
7	Hexaconazol & Penconazol	0.5 g/lit	30 days
8	Ziram	2 g / lit	21 days
9	Wettable Sulphur	2.5-5 g / lit	

15. INSECTS

Among the insect pests, the most common ones are woolly aphis, stem and root borers, tent caterpillar and san jose scale.

Woolly aphid

The woolly aphid live in groups and suck on succulent shoots and buds. In winter, they feed on roots. During sucking, they secrete some poisonous substance and nods are formed at the portions sucked. Affected trees remain stunted with greatly reduced fruit bearing capacity. This insect can easily be controlled by spraying any of the insecticides like Dimethoate, Methyl-Oxydemeton, Monocrotophos or Imidachloprid during the months of April-May and September-October. During winters, drenching of soil with any of the above insecticides is recommended.

Stem and root borers

The grubs of stem borer feed on wood inside the stem. It's excreta comes out from a hole. For control, a cotton wick soaked in any of the fumigating insecticides like Dichlorovos, is inserted inside the hole and is immediately sealed with wet clay soil. Similarly the grubs of root borer feed inside the roots. Any systemic insecticide like Phorate or Carbofuran is applied during March-April in the root zone and is well mixed with the soil. Pheromone traps placed in the orchards can trap the adults of these insects which can then be killed thus minimizing the population of grubs (damaging stage).

Hairy Tent Caterpillar

This caterpillar has hairs on its body and fond of living in groups inside tent like structure. These caterpillars feed on the foliage and keep on shifting to the other shoots of a tree. This insect is very common in neglected orchards. Under severe infestation a tree becomes leafless. For control of hairy tent caterpillar, insecticides like Monocrotophos or Endosulfan is sprayed during September-October.

San Jose scale

San Jose scale insects live on the surface of the bark of stems. Initially trees show small, greyish specks on the bark surface but severely infected trees have the bark covered with a grey layer of overlapping scale appearing as if these have been sprayed with wood ash. For control, one to two sprays of any of the tree spray oils (Esso Tree oil, Survo Orchard spray, Agro Spray orchard) are done during winter at green tip bud stage.

Table 6 : List of insecticides allowed for application in Apple

Sr.	Name of insecticide	Targeted Pest	Recommended Concentration	Waiting Period
1	Carbofuran	Woolly Aphid	5-50g/tree (based on size of a tree)	
2	Chloropyriphos		0.5ml/lit	
3	Dimethoate	Stem Borer	0.3ml / lit	
4	Fenazaquin	Mite	0.1ml/lit	7 days
5	Methyl O Demeton	Sanjose scale & Woolly Aphis	0.25-0.75 ml/ lit	
6	Phorate	Woolly Aphis	10-15g/plant	
7	Propargite	Mites	0.75-1ml/ lit	9 days
8	Quinolphos	Woolly Aphis / tent caterpillar	0.5ml / lit	
9	Spiromegifen	Mites	0.3ml / lit	30 days

16. INTERCROPPING

In widely spaced plantations, initially when the apple orchard is young and adolscent stage, sufficient area remains unoccupied by the tree Table-7.

Table 7: Availability of space for intercropping during initial years of orchard life

Tree Age	Area Occupied by single plant (m^2)	Area Occupied by plants (%)	Area available for intercropping (ha)
First Year	1.00	2.28	0.97
Second Year	2.25	6.30	0.94
Third Year	4.00	11.2	0.88
Fourth Year	6.25	17.5	0.82
Fifth Year	16.00	44.8	0.55
Sixth Year	25.00	70.0	0.30

It is clear from Table (7) that for the initial three year period, on an average, 90% area is available for growing of short season crops on the orchard land. In areas of high elevations (>2400 metre above msl) the tree growth is slow hence the vacant area for raising of inter crops may be available for few more years.

The trees grow over the years occupying the land allotted to them and growing of intercrops will not be profitable once the orchard trees have covered about 70% area. Potato is a good inter-crop for areas having climates like that of Lahaul-Spiti of H.P. and Harsil of Uttarakhand. Potato crop is planted in April-May and is dug in September-October. The other equally suitable crop is french bean which can be used as vegetable, and two crops are possible from April to October. Using drip system of irrigation, one hectare can easily produce 30 tonnes potatoes (27 tonnes as only 90% area is available) which at the present selling price would be of Rs. 2.7 lacs. After deducting Rs. 0.90 lacs as cost of production, the net income from intercropping from one hectare will be to the tune of Rs. 1.80 lacs. Under assured irrigation facilities, other suitable intercrops which can be grown are cauliflower, cabbage, pea and tomato.

In high density plantations intercropping is not recommended except during first year with low growing legume.

17.FRUIT PICKING, PACKAGING, YIELD & STORAGE

Yield : A standard apple tree on vigorous rootstock starts fruiting at the age of 4-5 years and the commercial yields are obtained on attainment of 9-10 /8 year age. The productive life of an apple tree is about 50 years. Under proper management, average production of about 12 tonnes/hectare under the climates of Himachal Pradesh and Uttarakhand and about 15 tonnes/hectare under the climate of Jammu-Kashmir, can be obtained every year.

The closely planted trees on dwarfing rootstocks can yield fruits 25 to 30 tonnes per hectare starting from 4th or 5th year upto 20-25 years age. With precocious dwarfing rootstocks, young apple trees can often overset in the 2nd and 3rd year resulting in biennial bearing as early as the 4th year. This results in increased vigour in the 4th year just when the trees have filled their allotted space and when reduced vigour is needed. Having the density of 1500 trees/ hectare for annual cropping cultivars like Gala, the recommendation for crop loads are as: 15-20 fruits/ tree in the second year, 25-40 fruits/ tree in the 3rd year, and 80-100 fruits/ tree in the 4th year. For slow growing and biennial bearing cultivars this number of fruits should be halved to two-third that of the regular bearing cultivars.

Maturity indices : Each cultivar takes certain number of days from petal fall to maturity. A variation of 8-10 days may occur between different climatic zones. For example, the same cultivar may take few more days when planted in colder regions. In general, the fruits of early, mid and late maturing cultivars ripen in August, September and October, respectively. There are several indices which are used, to know the maturity of fruits.

- Days after petal fall.
- Heat units since petal fall
- Fruit Colour
- Fruit T.S.S. (Total Soluble Solids)
- Fruit firmness
- Starch Index (Disappearance of starch from fruit)
- Ethylene content of fruits

Among the above methods T.S.S., fruit firmness and starch index are more robust and easy to measure in field.

Fruit T.S.S. can be measured by Hand Refrectometer available in market, it is a simple instrument and easy to use by following instruction given in leaflet along with instrument. Indicative T.S.S. of major varieties at various elevation is given in table below

Variety	TSS	
	Elevation (1500-2000m)	Elevation (2250-2750m)
Red Delicious	13.28	14.10
Royal Delicious	15.01	14.35
Rech-a-Red	14.03	15.00
Golden Delicious	12.10	11.50

Fruit firmness can be measured by an instrument "Penetrometer" having 2.5cm² plunger. This equipment can be purchased from scientific instrument shops. Depending target market, fruit firmness and starch Index are given below

Type of Market	Fruit Firmness (Pounds/2.5cm²)	Starch Index
Local fresh fruit market	13.0 - 15.5	4.5 - 5.0
Distant fresh fruit market	18.5 - 20.0	2.0 - 3.0
Export & Cold storage	18.0 - 22.0	2.0 - 3.5

Method to measure starch Index

Materials required - Knife, Potassium Iodide (KI), Iodine cristals, hand sprayer(500ml capacity).

Desolve 3.3 g potassium Iodide in 30 ml hot water. After desolving KI add 2.2g Iodine crystals and shake well. After desolving, make the volume to one litre.

Iodine Test - Cut fruit vertically into two halves and spray Iodine solution. After one minute observe colour change and identity index as given in picture below.

Determination of fruit maturity should be done by collecting 15-20 fruits from various parts of the orchard and any of the described method or combination of methods can be used to determine maturity. Fruit having sun

scald, injury, insect or disease attack should not be used for determination of maturity index. Testing of maturity index should be started two week before expected date of harvest and should be repeated at five days interval. Fruits must be fresh for maturity index and Iodine solution should be also fresh. In case refractometer or penetrometer are to be used, check them and these must be functional.

Fruit harvest

During picking the fruits should be plucked individually with pedicel attached and are placed in the basket. Fruits should be handled carefully to save them from mechanical injury.

Precooling

Shelf life, storage and transportability remains good if fruits are pre-cooled to 7°C immediately after harvest, it can be done by keeping them in pre cooling chambers or spraying of water having temperature of 7°C.

Grading and Packing

Fruits must be graded before sending them to market. Grading can be done manually or by machine. Damaged, blemished and diseased fruits must be separated. Fruits can be packed in telescopic corrugated fibre boxes with apple trays. Generally corrugated fiber boxes are of 504x300x282 mm (outer) and 500x300x282 mm (inner) size. Depending upon fruit size they should be filled in 4-5 layers. If more layers are filled advantage of using corrugated fibre boxes is lost and fruits are damaged. Table below give information about number of fruits and layers per box depending upon fruit grade.

Fruit Grade	Fruits/ Box	Fruits layers	No. of layers	Weight per box (kg)
Super Large	72	18	4	16
Extra Large	80	20	4	16
Large	100	20	5	18
Medium	125	25	5	20
Small	150	30	5	22
Extra small	175	35	5	24

Fruit Storage

Cold storages or modified atmosphere cold storages are suitable for long term storage. For short term storage evaporative or zero energy cool chambers can also be used. In cold storages recommended temperature is 0 - 2°C.

In modified atmosphere cold storages 3.3°C temperature with 2 - 5% CO_2 and 3% O_2 is recommend. Fruits can be stored upto 12 month in cold storage.

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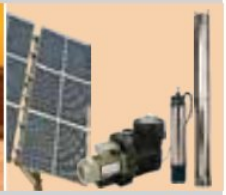
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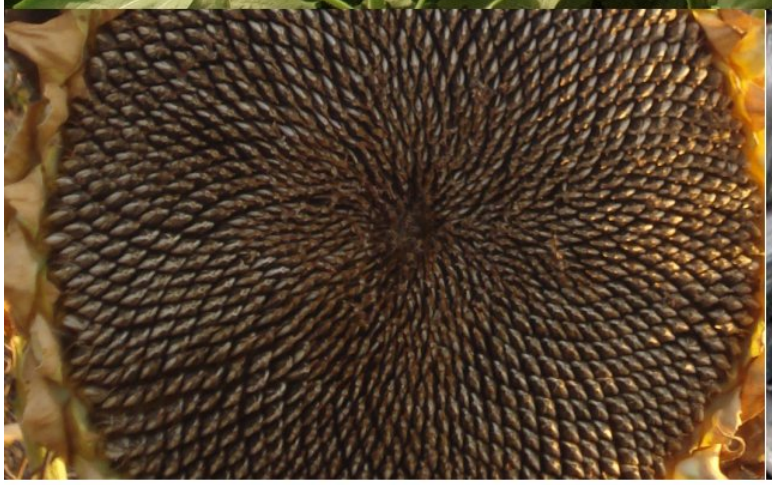

Irrigation Solution
Sunflower
With Jain Technology™

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Sunflower is one of the important crops in India's oil seed production that has contributed to rapid growth in oilseed production during the last two decades. Sunflower is the oil of preference among the consumers' world over due to its health appeal and in India too, sunflower oil is the largest selling oil in the branded oil segment. Sunflower is also a crop of choice for farmers due to its wider adaptability, high yield potential, shorter duration and profitability. The crop, is cultivated in about 3.5 M ha.

Varieties

Table 1- *Varietal recommendation*

Varieties/ Hybrids	States for which recommen-ded	Duration (days)	Plant height (cm)	Head dia. (cm)	Seed yield (kg/ha) under rainfed conditions*	Oil content (%)
Varieties						
Morden	All Sunflower growing states	85 to 90	90- 120	15-Dec	1000	42-45
EC 68414	All states	100-110	150-200	15-20	800-1000	40-42
TNAU SUF-7	All India	90-95	135-165	16-20	800-1200	38-42
Hybrids						
BSH-1	All states	130- 150	130-150	15-Dec	1000-1500	41-43
KBSH-1	All states	130-150	150-180	15-20	1200-1500	42-44
APSH-11	All states	90-95	120-150	15-20	1000-1500	40- 42
MSFH-1	All states	90-95	120-150	15-20	1000-1500	41-43
MSFH-8	All states	90-95	120-150	15-20	1000-1500	38-42
MSFH-17	All states	80-85	120-150	15-20	1000-1500	40- 42

- Under conditions of high inputs, favourable moisture and management, go in for cultivation of hybrids and long duration populations for higher returns.
- choose early maturing varieties / hybrids whenever chances of receiving post planting rains are less and application of protective irrigations are either remote or irrigation water is available only for limited period / no. of irrigations.

Soil

- Soils with an appreciable sand content are prefered.
- Good drainage is essential.
- Sunflower grows well on neutral to moderately alkaline soils, with a range of pH 6.5 – 8.0, but dislikes acid conditions.

Agro-Climatic Conditions

- Sunflower is grown from 40oS to 55 oN, but greatest production is between latitudes 20 and 50 oN and 20 – 40 oS. it will grow from sea level to 2500m, but generally gives highest yield of oil per ha below 1,500m.

Land preparation

- Generally sunflower is grown as a rainfed crop in kharif, hence to make use of rain water,
- It is necessary to plough the land once by a mould board plough followed by harrowing soon after the onset of the rains.
- F.Y.M or Compost @ 20-25 cartloads per hectare, should be applied at the time of the land preparation.

Planting

- As a field guide to final stand, most modern cultivars have 80-85 percent emergence 2-5 days after first seedlings appear.
- Seed should be dressed with a fungicide; Captan, Carboxin, Quintozene and Thiram are suitable, and preferably an insecticide, or a combination may be used, i.e. a standard groundnut or maize seed dressing.
- Seed should normally be planted 3-8 cm deep, depending mainly on the variety and moisture in the seed-bed.
- When using standard planters with 75 cm row-width, seed rates will vary from 3 to 8 kg/ha depending on seed size, to achieve a final spacing of approximately 30 cm between plants.
- Population in the range of 30,000 - 40,000 plants/ha at harvest is acceptable for the tall varieties and 35,000 - 60,000 for hybrids in areas where annual rainfall of 500 mm or above is normal; 14000 - 15000 plant/ha in very low rainfall areas.

SOWING

- The seed should be planted at 4 cm .deep in the plough for getting highest percentage of germination.

Seed dormancy and Viability

- Sunflower seeds (achenes) remain dormant upto 40-45 days of harvesting however, the dehusked seeds may germinate from 10th day after harvest.
- Exogenous application of ethrel, benzyl adenine and Gibberellic acid promotes germination of achenes.
- Pre-soaking of dormant seeds with ethrel solution (25 ppm) equivalent to 40% by volume of seeds has been found to be optimum.

Seed treatment

- The seed should be treated with Captan or Thiram Or Mancozeb 75 W.P @ 3 gm. per kg . of seed before sowing. For getting good result.
- After fungicide treatment, the seed can be treated with Azospirillum which helps in N-fixation (or) apply one kg or Azospirillum to soil after mixing with powdered FYM.

Seed rate

Straight varieties - Rainfed 8-10 Kg/ha/ ID 6-8 Kg/ha

Hybrids - Rainfed 6-7 Kg/ha/ ID 5-6 Kg/ha

Spacing

- The seed should be sown in lines 60 cm. apart (row to row) and in rows with a plant spacing of 30 cm.
- For a good crop ,row to row spacing of 80 cm, and plant to plant spacing of 20 cm. must be kept .

Table 2- Plant Spacing for different soil types

Soils	Spacing (cm)	Optimum population / ha
Light	45 x 20	1,11,000
Medium	45 x 30	74,000
Heavy	60 x 30	55,000

- Usually for long duration varieties or hybrids adopt a spacing or 60 x 30cm.
- In regions where the amount and distribution of rainfall is good adopt a spacing of 45 x 30cm.
- For short duration straight varieties like Morden adopt a spacing of 45 x 20 cm.

Recommended sowing dates

- Rainfed (and with life saving irrigation)

  Kharif July 15th to August 15th

  Kharif(Late) August 16th to August 31st

  Rabi September 15th to September 30th

  Rabi (Late) October 1st to October 15th
- Irrigated

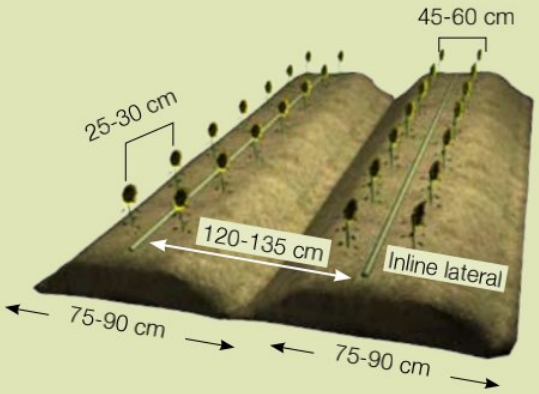
  Rabi October

  Summer January

Thinning

The sunflower seed is planted at the rate of 2-3 seeds per hill. Thinning is done to keep one healthy plant per hill as excess plant population adversely affects the growth and yield of the crop. Thinning should be done with 15-20 days of germination seeds

Drip layout on bed rised system



Drip layout on plain land

Cropping System

- Sunflower is not season bound crop.
- Its short growing period of 90-125 days makes it an ideal catch crop.
- It can follow potato, sugarcane or even early wheat.
- Sunflower also fit well in most multiple cropping program. It can also serve as a companion crop to a long duration crop like sugarcane.
- Sunflower is grown in rotation with several crops as follows:

  Sunflower + Redgram (2:1), Paddy-Sunflower, Maize-Potato-Sunflower, Maize-Sunflower, Maize-Mustard Sunflower and Red gram-Sunflower

Intercrop

- Sunflower based ntercropping system sanp recommended.
- Hybrid Sorghum + Sunflower at 4:2 ratio.
- Kharif sunflower is mostly grown as rainfed crop in which few crops like groundnut (2 : 6); Ragi (2 : 5); Cowpea or Blackgram (2 : 3) may also be intercropped.

Critical crop growth stages

The most critical periods for irrigation in sunflower are bud (button) stage, flowering and grain formation stages.

Table 3 : Critical growth stages for irrigation

Stage (Days after planting)	Short duration varieties (Days after planting)	Long duration varieties
Bud initiation	30-35	35-40
Flower opening	45-50	55-65
Seed filling	55-80	65-90

Water Requirement

Sunflower will produce good yields with only 300-500mm of added water. The most obvious field symptom is an increase in the number of unfilled or aborted seeds in the centre of the plant heads, although inadequate pollination or soil nitrogen may also be partially responsible.

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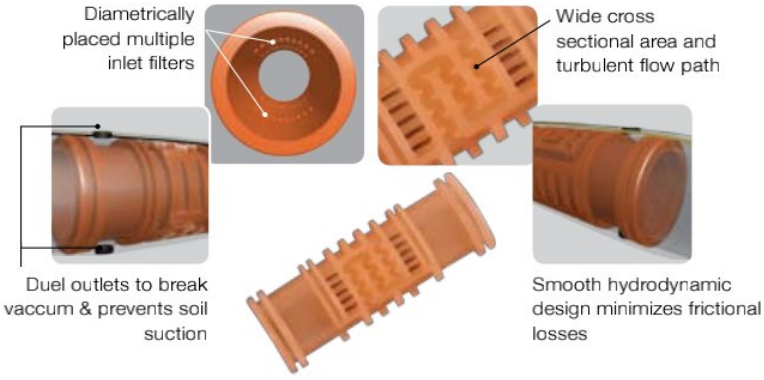

Benefits of drip fertigation

- Yield increase up to 120 %
- Suitable for all growth stages
- Water use is less compared to sprinkler.
- Irrigation can be performed duiring anthesis and pollen transfer stage.
- Flowering and Seed formation (grain filling) stages are most critical for irrigation requirement. Drip irrigation suits this situation.
- Effective fertigation, especially of N and K is possible with drip irrigation and providing K during the grain fill stage will increase weight of head and thus results in High yield.

Drip irrigation

Drip lines are placed at every 120 cm (skip row) for sun flower planted at 60 cm row to row spacing. Based on soil type one may choose dripper spacing of 40 cm (sandy loam) or 60 cm (clayey soil)

*Table 4: Water requirement of Sun flower for the pan E** shown.*

season	E mm	ET0 mm	kc	kp	Lit/ acre
Sept	4.5	3.2	0.35	0.5	2475
Oct	5	3.5	1	0.9	14140
Nov	4.5	3.2	1.15	1	16261
Dec	4	2.8	0.35	0.8	3519
1.Adjust for rainfall.					
2.**As Pan E chnages from location to location WR also will change					

Fertilizer Management

- It responds to fertilisers in soils of pH 6.5-8.5. With balanced fertilisation, seed yields of upto 3000 kg/ha can be obtained.
- Higher rates of P and K are recommended for hybrid seed production than for a regular crop.
- Add 3 M. T. FYM/acre to be applied at final ploughing

Table 5 : Recommendations of Fertilizers(kg/ha)

	Nitrogen	Phosphorus	Potassium
Rainfed			
a)Scanty rainfall areas	50-60	30	0
b)Assured rainfall areas	60	60	30
Irrigated			
a)Hybrids	60	90	40
b)Varieties (Non-Hybrid)	30	60	40

Fertigtaion Schedule for drip irrigated Sunflower

1. Apply all P at basal at planting; 90 P per ha for hybrids/ or 60 P /ha for varieties.

Fertigation for hybrids.

Table 6: Fertigation schedule for hybrid sunflower$$

Fertigation schedule for Hybrid sunflower			
Fertilizer recommendation for hybrids.			24: 36:16 per acre.
Time	N	P	K
Basal	5	36	0
15 DAS	3		0
22 DAS	5		0
30 DAS	6		2
45 DAS	4		4
60DAS			6
70 DAS			4
$$Fertigation units are given as N,P, K units.			
Use Urea as N source			
Use Potash as K source.			
Use SSP as P source. The S in SSP will be useful for Sunflower			

Secondary Nutients - Sulphur

- Sulphur increases seed yield and also the oil content.
- Apply Sulphur S-deficient soils at 13 kg/ha

Micro nutrients

- Among micro nutrients, iron, boron, manganese, copper and molybdenum are the important nutrients which show impact on Sunflower growth.
- Two to three sprays of (2g/l) copper sulphate solution at weekly intervals is recommended.
- Manganese sulphate should be applied to the soil at 50 kg per hectare.
- Foliar spray of (2-3g/l) manganese sulphate solution 2-3 times at weekly intervals is also recommended.
- Give directed spray of Borax (2 g/l) to capitulum at ray floret opening stage for increasing seed filling, yield and oil content.
- A spray mixture of 500 l/ha is required.
- Dissolve required quantity of Borax (2 g/l) in small quantity of hot water and make up the required volume.

Plant Protection

IPM practices

1. The cultural practices, starting from selecting the disease-free and robust planting material.
3. Deep tilling to weeding out unwanted vegetation and soil-borne pests and pathogens
4. Crop hygiene, keeping clean field and practicing hygiene by workers will contribute significantly in controlling crop pests.
5. The pest surveillance and monitoring exercises based on frequent visits to the fields and sweeping with insect nets,
6. Observing the movement of the pests using pheromone traps, light traps and sticky traps, and deciding on a spraying schedule with botanical insecticides (neem- based products).
7. The need-based application of safe botanical insecticides not only cuts the costs, but also helps in reducing the pollutant load in the environment.
8. The use of biological agents to manage the pests is another important aspect of IPM. Spiders and preying mantises can be effectively used in managing pests.
9. By growing "antenna" crops such as corn (maize) and sorghum (jowar or 'cholam') have also helped in attracting the birds to crop fields as bio-control agents.
10. By raising companion crops along the main crops the pest could be managed well. While, the trap crops help in trapping the pests in them, other plants with strong aroma, such as fennel and garlic, help in repelling the pests.
11. The pests can be managed well by judiciously following the mixed-cropping groundnut (marigold or sorghum) , alley cropping (marigold, softwood trees like sesbanea) and border cropping (marigold, Castor) with suitable crop varieties.
12. The light traps are mostly used for monitoring the pest movements in the fields.

Table 7 : Insect pests of Sunflower and their control

Name	Part and stage of crop	Control Mesaure
Jassids *Amrasca biguttula bigguttula*	Undersurface of leaves	Spray Dimethoate (2m/l)
White Fly *Bemisia tabaci*	Undersurface of leaves	Spray monocrotophos (1.6 ml/l) or Acephate (0.5g/l)
Leaf Eating Caterpillar *Spodoptera litura*	Feed on leaves	Early infection, spray Endosulfan (2 ml/ l) (1ml/l); Late infection Quinalphops (1ml/l)
Gram Caterpillar *Helicoverpa armigera*	Feed on leaves, later on the florets and seeds	Ha NPV (500l.E./ha) Avoid spraying at Pollination stage to protect Honey bees

Table 8 : Diseases of Sunflower and their control

Name	Part and sage affected	Control Measures
Alternaria blight *A. helianthi*	Occurs in winter season petiols, leaves and flowers	use tolerant varieies BSH 1, seed treatment with captan 3g/kg seed Spray Mancozeb (2g/l) at 10 days interval
Rust *Puccinia helianthi*	leaves	use tolerant variety pracice crop rotation-Spray Mancozeb (2g/l)
Head Rot *Rhizopus sp.*	When rain falls on head Wind transmission of fungus	Spray fenthion 1ml/l pluswettable sulphur 2g/l at head initiation
Charcol rot *Macrophomina phase-olina*	Wilting at flowering Soil infection	Seed treatment with Trichoderma viride 4g/ kg seed.
Downy Mildew *Plasmopara halstedii*	leaves, all stages	Seed treatment with Metalaxyl 6g/kg seed Foliar spray Ridomil 2g/l
Collar wilt *Sclerotium rolfsii*	40 days after sowingBase of stem	Seed treatment with Captan 3g/kg Soil drenching cheshnut copmpound 3g/l
Powdery mildew *Erysiphe cichoracerum*	in dry conditions on leaves	wettable sulphur 3g/l at or Calyxin 1ml/l
Mosaic Virus	Irregular yellow patches on leaves, all stages	Rouging infected plants. Spray triazophos 1ml/l or monocrotophos 1.5 ml/l

Crop yields on depend on Climate, Soil and Management and therefore can't be guaranteed by the company

Crop yields depend on climate, soil and management and therefore can't be guaranteed by the company.

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Jain Sweet Orange cultivation Jain Technology

Citrus fruits rank third in area and production after banana and mango in India. Sweet orange (Citrus sinensis) are the second largest citrus fruit cultivated in the country. Telangana, Andhra Pradesh, Maharashtra, Karnataka, Madhya Pradesh and Punjab are main sweet orange growing states. It's grown commercially in tropical, subtropical, arid-irrigated and mountains regions in varying soil and weather conditions. Although sweet orange tree does well in dry climate, with rainfall between 750-1250 mm. however the states of Telangana, Andhra Pradesh and Maharashtra have the largest share of cultivation. Among sweet oranges Mosambi (Maharashtra), Satgudi (Andhra Pradesh and Telangana) and Malta and Jaffa (Punjab) are traditionally grown in India. The average yield of sweet orange fruit in India is low (11.6 t/ha) compared to other developed countries like USA and Brazil (22-35 t/ha).

Jain Irrigation systems Ltd. (JISL) have introduced and acclimatized the table as well as processing varieties with the introduction of "Jain Sweet Orange". Jain sweet orange available in five varieties. These varieties are high yielding, early to late harvest type. Farmers with available land with these new varieties can expect to harvest twice that of the current production with the same amount of water resources as of today.

Soil

Sweet Orange grown in a wide range of soils ranging from sandy loam or alluvial soils of north India to clay loam or lateritic/acidic soils in Deccan plateau. Orchards develop well in light soils with good drainage. Deep soils with pH range of 5.5 to 7.5 are considered ideal. However, they can also be grown in a pH range of 4.0 to 9.0. High calcium carbonate concentration in feeder root zone may adversely affect the growth. Soils having a high water-table should be avoided. The sweet orange growing areas of Maharashtra have black soils. Thus, a well-drained sandy loam to clay loam is preferred by sweet orange.

Climate

Sweet orange grow well in tropical and subtropical climates and can withstand on drought conditions. The average temperature for good growth is about 13°c to 37°c. sweet orange can grow well between altitudes of 500 m to 1000 m. It grows well in drier areas having rainfall up to 500mm.

Varieties

Variety	Flowering to harvesting period
Jain Orange 1	240-270 days
Jain Orange 2	240-270 days
Jain Orange 3	270-300 days
Jain Orange 4	270-300 days
Jain Orange 5	310-340 days

Propagation

Budding, i.e. with 'T' budding and patch budding or shield budding are most commonly used propagation method for sweet oranges. When the rootstock plants of the selected rootstock are one-year–old or come to a budded at a height of about 15-25 cm from the ground level. JISL has standardized commercialized micro-budding practice to produce better plants.

Planting

- Generally planting to be done during June to March month.
- Pits are made of 2x2x2 feet dimension in deeper soils or 3x3x3 feet in shallow soils.
- Fill the pits with a mixture of top soil, 20 kg FYM, 2 kg SSP, 2 kg neem cake, 25 g. phorate & 25 g trichoderma powder.
- Removal of plants with roots from container (Without injuries to root ball) for planting.
- Watering must be done immediately after planting.

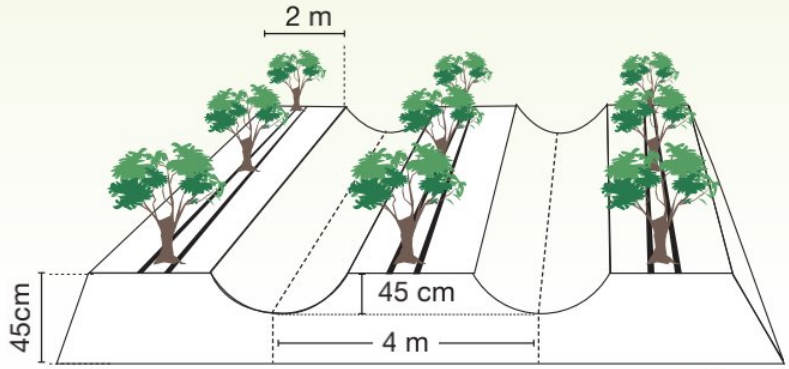
Bedding systems of plantation

- For sweet orange, planting distance of 4x3 m modified raised beds have been prepared. These beds are 2 m wide, 45cm high at the middle (near the stem of the plant) and sloping down both ends. Its purpose to water drains from the beds into furrows.
- A raised bed planting is beneficial for sweet orange cultivation.
- At the time planting, bud union should be 20 cm above from soil.

Comparison of Conventional and Hi tech Jain sweet orange

Conventional sweet orange cultivation	Hi-Tech Jain sweet orange cultivation
Rootstock seedling raised on soil	Rootstock seedling raised in soilless media cups in green house
Rootstock is the cause of spread of diseases	Prevented diseases through rootstock
Mother plants plot is raised elsewhere, without control	Mother plants raised in controlled greenhouse conditions
Virus and Viral diseases not controlled	Virus and viral diseases are controlled
Budding done on raised rootstock on soil	Budding done on raised rootstock in green house through micro budding techniques
No virus indexing of plants	Virus indexing done plants are virus free
Complete growth of budded plants in nursery or open field in poly bags.	Complete growth of budded plants in (root trainer) container in controlled conditions.
Plants uprooted from field cause breaking and injuries to roots.	Plants delivered in 2050 ml. container cups, with well-developed root ball without injuries to roots.
Chances of mortality are more after planting.	Chances of mortality is rare after planting
Promote Phytophthora and gummosis like diseases	To check Phytophthora and gummosis like diseases
Percent of juice is less	Percentage of juice content is more
Commercial production starts late 5-6 years.	Commercial production starts early in 4 th year
Fungal like disease infection start from nursery	Table with container cups used to check fungal attack.
Fruits contains more seeds	Fruits contain minimum seeds or seedless

Layout of drip irrigation for sweet orange



Planting Distance

Jain Sweet Orange high density planting plant spacing should be 4m x 3m (333 plants/acre) .

Rootstock sprouts (water shoot) management and pruning

Sweet orange plants are planted in field. In initial years rootstock exposed to sun cause water shoots emergence on it. To check water sprout the trunk must be covered with polyfilm bags or PVC pipe.

Jain sweet orange high density planting done on 4 m x 3 m distance. Initial first light pruning to be done on third year. After fifth year of age, removal of dried twings and criss-cross branches are done, immediate after this Bordeaux paste applied and tree canopy like umbrella formed. After harvest, immediately pruning to be done. On big trees water shoots should like dark green in colour such water sprouts removed regularly.

Intercrop

After planting immediately intercrop is not recommended. After first year, seasonal crops below the height of tree can be taken as an intercrop.e.g. Black gram, mung, ground nut & soybean like seasonal crop can be selected. Strictly avoid seasonal crop e.g. Cotton, chilli, brinjal as intercrop.

Mulching

To protect orchard from weeds and hot sun mulching with wheat husk, dry leaves, sugarcane husk up to 8 cm thick layer on raised beds done also to minimize evaporation rate and help to improve quality of fruits.

Layout of drip irrigation for sweet orange

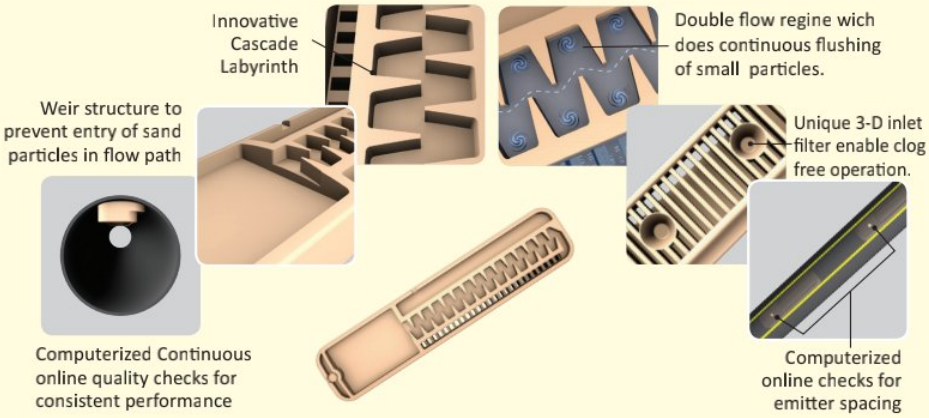
Initial two years 20 or 16 mm diameter lateral, 4 lit. /plant capacity dripper to be used. After two years use two 20 or 16 mm inline laterals, 40 cm with 4 LPH capacities to be laid both sides of plants, it should be 45 cm away from plant stem.

After two years use two 20 or 16 mm laterals with 4 LPH capacity 3 drippers and keep 50 cm distance between two drippers, likewise other side keep 3 dripper total 6 drippers per plant should be maintained.

ONE STOP SHOP for Your

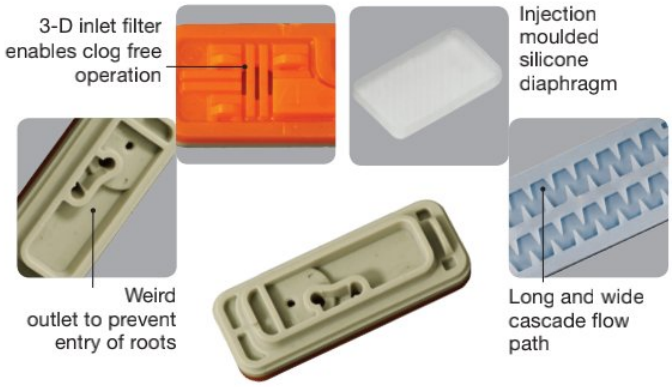
Jain Turbo Excel®

- Five Star rated dripline from worlds renowned institute IRSTEA (Cemagref), France.
- Available discharge rates - 0.85, 1.2, 1.6, 2.1, 4 lph @ 1kg/cm².
- 12, 16, 20, 25 mm nominal diameter.
- Dripper Spacing 15, 20, 30, 40, 50, 60, 75,90 cms.



Jain Turbo Top™

- Available discharge rates – 1.1 & 1.7 lph
- Injection moulded silicon rubber compensates with pressure and discharge gives uniform performance.
- Anti Syphone feature (optional) prevents suction of sand and silt particles inside the dripper.
- Cascade labyrinth gives strong, self-cleaning turbulence.
- Available in 16 & 20mm nominal diameter. (12, 16 & 20 mm in Thin Wall option)
- Suitable for surface as well as subsurface installations.

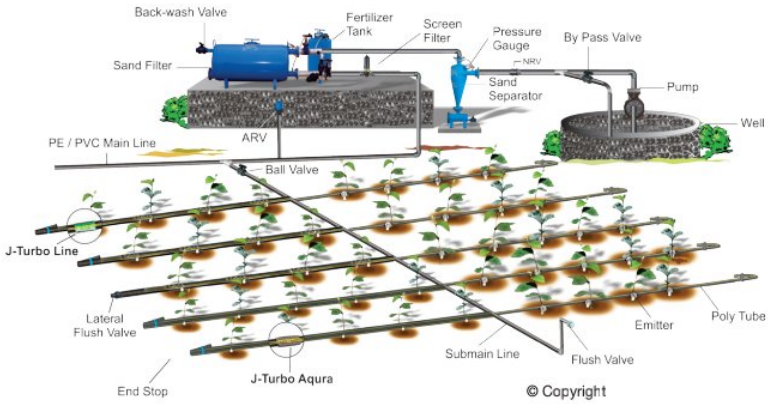


Why Jain Drip Irrigation ?

Water is not the only need of the plant. To uptake this water efficiently, it requires proper air-water balance within the root zone. Drip irrigation, with its low application rate, prevents the saturation of water within the root zone and continuously maintains field capacity. This provides a favorable condition for the growth of the plant. Drip irrigation also helps to use fertilizer efficiently. With drip irrigation water can be provided at frequent intervals which helps maintain required soil moisture level within the vicinity of the plant roots. Jain is the pioneer of drip irrigation. Ours is the only company in the world, which fulfills your entire irrigation system requirement under one roof.

Characteristics of drip irrigation

1) Water is applied at a low rate to maintain optimum air-water balance within the root zone.
2) Water is applied over a long period of time.
3) Water is applied to the plant and not to the land.
4) Water is applied at frequent intervals.
5) Water is applied via a low pressure network.

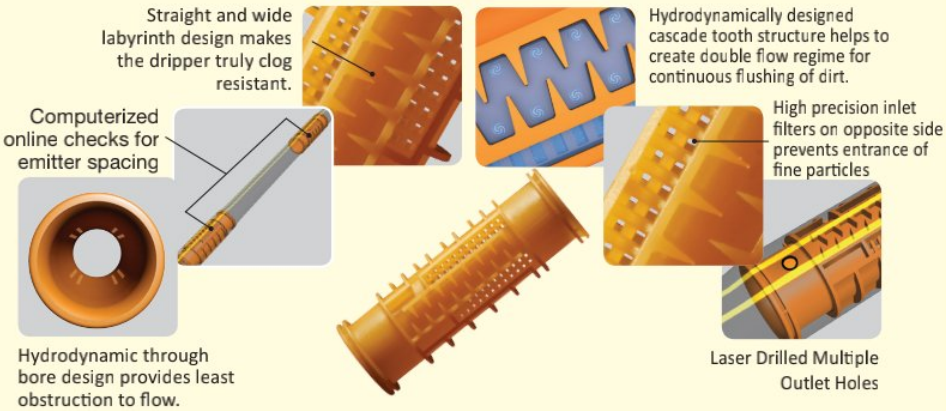


Jain Drip
More Crop Per Drop®

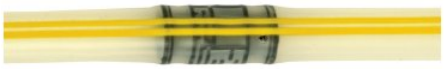
Micro Irrigation Needs

J-Turbo Line® Super

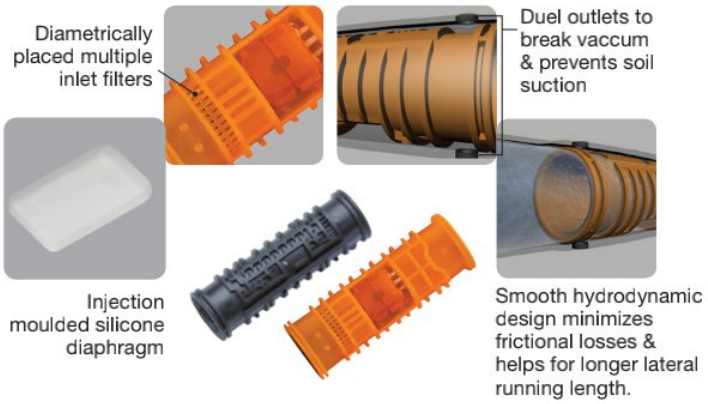
- Available discharge rates (at 1kg/cm²)
  12mm - 2.2, 4 lph
  16mm - 4, 8 lph
  20mm - 2.2, 4, 8 lph
- Availabe in 12, 16 & 20 mm nominal diameter.
- Suitable for surface as well as subsurface installations.



Turboline PC®



- Available discharge rates - 1.4, 1.8, 2.6 & 4.0 lph within pressure regulation range of 0.7 to 3 kg/cm².
- Injection moulded silicone rubber compensates with pressure and discharge gives uniform performance
- Application on undulating land/ Terrains/ Steep slopes.
- Available in 16 & 20 mm nominal diameter.
- Suitable for surface as well as sub-surface installation.
- Application where ever longer lateral length is necessary.
- Conforming to IS 13488, ISO 8261 Standard.



Widest Choice ! Customized Irrigation Solutions

Jain Drip
More Crop Per Drop®

Water requirement

Water requirement 1- 4 th year age of plant (lit./plant/day) Bahar water requirement									
Month	Evaporation (mm)	1st year	2nd year	3rd year	4th year		Mrug Bahar	Ambia Bahar	Hasta Bahar
January	2.86-4.60	7	14	20	30		87-97	17-20	77-93
February	3.38-5.90	9	19	30	40		104-114	35-38	82-95
March	3.69-7.29	12	24	36	48		126-136	62-68	91-104
April	6.69-8.38	15	29	42	55		Stress	91-104	101-111
May	7.54-9.32	17	36	52	60		Stress	120-143	120-143
June	5.97-7.45	12	24	36	48		21-24	101-111	126-143
July	4.24-7.47	9	19	30	40		25-35	83-105	91-104
August	3.22-7.84	9	18	27	40		39-54	80-109	Stress
September	3.57-7.78	8	17	25	36		64-72	96-108	Stress
October	4.44-7.87	9	19	30	40		77-93	96-108	39-54
November	3.48-3.84	9	18	27	36		82-95	Stress	64-72
December	3.15-3.90	7	14	20	30		76-95	Stress	64-72

Fertigation management and dose

(kg/acre/week)

Year	Month	Total dose	Urea	Phosphoric acid	12.61.00	MOP
1 St.	Jul - Sept	12	1.3	1	0	0.48
	Jan - Apr	16	1.8	0	1.2	0.78
2 nd.	Jul - Sept	12	1.9	1	0	0.55
	Jan - Apr	16	2.5	0	1.2	0.9
3 rd.	Jan – May	20	2	1.5	1.7	2.5
	Jun – Sep	16	1.5	0	0	2.5
4 th	Jan – Apr	20	3.0	2.3	00	3.5
	June-Sep	20	2.5	1.8	0	
	Jun - Sep	16	2	0	2	3
5 th	Jan – May	20	3	2.3	0	3.5
	Jun - Sep	16	2.5	0	2.66	3.5

Fertilizer

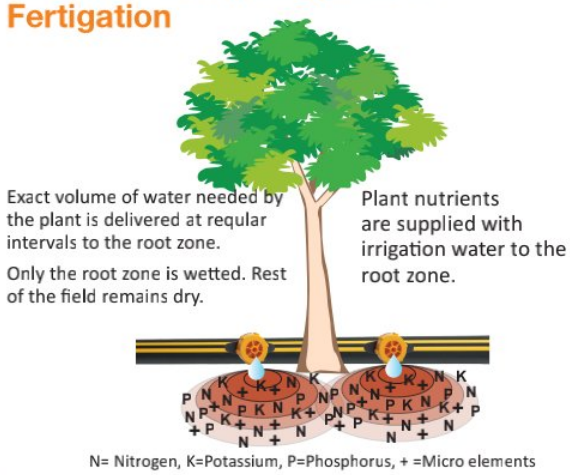
Year	g/plant			FYM/Kg
	N	P	K	
First	58	30	43	10
Second	87	30	43	20
Third	90	75	60	30
Forth	114	90	60	40
onward	140	117	72	40

Micronutrient

A composite nutrient spray prepared and spread twice or thrice at 20 to 25 days interval commencing from the appearance of new flush will correct deficiencies and increase the yield and quality of fruits. It prepared as follows.

Zinc Sulphate	500 g
Copper Sulphate	250 g
Magnesium Sulphate	200 g
Ferrous Sulphate	200 g
Borax	100 g
Lime	900 g
Urea	1 kg
Water	100 lit.

Principle of Drip Irrigation & Fertigation



N= Nitrogen, K=Potassium, P=Phosphorus, + =Micro elements

Benefits of Drip irrigation for sweet orange

- Increases leaf yield upto 50%
- Reduces water used for irrigation up to 50%
- Increased fertilizer uptake by plants when fertigation is practised Increased fertilizer use efficiency through fertigation.
- Consequently a reduction of up to 30% of applied fertilizer from the recommended dose is possible.
- Reduces NO3-nitrogen leaching (thereby nitrate pollution) avoided by 50% when fertigation is practised.
- Controls weed growth as water is applied only to the root zone.
- Allows for intercropping during the early years.

Following table shows micronutrient for soil application

Age	Copper Sulphate	Ferrous Sulphate	Zinc Sulphate
1 and 2 year	25	25	25
3 to 4 year	50	50	50
5 year	100	100	50
Onward	150	150	100

Pest and Diseases

Lemon Butter fly

Symptoms

Pest attacks on tender leaves, larvae being feeder cause severe defoliation of plants.

Management

- Limited use of chemical fertilizer
- Collect and destroy
- Insecticidal spray when butterfly laid eggs on leaves

Infestation

- Throughout the year

Control

- Spray Quinalphos 25% EC 2ml/lit of water.

Leaf Minor

Symptoms

Newly emerged larvae mines under surface of the leaf in zigzag way. Mines on the underside of leaf are silvery in colour. Attacked leaves curl-up from the margins towards inner side, eventually dry up and fall down.

Management

- Inspect big trees on February and August.
- Larvae attack more in March and September

Infestation

- June –July, January- February

Control

- Prune heavily infested branches destroy them and spray should be aimed at young flush only.
- Spray Neem oil 10 ml/lit. of water on new flush.
- Spray Diamethoate 30% EC 2 ml. or Dichlorovos 76WSC 1ml. /lit. of or Imidacloprid 17.8% SL 0.3 ml./ lit of water

Citrus Psylla

Symptoms

Nymphs and adult in flocks of tens and hundreds suck the cell sap from young twings, leaf and flower buds that results into heavy drop of young flush and fruits and drying of twings.

Management

- Inspect during new flush emergence on tree.
- Psylla cause spreading greening diseases so always use disease free and healthy plants for planting.

Infestation

January- February, October to December

Control

Spray Quinalphos 25% EC 2 ml. or Cholropyriphos 2 ml./ lit or Profenophos 50% EC 2 l./lit. of water

Thrips

Symptoms

The nymphs and adults suck the sap from fully developed flower and leaf buds, young leaves and grown-up fruits. The leaves become cup shape and leathery.

Management

- Limited use of chemical fertilizer
- Inspect during new flush emergence on tree

Infestation

- January- July-November

Control

- Spray Quinalphos 25% EC 2 ml. /lit or Imidacloprid 17.8% SL 0.3 ml. /lit of water

Viral Diseases

Citrus species trees are prone to the attack of many viral diseases. Phytophthora, Cholototricum, fusarium and etc.

Mode of disease spread

- Flood irrigation and flat bed system
- Retention of water for longer period in beds
- Prolonged period of wet weather
- Repeated use of same land for orchard

Symptoms

Phytophthora causes foot rot, root rot; gummosis, leaf fall and brown rot disease in well grown orchards Foot rot lesions develop as high as 60 cm from the ground level on the trunk and may extend below the soil on crown roots as crown rot. On scraping the dark bark.

Cultural management and care

- Always use root trainer container plants for planting.
- Plants should be selected from Phytophthora-free certified nurseries.
- Plant should have be budding (above 6" ht.).
- At the time planting, care should be taken to keep bud union as high as possible.
- Selection of soil should be kept well drained and flood irrigation and stagnation of water for longer period in the basin should be avoided.
- Injuries to trunk and root system by farm operation should also be avoided.
- Disease free and insect free planting material should be selected for planting
- Use drip irrigation system to control irrigation.
- Regular monitoring for the disease symptoms should be done to control the disease at its initial stages.

Disease management

- Disease-free planting material should be selected for planting.
- Flood irrigation in order to check water logging and water stagnation for longer period should be avoided.
- Tree trunk should not be allowed to come in contact with irrigation water.

Chemical Control

- Copper fungicides are used as foliar spray.
- Fungicidal drenching at basins of tree.
- Fungicidal pasting to disease affected trunks and twings.
- During monsoon season, alternate 40 days spraying whole plant of Redomil 2.5 g/lit or Mancozeb 2.75 g/ lit.
- Bordeaux paste should always be applied before onset of monsoon on tree trunk.
- Alternate use of both fungicides should be practiced to minimize the risk of the development of fungicide resistance.

Production

Particular	Conventional planting	High density planting
Planting distance (m)	6 x 6	4 x 3
Plant population/ Acre	111	333
Production starts in	4-5 years	3-4 years
Commercial production start	6-7 years	5-6 years
Orchard life	25 years	15-20 years
Approximate production/acre (Ton/acre)	4-5 ton	10-12 ton
Approximate annual income Rs./acre (Rs.20/kg)	Upto 1 lakh	Upto 2.25 lakh
Approximate cost of production Rs./acre	40,000	80,000
Approximate annual profit Rs./acre	Up to 60,000	Up to 1,45,000

Yield

Bearing starts from 3rd year. Expected commercial yield start at 4th year 5-6 tons /acre. 5th year and onwards 8-12 tons/acre.

Jain Drip — More Crop Per Drop
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Irrigation Solution
Tomato
With Jain Technology™

Jain Irrigation Systems Ltd.
Small Ideas. Big Revolutions.®

Tomato *(Lycopersicum esculentum)* is edible, belongs to the family Solanaceae. It is a herbaceous annual plant with bisexual flowers. The fruit is a true berry. It is a self-pollinated crop but in some cases as high as 30% cross-pollination has been reported. Depending upon the growth habit, the tomato plants have been categorized into two-indeterminate and determinate types. The plant of former type terminates in a vegetative bud, whereas that of the determinate type terminates in a flower-bud and is appropriately called 'self topping' or 'self pruning' type. Many varieties of determinate type tomato plants do not have adequate foliage to protect their fruit. Some of them fruit very early. The determinate varieties can be harvested in 2-3 harvests while the fruiting period of indeterminate type is prolonged.

Climate

Tomato is a warm season crop, it requires warm and cool climate. The plants cannot withstand frost and high humidity. Also light intensity affects pigmentation, fruit colour, fruit set. The plant is highly affected by adverse climatic conditions. It requires different climatic range for seed germination, seedling growth, flower and fruit set, and fruit quality. Temperature below 10ºC and above 38ºC adversely affects plant tissues thereby slow down physiological activities. It thrives well in temperature 10ºC to 30ºC with optimum range of temperature is 21-24ºC. The mean temperature below 16ºC and above 27ºC are not desirable. The plant doesn't withstand frost, it requires low to medium rainfall, and does well under average monthly temperature of 21 to 23ºC. Avoid water stress and long dry period as it causes cracking of fruits. Bright sunshine at the time of fruit set helps to develop dark red coloured fruits.

Soil

Tomatoes do very well on most mineral soils, but they prefer deep, well drained sandy loams. Upper layer of soil should be porous with little sand and good clay in the subsoil. Soil depth 15 to 20cm proves to be good for healthy crop. Deep tillage can allow for adequate root penetration in heavy clay type soils, which allows for production in these soil types.

Tomato is a moderately tolerant crop to a wide pH range. A pH of 5.5- 6.8 is preferred. Though tomato plants will do well in more acidic soils with adequate nutrient supply and availability. The soils with proper water holding capacity, aeration, free from salts are selected for cultivation.

Soils extremely high in organic matter are not recommended due to the high moisture content of this media and nutrient deficiencies. But addition of organic matter to mineral soils and soils depleted of continuous cultivation will increase yield.

Varieties

Selection of tomato varieties have been in plenty suitable almost all parts of the country. Some of the sought after varieties are given below.

Sioux- Highyielding dwarf, spreading

Pusa red plum- Table variety, determinate (IARI)

Pusa early dwarf- Suitable for kharif and rabi (IARI)

Co-1- Semi spreading dwar, fruits in cluster (TNAU)

Co-2- Mutant of Co-1.

S-12- High yielding, variety from PAU

PKM-1- Round fruits with green shoulder

Pusa Ruby- Indeterminate, flat fruits (IARI)

Pusa Gaurav- Good for processing (IARI)

Paiyur 1- Suitable for rainfed cultutre

Arka Saurabh- Semideterminate, round fruits; good keeping quality (IIHR)

Arka Vikas- High yielding table variety

Arka Ahuti- Oblong fruits, TSS 5.4% (IIHR)

Arka Ashish- Determinate oval fruits; tolerant to DM (IIHR)

Arka Abha- Determinate; bacterial wilt resistant (IIHR)

Arka Meghali- Rainfed' thick flesh.(IIHR)

Sakthi- Resistant to Bacterial wilt (KAU)

HS 101- Determinate; dwarf spreading, good for winter season. (HAU)

HS 102- Early variety (HAU)

HS 110- Late, table purpose variety, (HAU)

Hisar Arun- Extremely early, large fruits (HAU)

Hisar Lalima- Determinate, early, ;large fruit (HAU)

Hisar Lalit- Semi determinate, root-knot nematode tolerant (HAU)

Hisar Anmol- Tolerant to leaf curl virus, determinate (HAU)

SL-120- Semideterminate, root-knot nematode tolerant (IARI)

S-12- Dwarf bushy plants (PAU)

Pant Bahar- Bushy and much branched (GBPU)

NDT-1- Indeterminate, large fruits.

NDT-120- Determinate, good for processing.

Solan gola- From Himachal (YSPU)

F1 Hybrids

Apart from the above Varieties with yield potential only 25-30 t/ha a series of Hybrids are developed by Research Institutions, Universities, and Private Seed companies. The main thrust is for very high yields (75-120t/ha) and long shelf life apart from other qualities like TSS etc. Tomato hybrids are made available for both salad and puree end use.

Early and high yield, uniform fruiting, and resistance to adverse environmental conditions are some of the advantages of using F1 hybrid seeds. A combination of Pusa Ruby and Best of All is preferred as the F1.It not only yields 50 per cent more than Pusa Ruby but its fruit quality is also very attractive. The other combination recommended is Pusa 120 x Pusa Ruby.The F1 not only gives a high yield of attractive fruits but is also resistant to root-knot nematodes. Pusa Hybrid-2 has also performed well. The main drawback is the high cost of production of these seeds.

Some of the other Hybrids available in the country are; Arka Vishal, Arka Vardan, COTH hybrid 1, BRH 1 and 2, .Rashmi, Vaishali, Rupali, Naveen, Avinash2, MTH 4, Sada Bahar, Gulmohar, Sonali etc.

Nursery practices

- Tomato seeds are sown on raised beds or seed boxes.
- Raised beds of 1 m width and 10 m long in one or more bits according to the availability of space surrounded by drainage channels of 30 cm width are to be formed. The height of the bed should be 15 to 30 cm.
- Incorporate 8 t/ha of organic manure (FYM) before firming up the surface of the bed.
- Sow seeds uniformly using 36,000 seeds (plus 10%) for 1 ha transplanting.
- Seeds are sown at a depth of 1-2 cm and 5 cm x 4 cm or 5 cm x 3 cm spacing.
- Consolidate the beds after sowing with a light roller.
- Provide light mulch on the surface with dry leaves or dry grass.
- Two beds of 40 m2 area are required for producing for seedlings for 1 ha.
- Application of 200g of Furadan granules per 80 m2 of bed area.
- Seed treatment with Thiram or Dithane M-45 is done at the rate of 3 g/kg seed.
- Spraying copper fungicide on 12th day and 19th day of sowing to prevent damping off disease.
- Only organic manures are to be applied. If the soil is very low in fertility, apply phosphate at 75 kg/ha and potash at 200 kg/ha rates.
- Install micro sprinkler system for irrigation. Sprinklers and sprinkler lateral at 2.3 m spacing.
- Apply irrigation water in the form of a fine spray every evening.
- Six weeks old seedlings are to be used for transplantation.
- Harden the seedlings before transplanting. This is done by suspending irrigation to the nursery beds for 4 days prior to transplanting.

Land preparation

The field is ploughed three or four times and leveled properly. At the last ploughing 20-25 tonnes of farmyard manure, 10 kg carbofuran granules or 200 kg neem cake has to be applied.Ridges and furrows are formed at a spacing of 60 cm.

Transplanting to Main Field

- Condition the seedlings for 1-2 days before transplanting by slightly reducing the moisture and maintaining approximate outdoor temperatures.
- Thoroughly water plants l2 to l4 hours before transplanting to the field. Plants should be dug or cut loose from the soil when being transplanted; ensure the roots are not exposed to sun or drying wind.

Spacing Spacing varies with the varieties

- Generally Tomato can be planted on 1.0 m wide raised broad beds (furrow between beds is 30 cm wide).
- Plant two rows of Tomato on each bed on either side of 60 cm space at the centre of the bed.
- Plant to plant spacing in both cases can be 45 cm or 30 cm based on varieties.
- Some hybrids with large canopies are planted at 120 cm x 45 cm (18,500 plants/ha).
- Plant Population36000 (60 cm x 45 cm) plants per hectare based on varieties.
- Irrigation Inline drip line with 4 lph emitters spaced at 40 or 60 cm is found suitable for Tomato. The lateral spacing of 1.3 m would suit for a number of other row crops- Brinja, Okra, Potato, flower, Cabbage, Cauli flower , Leaf vegetables etc.
- Tomato Root system is mainly (70 % or more) spread in the top 20 cm soil layer. Irrigate daily as per the schedule for the season.

Water requirement of Tomato

Water requirement is depended upon Evaporation of the place and crop factor (Kc) at different stages of the crop.

October Planting

Month	Water requirement	
	Mm/day	Lt/ha/day
October	1.02-1.22	10200-12200
November	2.62-3.0	526200 - 30500
December	3.48-4.38	34800-43800
January	5.32-6.07	53200-60700
February	5.31-6.00	53100-60000

November planting

Month	Water requirement	
	Mm/day	Lt/ha/day
November	1.00-1.16	10000-11600
December	2.26-2.84	22600-28400
January	3.92-4.47	39200-44700
February	6.49-7.33	64900-73300
March	6.42-7.03	64200-70300

December planting

Month	Water requirement	
	Mm/day	Lt/ha/day
December	0.86-1.08	8600-10800
January	2.54-2.90	25400-29000
February	4.78-5.40	47800-54000
March	7.84-8.59	78400-85900
April	7.03-7.96	70300-79600

January planting

Month	Water requirement	
	Mm/day	Lt/ha/day
January	0.97-1.10	9700-11000
February	3.10-3.41	31000-34100
March	5.78-6.33	57800-63300
April	8.59-9.74	85900-97400
May	7.16-8.48	71600-84800

Fertilizer Management

Tomato removes 2.8, 1.3,and 3.8 kg/ton yield of N,P and K from the soil. Therefore the fertilizer recommendation has to depend on the variety and target yield.

Apply organic manure (FYM, Cattle dung, poultry manure, or Compost) 20 t/ha rate at the last plough and incorporate with top soil.

A generalized fertigation schedule is given below. Contact Jain Irrigation Expert for guidance on specific variety and target yield and location.

Jain® Drip

Fertigation Schedule for Tomato				
Part by water Soluble Fertilizers				
		80:100:100 kg/ac NPK		
Stge of crop	duration	fert grade	total kg/ac	quantity Sch. (every 3 days)
Plant establishment	10 days	19:19:19 13:00:46 Urea	26.5 11 3.5	8.8 kg 3.7kg 1.2 kg
Flower initiation stage	30 days	12:61:0 13:00:46 Urea	16.4 89 40	1.6 kg 8.9 kg 4 kg
Flower to fruit set	30 days	19:19:19 13:00:46 Urea	26.5 55.5 25.5	2.6 kg 5.5 kg 2.5 kg
fruit set and maturity	70 days plus	12:61:0 13:00:46 Urea	8 44.5 20	1 kg 3.2 kg 3 kg

75 % of P is given as basal at land preparation 469kg SSP/ac

Micronutrients

- Iron deficiency is visible in highly calcareous soils or when water containing high carbonates are used for irrigation. Its deficiency can be corrected by spraying 0.25 per cent ferrous sulphate till the chlorotic symptoms do not appear on young leaves.
- Spraying 0.25 per cent Zinc sulphate twice at weekly intervals corrects Zinc deficiency and for prevention soil application of zinc sulphate @ 50 kg/ha is recommended.
- Mg deficiency can be corrected by spraying 0.5 per cent magnesium sulphate twice at weakly intervals.
- Weeding and interculture are essential for high yield performance.

Pest management ; Diseases of Tomato

Damping off *(Rhizoctinia solani):*

Seedling appear pale green with brownish water soaked lesions at basal portion of the stem.The lesion girdle the stem,affected tissue rot and seedling collapse and killed.

Partial sterlization of the soil by burning trash on the surface, proper drainage,forming raised seed bed.seed treatment with 3g thiram/kg or drenching the soil with 1% Bodeaux mixture or captan 2gm/ litre.

Early blight *(Alternaria solani):*

Small, isolated, scattered spots on the leaves, fully developed spots are irregular, brown to dark brown in colour & with concentric rings inside the spot. Often several spots coalesce to form large patches resulting in blight

Timely spray of captan or zineb or mancozeb @3g/l of water is effective.

Late Blight *(Phytophthora infestans):*

Irregular water soaked patches on leaves. White fungal sporulation on undersurface of leaves. Later lesions dry and turn brown. Lesions on stem and petioles. firm olive brown irregular shaped areas on fruits.

Fungicides like Bravo or Mancozeb

3g/l of water. Ridomil gold as spray. Do not plant near or after a potato crop.

Anthracnose *(C. gloeosporioides):*

Small.slightly depressed,circular lesion appear on the ripe fruits, lesion may enlarge and become sunken,with concentric rings

Crop rotation, weed control, spraying mancozeb @2.5g/l gives effective control.

Grey Leaf spot *(Stemphylium solani)*

Leaf spots appear on under side of leaves as small brown small specks,later it develop on both surfaces into greyish brown, glazed lesion. On older leaves lesions dry up, crack and centre drop out leaving a hole appearance, leaves defoliate.

Foliar application of mancozeb at 2.5g/l proves effective.

Powdery mildew *(Leveillula taurica):*

Light green to bright yellow lesion otic spots with concentric rings may develop,powdery covering can be seen on the leave which later on moves to upper suface also,leaves die.

Apply tridemorph or dinocarp at 1ml/l or hexaconazole 2ml per litre for effective control.

Wilt *(Fusarium oxysporium):*

Clearing of the veinlets and chlorosis of the leaf, soon the petiole and leaves drop and wilt. Younger leaves may die in succession and entire plant may wilt and die. Black discoulration of the vascular tissue may be seen.

Crop rotation, summer plouhging, seed treatment with 4 g *Trichoderma viride* formulation or 2.5 g carbendazim per kg of seed is effective.

Bacterial spot *(X. compestris):*

Small circular to irregular water soaked areas on lower surface of the leaves. These spots become depressed with a bulge on the lower surface. This bulging surface first smooth but become tough later,a narrow yellow halo may surround the spot, leaf dies, hon green fruits water soaked border can be seen.

Spraying of crop with mixture of streptocycline 200 mg/l & copper oxychloride 3g/l of water gives good control.

Bacterial canker *(C.michiganensis):*

Unilateral leaves, wilted leaflets, water-soaked spots on fruits.

extraction of seeds through fermentation, 3-year crop rotation.

Bacterial wilt *(P.solanacearum)*

Wilting, stunting, yellowing of the foliage and finally collapse of the entire plant, lower leaves may drop before wilting occur. Vascular system become brown and ooze from it can be observed.

crop rotation with cruciferous plants is recommended.

Tomato spotted wilt *(Virus):*

Young leaves usually turn bronze and later develop numerous dark spots, growing tip may die-back, plant may have one sided growth habit or stunted and have drooping leaves, produces no fruits or with chlorotic ring spots, green fruits have slightly raised area with concentric rings.

rouging, control of thrips with insecticides like carbofuran granules (100g/m2) in the nursery & in the main field 6kg/acre 10 days after transplantation gives good protection

Tomato mosaic *(Tomato mosaic virus):*

Mottling of the leaves, dicolouration of leaves, sunken or cup like patches on leaf, edges of the leaf is downward, chloroticring appear on the fruit.

use of virus free seedlings and hot water treatment of seed or seed treatment with 20% trisodium orthophosphate is affective.

Leaf curl *(Tomato leaf curl virus):*

Severe stunting of the plants with downward rolling and crinkling of leaves, chlorosis of the leaves, curl leaves become hairy and leathery plants become pale and bushy.

Use of systemic insecticides such as dimethioate 0.05%/ carbofuran or phorate granules20kg/acre as soil application is effective.

Blossom end disorder *(Physiological disorder Ca-deficiency):*

Begins with light tan, water soakedspot which enlarge, turn black and leathery.

Liming with high calcium limestone 2-4 months proir to planting.

Insect pests of Tomato

Aphids *(Aphis gossypii):*

Leaves are stunted and distorted and curl under. The upper surface is sticky and a black moldy growth appears

Aphids are virus vectors. Spray often to control with systemic insecticid.

Fruit borer *(H. armigera):*

Leaves and flowers are attacked. sometimes young fruits are also attacked.

Transplant 2 rows of marigold for every 16 row of tomato as trap crop,spray 5% neemseed kernel extract,spray NPV @250LE/ac. spray 2ml endosulphan or chloropyriphos or Quinolphos/lwater.

Tobacco caterpillar:

Leaves and fruits are attacked specially at night.

Plant castor as trap crop, collec & destroy the eggs, pheromone trap@10/ha,poison(bate-10kg bran+ 1kg jaggery + 1l cabaryl) with little water.

Leaf minor *(Liriomyza spp.):*

Mesophyll of the leaves are fed.

Root knot nematode

Galls are visible on the root.

Deep summer ploughing, crop rotation with mustard, use of carbofuran 3g at 65g/m2 in nursery & 3.8kg/ha in the main field.

Harvesting

Harvesting stage differs depending upon the end use of the fruits

Green stage

The fruits are fully developed but are green and suitable for sending to distant markets.

Pink stage

Some of the portion is red or pink and the fruit is not fully ripe. It is most suited for local markets.

Ripe stage

The major portion of the fruit is red and the softening begins. It may be picked up for home or table use.

Full ripe stage

- The fruit develops maximum colour and turns soft.
- It is suited for processing purposes.
- After picking the fruits are graded and sorted out into cracked, bruised, injured fruits and well-matured ripe fruits.
- For marketing purpose ISI standard is advocated.
- On an average yield of 25t/ha is expected from the improved tomato varieties but an excellent hybrid crop can produce as high as 40 t/ha.
- It is strongly recommended to transport harvested fruits in Plastic crates to reduce damage to fruits.
- Best storage temperature for tomato fruit is 12-15° C.

Dos

- Ensure good drainage in the field.
- Adopt drip irrigation.
- Compulsorily apply organic manure as per recommendation
- Select high yielding, disease and pest tolerant variety suitable for each location.
- Practice drip irrigation from the beginning.
- Strictly follow the irrigation schedule given.
- Follow the drip system maintenance schedule given.
- Compulsorily weed/ inter-cultivate, timely operation helps in crop growth.
- Follow fertigation schedule as given.
- Follow the precautions while operating the drip system as explained.
- Follow disease and pest control measures timely and effectively.
- Apply sprays in the evening or early morning only.

Don'ts

- Don't over irrigate the crop at anytime.
- For fertigation don't mix solid fertilizers and dissolve them together. Prepare individual solutions and mix them for application.
- Don't spray the crop under hot sunlight.
- Don't make a fire in the field with Drip system.
- Don't use the fertigation unit for bulky organic manure and fertilizers that are not soluble in water.
- Don't add solid fertilizer from the bag directly to the fertilizer tank. Prepare solution separately and pour the solution to the fertilizer tank. Prepare solution only in plastic buckets. Don't use metal container.

Crop yields depend on climate, soil and management and therefore can't be guaranteed by the company.

Jain Drip More Crop Per Drop® | Jain Irrigation Systems Ltd. Small Ideas. Big Revolutions.® | More Crop per Drop

Jains Mobile App

Tel: +91-257-2258011; **Fax:** +91-257-2258111; **E-mail:** jisl@jains.com; **Website:** www.jains.com;
Toll Free: 1800 599 5000

Irrigation Solution
Wheat
With Jain Technology™

Jain Irrigation Systems Ltd.
Small Ideas. Big Revolutions.®

Wheat growing areas of India.

The wheat growing areas of India are classified into 6 major zones.

1. **Northern Hills Zone (NHZ) :** Western Himalayan regions of J&K ,Himachal Pradesh, Uttaranchal, Sikkim and hills of West Bengal and N.E.States. This Zone has Wheat growing area of 0.8 million hectare (mha) which is predominantly rainfed. Av. Productivity of wheat in this zone is 1.6t/ha.

2. **North Western Plain Zone (NWPZ) :** Punjab, Haryana, Delhi, Rajasthan and Western U.P, Tarai region of Uttaranchal. This zone has wheat growing area of about 9.5 mha. The average productivity of wheat in this zone is 3.9 t/ha.

3. **North Eastern Plain Zone (NEPZ) :** Eastern Uttar Pardesh, Bihar, Jharkhand, West Bengal, Orissa, Assam, Sikkim and plains of far eastern states under irrigated conditions. This zone has wheat growing area of about 9.5 mha and average productivity of wheat in this zone is 2.5. t/ha.

4 **Central Zone (CZ) :** Gujarat, Madhya Pradesh, Chattishgarh, Jhansi division of UP and Kota and Udaipur Rajasthan. This zone has wheat growing area of about 4.5 mha and average productivity of wheat in this zone is 2.4 t/ha.

5. **Peninsular Zone (PZ) :** Maharashtra, Andhra Pradesh, Karnataka, Goa and plains of Tamil Nadu. This zone has wheat growing area of about 1.5 mha and average productivity of wheat in this zone is 2.9 t/ha.

6. **Southern Hills Zone (SHZ) :** Hills of Tamil Nadu and Kerala comprising the Nilgiri and Palni hills of southern plateau. This zone has wheat growing area of about 0.2 mha and average productivity of wheat in this zone is 1.0 t/ha.

Varieties

The choice of the correct variety plays a very important role in achieving optimum yield. For deciding on a variety for cultivation under irrigated conditions, the following are very important considerations:

1. Disease resistance
2. Fertilizer responsiveness
3. Lodging and shattering resistance and
4. Desired maturity

Varieties, PBW 502, PBW 343, WH 542, PDW 509, PBW 373, are double dwarf varieties suitable for irrigated agriculture. They are aestivum blood and suitable for “atta” and bread.

Varieties, PDW 291, PDW 274, and PDW 233 are durum wheat (used for Maida and Pasta and Noodles) suitable for irrigated cultivation.

Soil and Climate

Wheat is grown in a variety of soils: sandy, loamy and clayey (black soil). The soil should be well drained and close to neutral pH.

Right from alluvium of Gangetic and Indus plains, clayey black soils of central and southern India to the desert soils of Rajasthan, all the soils support wheat crop.

Wheat has wide adaptability. It can be grown not only in tropical and sub tropical zones but also in temperate zones and the cold tracts of the far north. It can tolerate severe cold and snow.

It can be grown in regions where rainfall varies from 25 to 150 cm/year. Wheat requires medium (50-60%) humidity for their growth. But at the time of maturity crop requires less humidity land warm season. Wheat in India grows best in subtropical climates. Its requirement for best performance is given in Table 1.

Table 1 : The optimum temperature requirement for wheat at different physiological stages.

Growth stages	Temperature requirements
Germination	20 to 25°C mean daily
Accelerated growth	20 to 23°C mean daily
Accelerated growth	20 to 23°C mean daily
Proper grain filling	23 to 25°C mean daily

Precision farming

Precision farming is farming where 1.Timeliness of operations and 2.Precision in quantities of inputs and control measures are practised. The different steps followed in precision farming varies from crop to crop and differences of these practises from conventional practises also varies from crop to crop. In Precision farming of wheat we recommend the following steps: Planting on raised beds, adopting a plant spacing of 0.225 m x 0.2 m, irrigating with drip following an irrigation schedule and fertilizer thru fertigation scheduling and weed control by weedicide.

Land Preparation

Wheat crop requires a well pulverized but compact seed bed for good uniform germination. One deep ploughing with soil turning followed by two harrowings and planking is desirable.

Though in most of the areas wheat is planted on flat seed bed, for efficient water management and ease of drainage it is recommended to plant wheat on raised broad beds with 30 cm furrows between adjacent beds.

Seed rate

Crop	Seed rate, kg/ha	Time of sowing	Plant spacing (cm)
Irrigated Timely sown	100	10-25 Nov.	20-22.5
Irrigated Late sown	125	25 Nov. to 25 Dec.	15-18
Rain-fed timely sown	100	25 Oct. to 10 Nov.	20-25

Seed treatment

To protect the crop from Termites and White Ants, treatment is suggested with Chlorpyriphos 20 EC @ 700 ml per 100 kg of seed by mixing in 5 litres of water and spraying over the seed followed by seed drying overnight before sowing.

For the control of diseases like Bunts and Smuts, seed treatment is suggested with Vitavex, Bavistin, Thiram or Agrosan GN @ 2.5 gm per kg of seed.

Depth of sowing

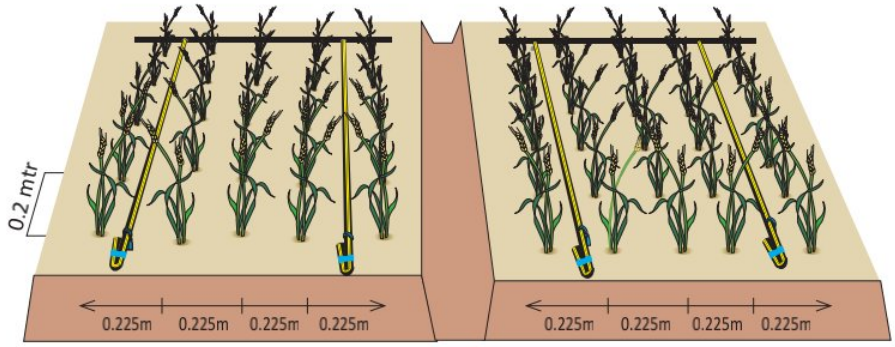
5-6 cm in the seed bed where sufficient soil moisture is maintained. The grain requires 35-45 % water by weight to germinate.

The best method of sowing is with a seed drill or dropping seed with a Chonga attached to a desi plough.

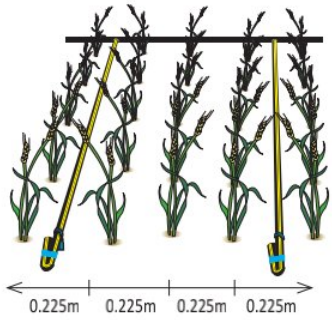
Wheat based cropping systems

Wheat is grown mainly in cropping sequences like Rice-Wheat, Jowar-Wheat, Bajra-Wheat, Maize-Wheat, Pulse-Wheat, Cotton-Wheat, Soybean-Wheat etc. in different parts of the country under irrigated condition

Jains Drip layout



BBF System



Flat System

Table 2 : Different wheat based cropping systems practiced in different states.

State	Cropping System
Assam	Maize-Wheat, Sugarcane-Wheat, Pigeon Pea-Wheat
Bihar	Rice-Wheat, Maize-Wheat, Sesame –Wheat
Jharkhand	Rice-Wheat
Gujarat	Groundnut-Wheat, Maize-Wheat, Rice-Wheat, Cotton-Wheat, Pigeon Pea-Wheat
Haryana	Rice-Wheat, Sorghum-Wheat, Cotton-Wheat, Bajra-Wheat, Maize-Wheat
Himachal Pradesh	Maize-Wheat
Jammu & Kashmir	Rice-Wheat, Maize-Wheat
Karnataka	Groundnut-Wheat
Madhya Pradesh	Rice-Wheat, Sorghum-Wheat, Soybean-Wheat, Cotton-Wheat,
Chattishgarh	Soybean-Wheat, Rice-Wheat, Sorghum-Wheat, Cotton-Wheat
Maharashtra	Soybean-Wheat, Bajra-Wheat, Rice-Wheat, Cotton-Wheat
Orissa	Sesame-Wheat,
Punjab	Rice-Wheat, Cotton-Wheat, Maize-Wheat,
Rajasthan	Sorghum-Wheat, Maize-Wheat, Bajra-Wheat
Uttar Pradesh	Rice-Wheat, Bajra-Wheat, Sorghum-Wheat, Sugarcane-Wheat
West Bengal	Rice-Wheat

Irrigation

Efficient water management and high Water use efficiency are achieved through drip irrigation.

For scheduling drip irrigation and fertigation knowledge of the physiological stages of the crop is essential. The physiological mile stones of wheat are as follows:

1. Crown Root Initiation (21 days after sowing)
2. Late Tillering (42 days after sowing)
3. Late Joining(60 days after sowing)
4. Flowering (80 days after sowing)
5. Milk stage (95 days after sowing)
6. Dough Ripe (115 days after sowing)

Table 3 : Water requirement of Wheat (eg : for Modipuram in UP)

	E mm**	Drip 0.9 effi (mm)	DRIP l/ha/day
1-15 days	4.59	0.44625	4463
16-45 days	4.4	2.772	27720
46-75 days	5.17	4.624278	46243
76-105 days	6.37	4.211278	42113
106-135 days	7.86	1.5589	15589

*** When E changes the volumes also change accordingly for other locations.*

Drip Irrigation - The concept

Drip irrigation is the slow, even application of water at low pressure to the root –zone using a net work of plastic tubing placed above the rooting zone (surface drip) or buried among the root branches inside the rhizospherical soil at a certain depth from surface. (subsurface drip).

In drip irrigation method, crops are irrigated daily to the precise volume of water equivalent to the evapotranspiration (ET) of the crop. It is estimated from daily Evaporation data using crop and canopy coefficients, the latter two factors vary with the age of the crop and the size of its canopy.

These are the two factors that affect the volume of transpiration of the plant/crop that changes with growth of the crop. Factoring in of these two coefficients is what makes the water requirement estimate unique to that particular crop at that particular stage of its growth.

Fertilizer Application

The fertilizer application should normally be on the basis of soil test. In case the facility for soil testing is not available, fertilizer may be applied at the following rates:

i) N: P: K

The time of fertilizer application depends upon the growth stages of the crop. Fertigation schedule is prepared considering this issue.

FERTILIZER RECOMMENDATION*

N:60 **P**:24 **K**:24 kg/ac			
UREA	kg/ac	146	
SSP	kg/ac	150	Full Basal
MOP	kg/ac	40	
Zn SO4	kg/ac	10	Full Basal
FYM	t/ac	25	Full Basal

*** Based on Literature of Wheat Directorate.*

FERTIGATION SCHEDULE FOR IRRIGATED WHEAT

Duration		Urea	MOP
5-20 DAG	5 times (every 3 days)	9.6 kg/time	0
21-80 DAG	20 times (every 3 days)	4.9 kg/time	0
60-120 DAG	20 times (every 3 days)	0	2 .0 kg/ time

DAG - Days of Germinatio

Jain® Drip
More Crop Per Drop®

Benefits of Jain Drip in Wheat Cultivation

- Enhanced yield upto 50% .
- Conserving irrigation water up to 50%
- Conserving energy use for pumping up to 50%.
- Incidence of diseases and insects significantly low
- Higher water and fertilizer use efficiency.
- More Productive tillers
- Higher and cleaner straw production.
- Reduces yield loss due to Terminal Heat.
- Early Maturity.
- Uniform in grain size.
- Reduced chaffiness & shattering of grains.
- No need for land leveling (prerequisite for flow irrigation).
- Wheat and Rice crop rotation is possible with intermediate pulse crop during summer.
- Reduced humidity in micro climate .

ii) Secondary & Micronutrients

Sulphur

In some wheat growing areas, particularly where Rice–Wheat crop rotation is continuously taken, the deficiency of Sulphur is well known. Recent studies at Modipuram indicated wide spread deficiency of Sulphur in the soils of Rice-Wheat growing areas of western Uttar Pradesh.

The Sulphur deficiency can be managed by application of fertilizers like Super Phosphate or Ammonium Sulphate.

Zinc

Among micronutrients, Zinc (Zn) is the most common disorder of Indian soils, particularly those managed under Rice-Wheat cropping system.

Application of 10 kg Zinc Sulphate/ac is sufficient to meet the Zn demands of Rice as well as subsequent Wheat.

Management of Weeds

For an effective control of weeds following chemicals should be sprayed by making a solution in 400 to 600 litres of water/ha.

A mixture of Isoproturon at 0.75 kg a.i /ha and 2,4-D at 0.4 kg a.i/ha doses of each or Isoguard-plus @1.2 kg a.i/ ha 30-35 days after sowing will control both narrow and broad leaf weeds.

Management of Disease

Most of the varieties released today are resistant to nearly all the diseases but even after electing such varieties if the diseases are noticed, we should apply the following chemicals for their control.

Glume blotch *(Septoria nodorum)*

Small, linear or oblong, to dark-brown blotches, appear on floral bracts and culms

Treat seed with Carboxin 75%WP@ 2 g/kg; practice crop rotation and field sanitation.

Pythium root rot *(Pythium graminicolum)*

Roots stunted and rotted; leaves pale greenor brown

Seed treatment with Thiram (0.25%) or Carboxin 75% WP @ 2g/kg ; soil treatment with Thiram @ 25 kg/ha.

Leaf blight *(Alternaria triticina)*

Leaves show reddish-brown spots; later, the spots coalesce, giving the leaf a blighted

Appearance Grow resistant varieties like (K-9107), (HD-2643), (NW-1012), (NW-1014), (K-9465), (K-9644), HP – 2733, (K-8434), (K-7903).

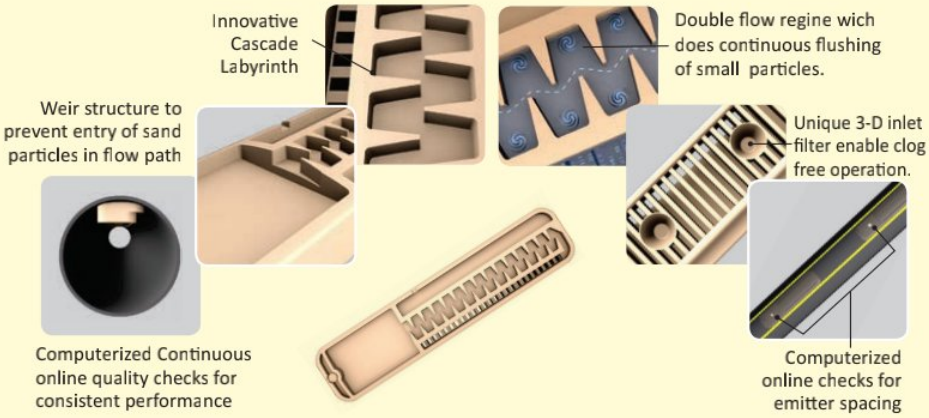
Seed soaking in hot-waters (at 52°C) for 10 minutes; spray of Ziram, Dithane M- 45 or

Dithane Z-78 (0.25%)

ONE STOP SHOP for Your

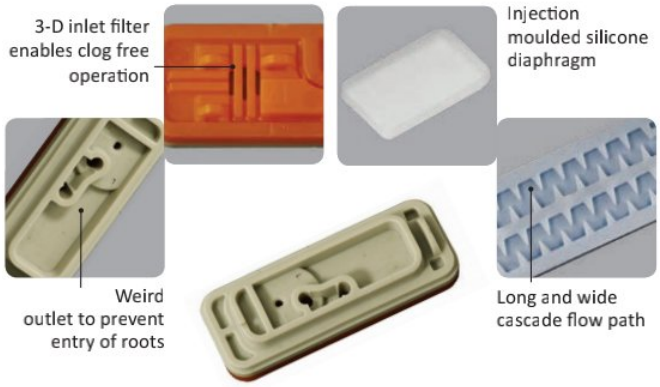
Jain Turbo Excel®

- Five Star rated dripline from worlds reknowned institute IRSTEA (Cemagref), France.
- Available discharge rates - 0.85, 1.2, 1.6, 2.1, 4 lph @ 1kg/cm².
- 12, 16, 20, 25 mm nominal diameter.
- Dripper Spacing 15, 20, 30, 40, 50, 60, 75,90 cms.



Jain Turbo Top®

- Available discharge rates – 1.1 & 1.7 lph
- Injection moulded silicone rubber compensates with pressure and discharge gives uniform performance.
- Anti Syphone feature (optional) prevents suction of sand and silt particles inside the dripper.
- Cascade labyrinth gives strong, self-cleaning turbulence.
- Available in 16 & 20mm nominal diameter. (12, 16 & 20 mm in Thin Wall option)
- Suitable for surface as well as subsurface installations.

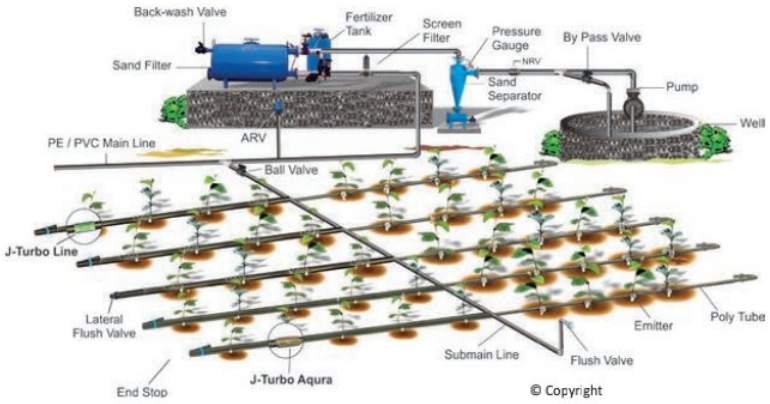


Why Jain Drip Irrigation ?

Water is not the only need of the plant. To uptake this water efficiently, it requires proper air-water balance within the root zone. Drip irrigation, with its low application rate, prevents the saturation of water within the root zone and continuously maintains field capacity. This provides a favorable condition for the growth of the plant. Drip irrigation also helps to use fertilizer efficiently. With drip irrigation water can be provided at frequent intervals which helps maintain required soil moisture level within the vicinity of the plant roots. Jain is the pioneer of drip irrigation. Ours is the only company in the world, which fulfills your entire irrigation system requirement under one roof.

Characteristics of drip irrigation

1. Water is applied at a low rate to maintain optimum air-water balance within the root zone.
2. Water is applied over a long period of time.
3. Water is applied to the plant and not to the land.
4. Water is applied at frequent intervals.
5. Water is applied via a low pressure network.

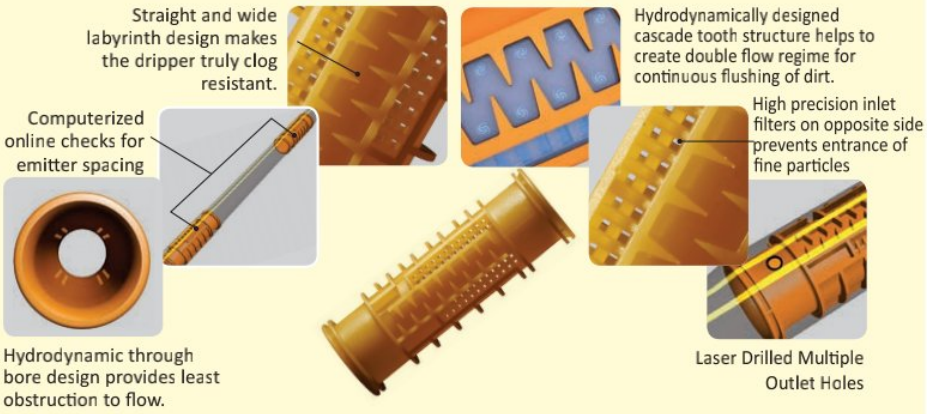


Jain® Drip
More Crop Per Drop®

Micro Irrigation Needs

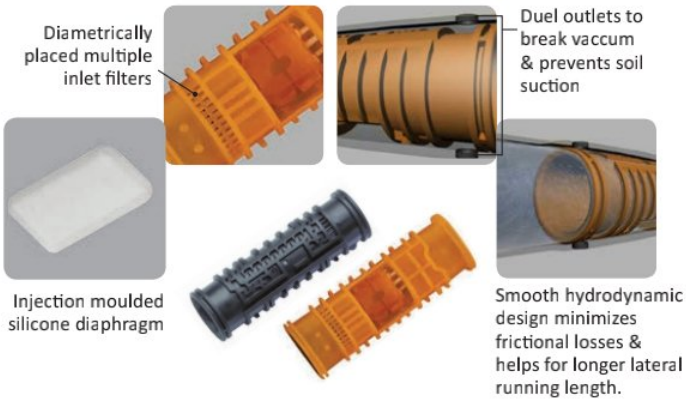
J-Turbo Line® Super

- Available discharge rates (at 1kg/cm²)
  - 12mm - 2.2, 4 lph
  - 16mm - 4, 8 lph
  - 20mm - 2.2, 4, 8 lph
- Availabe in 12, 16 & 20 mm nominal diameter.
- Suitable for surface as well as subsurface installations.



Turboline PC®

- Available discharge rates - 1.4, 1.8, 2.6 & 4.0 lph within pressure regulation range of 0.7 to 3 kg/cm².
- Injection moulded silicone rubber compensates with pressure and discharge gives uniform performance
- Application on undulating land/ Terrains/ Steep slopes.
- Available in 16 & 20 mm nominal diameter.
- Suitable for surface as well as sub-surface installation.
- Application where ever longer lateral length is necessary.
- Conforming to IS 13488, ISO 8261 Standard.



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Online Dripper & Spray Heads

Jain Filtration Equipment

Jain Fertigation Equipment

Jain Rainport / Micro Sprinkler

Jain PVC/PE Pipes & Fittings

Automation Equipment

Jain® Drip
More Crop Per Drop®

Foot rot (Helminthosporium sativum and Fusarium spp.)

Dark-brown patches appear on collar; plant turns yellow and dries up

Seed-dressing with Carboxin 75% WP@ 2 g/kg or Tebuconazole 2DS; delay sowing till the 3rd week of October

Hill bunt *(Tilletia foetida and Tilletia caries)*

Affected plants ripen earlier; ears become dark green; grains are transformed into a black sooty mass covered by a membrane and smelling of rotten fish

Treat seed with Carboxin 75% WP @2.0 g/kg, grow resistant varieties, e.g. 'Kalyan Sona' 'Panjamo 62' and PV 18';

Karnal bunt *(Neovossia indica)*

Diseased grains partly converted into black sooty powder which smells like rotten fish;

Grow resistant varieties like (HI-8381), Raj-3765, PBW-343, (HD-2643), (NW-1012), (NW- 1014).

Flag smut *(Urocystis tritici)*

Grey or greyish-black, long Seed streaks on leaves, leaf sheaths, eventually rupture and expose a black sooty mass of spore powder; affected plants stunted, with leaves twisted;

Seed-dressing with Carboxin 75% WP @ 2.0g/kg; grow resistant varieties; practice crop rotation, rogue out diseased plants

Loose smut *(Ustitago tritici)*

Smutted heads; grains replaced by a black powdery mass of spores;

Solar-heat or hot-water treatment of seed;grow resistant varieties e.g. Narendra Wheat (NW-1012), Narendra Wheat (NW-1014), Gomti (K-9465), Malviya – 468, Naina (K-9533)

Stem rust *(Puccinia graminis)*

Reddish-brown to oblong, pustules on culms and leaf sheaths;

Seed treatment with Carboxin 75% WP @ 2.0g/kg; grow resistant varieties.

Stripe rust (yellow rust) *(Puccinia glumarum striiformis)*

Mosaic mottling of leaves sometimes associated with flecking; also infects oats and wheat

Tolerant varieties Raj-3765, PBW_343, (HD-2643), (HP-1744), (HD-2687), VL-804, (K-9162), etc.

Leaf rust (brown rust) *(Puccinia recondite)*

Round or oblong, orange, scattered pustules on leaves

Grow resistant varieties like (HI-8381), (DL- 803-3), Raj - 3765), PBW-343, (HD-2643), (HP-1744), (DL-788-2), GW-273, (NW-1012), (NW-1014), (HD-2687), (HI-8498), (HD-4672)

Management of Insect pests

Termites: *Social insects that live underground in colonies ; attack young seedlings as well as grown up plants;*

Soil application of Fipronil 0.3% GR or Chlorpyrifos 10% GR @ 10 kg per acre just at the time of sowing

Stem-borer : *lay eggs in clusters inside the leaf sheaths; pinkish-brown caterpillars bore into stems and kill central shoots; causing dead-hearts.*

In the initial stage, pull out and destroy dead-hearts; spray Chlorpyrifos 20% EC @ 2ml/l

Cutworms : *Caterpillars are general feeders*
spray Chlorpyrifos 20 EC @ 2ml/l

Armyworm : *Caterpillars march from field to field and voraciously feed on foliage; appear after heavy rains or early floods*

Trap caterpillars in grass heaps or plough up infested fields; Spray Profenofos 50% EC or Dichlorvos(DDVP) 76% EC @ 1ml/l

Thrips: *:Nymphs and adults lacerate tender leaves, causing characteristic whitish streaks; temperature favourable to rapid multiplication*

Spray Dimethoate 30% EC @1 ml/l or Diazinon 20% EC @1.5 ml/l or Acetamiprid 20% SP @0.5 g/l

Wheat aphids : *Nymphs and adults suck sap from leaves, tender shoots and immature rain; extremely fast, forming large colonies*

Spray Dimethoate 30% EC @ 1 ml/l or Diazinon 20% EC @ 1.5ml/l or Imidachloprid 17.8% SL @ 0.5ml/l

Shoot fly : *The maggots attack seedlings and kill the central shoots, causing dead-hearts*

Apply Phorate (10%) or Disulfoton (5%) to the soil at the time of sowing

Harvesting & Threshing

The crop is harvested when the grains become hard and the straw becomes yellow, dry and brittle. Most of the harvesting in India is done with sickle. However, in recent years in some states like Punjab, Haryana, Uttar Pradesh etc. harvesting & threshing is done by combine harvester.

Storage

The grain should be thoroughly dried before storage. Grains with less than 10% moisture store well. The storage pits, bins or silos should be moisture proof and should be fumigated to keep down the attack of stored grain pests.

Wheat - Terminal Heat Stress

What is Terminal Heat Stress : Optimum temperature for wheat anthesis and grain filling is 12-22°C thus temperature above 22°C causes heat stress to plant.

In last few years it has been observed that at many times during February and March temperature goes above 22°C.

Heat stress during reproductive phase in wheat causes floret abortion, pollen sterility, tissue dehydration, lower CO_2 assimilation and increased photorespiration which results in to reduction in number of grains per spike and grain weight, loss in yield as well quality.

It is established that, more than 10% yield is lost due to terminal heat stress. This loss is observed more in late sown wheat.

How Jain Rainport System help avoid terminal heat stress

- Maintains optimum soil moisture during all growth phases.
- Maintains leaf water potential and stomatal conductance.
- Micro Irrigation System ensures optimum soil moisture availability, which facilitates enhanced evapotranspiration and helps in reducing canopy surface temperature.
- Jain Rainport Sprinkler Irrigation Systems allow more moisture availability for evaporation resulting in temperature reduction at canopy surface.

Jain Micro Irrigation - A solution to prevent yield loss

- It has been observed that high temperature during reproductive phase causes rapid loss of soil moisture as plants try to uptake more water to cool them by transpiring more water.
- Light and frequent irrigation has been suggested best agronomic strategy to avoid yield loss from terminal heat.
- Jain Drip & Rainport Systems enables us to provide light and frequent irrigation to maintain soil moisture besides maintaining good microclimate.
- To fight terminal heat streess Jain Rainport Systems can do irrigation on daily basis or frequently. (Even on hourly basis to combat specific situations.)
- Results in significant increase in wheat yield.
- Jain Rainport System results in more grains per spike as well as increased 1000 grain weight. (Means bold grain.)
- Jain Drip irrigated wheat also gives significant reduction in loss due to terminal heat.
- Jain Rainport Systems are best suited for this purpose.
- Jain Rainport Systems can be also installed for short period specially to mitigate terminal heat during reproductive phase.

Jain® Drip
More Crop Per Drop®

Rice + Wheat Cropping System

Rice - wheat cropping system is followed in major wheat growing areas and yield of both crops are stagnated or going down in these areas due to vanicing soil fertility and decreasing water availability and quality. Drip irrigation system offers solutions to improve yield besides associated other benefits. Drip irrigation system for wheat can be used for Rice as well as for various other crops of wheat based cropping systems.

Adopting drip irrigation for rice - wheat cropping system helps in increasing sustainability of this cropping system as it saves water and nutrients and gives higher crop yield. As scientific and sustainable farming advocates to grow at least one pulse crop in between rice and wheat, irrigation systems also allows to grow short duration pulse crop with limited irrigation during summer.

The drip irrigation system installed for Rice or Wheat, is also suitable to Maize, Soybean, Jowar, Bajra, Sorghum, Cotton, Vegetables and many other crops. Significant yield improvements besides associated benefits have been recorded in these crops by use of drip irrigation.

Benefits of Jain Drip in Rice Cultivation

- Direct Seeding and no transplanting results in reducing the seed rate and labour required for transplanting.
- No need of Nursery help in reducing cost of production.
- Conserving irrigation water up to 66%
- Conserving energy use for pumping up to 52%.
- Incidence of diseases and insects significantly low
- Higher water and fertilizer use efficiency.
- More Productive tillers
- Enhanced yield upto 50% .
- Higher and cleaner straw production.
- Early Maturity
- Uniformities in grain size
- Reduced chaffiness & shattering of grains
- No need for land leveling (prerequisite for flow irrigation).
- No need for labour use for trimming bunds and plugging breaches to contain water.
- Intercropping and rotation cropping is possible. Pulse rotation crop will be beneficial.
- Soil structure is maintained (absence of puddling operation that destroys soil structure.
- Lower mosquito population in the ecosystem as there is no standing water.
- Maintains aerobic condition in the soil.
- Prevents Nitrous oxide formation .
- Reduced humidity in micro climate .
- Prevents Methane emission and protects environment as there is no standing water
- Absence of pollution from leached and washed Nitrate.
- Ensures water energy and food security in a sustainable manner.

Jain® Drip
More Crop Per Drop®

Jain Drip - Farmer Sucess Story

	Mr. R. Kumawat (Rajasthan)	Mr. Vijay Bhoot (Madhya Pradesh)	Mr. Baldev Singh (Haryana)	Mr. S. Arshwinder (Punjab)
				
Address	Rampuria, Asind, Dist. Bhilwara Cell: 08107521797	Badgonda Mhow, Dist. Indore Cell : 09826010872	Santnagar, Rania, Dist. Sirsa Cell: 09896500723	Vill. Ghosegarh, Dist. Ludhiana Cell: 09779759685
Variety	Lok - 1	Lok - 1	W - 343	HD 2967
Soil Type	Loamy	Medium black clay loam	Medium	Medium
Drip System detail	Dripline J-Turbo Aqura	Dripline J-Turbo Aqura	Dripline J-Turboline	Jain Rainport Mini Sprinkler
Area Cultivated	5 acre	10 acre	2 acre	2.5 acre
Date of sowing	8/11/2012	20/12/2009	21/11/2011	16/11/2012
Lateral spacing	100 cm	60 cm	60 cm	10 x 10 mtr
Crop Spacing (cm)	22.5 cm	22 cm	20 cm	22 cm
Total Cost of Drip system/acre	Rs.57,200/acre	Rs.42,000/acre	Rs.60,000/acre	Rs.29,500/acre
Subsidy given to the farmers	Rs.41,200/acre	Rs.29,400/acre	Rs.45,000/acre	Rs.17,500/acre
Cost of drip per crop (6 Crop seasons)	Rs.2,140	Rs.2,100	Rs.2,500	Rs.1,380
Cost of cultltivation /acre	Rs.14,000	Rs.6,000	Rs. 6,500	Rs.6,434
Total costs (Crop + drip cost of 1 season)	Rs.16,140	Rs.8,100	Rs.9,000	Rs.7,814
Yield (t/acre)	2.84	1.8	2.71	2.06
Selling price/t	Rs.13,500	Rs.12,000	Rs.13,300	Rs.13,500
Gross Income for 1 acre	Rs.38,340	Rs.21,600	Rs.36,043	Rs.27,810
Net Profit (1 acre)	Rs.22,200	Rs.13,500	Rs.27,043	Rs.19,996
Benefit to Cost Ratio	1.37 : 1	1.66 : 1	3 : 1	2.55 : 1
Incremental Yield	1.04 t/acre	0.6 t/acre	0.9 t/acre	0.3 t/acre
Net Incremental Income	Rs.14,040	Rs.7,200	Rs.11,970	Rs.4,050
Water Saved	50%	55%	45%	40%

Jain® Drip
More Crop Per Drop®

The Company

Jain Irrigation Systems Ltd. (JISL) derives its name from the pioneering work it did for the Micro Irrigation Industry in India. However, there is more to Jain Irrigation than Irrigation. Now Jain Irrigation is a diversified entity with turnover in excess of Rs. 5000 crore. We have a Pan-India & Global presence with 28 manufacturing bases spread over 4 continents. Our products are supplied to over 116 countries with able assistance from more than 6700 dealers and distributors worldwide.

Jain Piping Division is the largest producer of Thermoplastic piping systems for all conceivable applications with pipes ranging from 3 mm to 1600 mm in diameter and in pressure ratings ranging from 1.00 kgf/cm² to 16 kgf/cm² and above. JISL has a production capacity of over 5,00,000 M.T. per annum or 5000 km/day

JISL is the only manufacturer to own DSIR approved R&D setup with state-of-the-art facilities.

The pipes are manufactured confirming to IS, DIN, ISO, ASTM, TEC and other customised specifications.

The Piping Division includes PE, PVC Pipes and Fittings catering to the urban and rural infrastructure needs of the country apart from irrigation needs of the farmers.

Micro-Irrigation Division manufactures a full range of precision-irrigation products, provides services from soil survey, engineering design to agronomic support and nurtures a sprawling 2300 acre Hi-Tech Agri Institute. It undertakes turnkey projects for total agricultural development. The division's pool of over 800 agri scientists, technologists and technicians are well equipped to render consultancy for complete or partial project planning and implementation e.g. Watershed or Wasteland and/or Crop Selection and Rotation.

Tissue Culture Division grows Grand Nain Banana plantlets and has established vast primary and secondary hardening facilities and R&D labs.

Agricultural and Fruit processing wastes are converted into Organic Manure. Neem-based pesticides are also formulated. Both are critical inputs for Organic Farming.

Agro Processed Products Division processes tropical fruits into Purees, Concentrates & Juices. The Dehydration facility dehydrates Onions & Vegetables.

Plastic sheet division's globally marketed products help conserve forests by providing alternatives to wood in the home building market.

Solar Energy Heating, Lighting Equipments, Solar Pump and Bio-Energy sources are new additions.

In a nutshell, the Corporation is the only 'one-stop-shop' encompassing manufacturing and marketing of hi-tech agricultural inputs and piping services as well as processing of agri produce. No wonder, it has distinguished itself as a leader in the domestic as well as global markets.

The corporate product range improves productivity and adds value to the agri-sector. Conservation of scarce Natural resources, protection and improvement of the environment emerge as a blessed outcome.

The Corporation has pioneered and raised a new Micro Irrigation industry in India and thereby helped harbinger a Second Green Revolution.

The reward has been over millions of smiling farmers and scores of customers in 116 countries.

Crop yields depend on climate, soil and management and therefore can t be guaranteed by the company.

Jain Drip — More Crop Per Drop® | JAIN Jain Irrigation Systems Ltd. — Small Ideas. Big Revolutions.® | More Crop per Drop

Jains Mobile App

Tel: +91-257-2258011; **Fax:** +91-257-2258111; **E-mail:** jisl@jains.com; **Website:** www.jains.com;
Toll Free: 1800 599 5000

Jain Drip | Jain Pipes | Jain PE Pipes | Jain Sprinklers | Jain Tissue-Culture | Jain Greenhouse | Jain Solar Pump | NUTRICARE | NAANDANJAIN — A JAIN IRRIGATION COMPANY

Precision Farming

MANGO UHDP

With Jain Technology™

Jain Irrigation Systems Ltd.

Small Ideas. Big Revolutions.®

MANGO - ULTRA HIGH DENSITY PLANTATION

You have always wished that you had more land and more trees to grow more mangoes. You now have an revolutionary technology which can give up to three times yield. This revolutionary technology called 'Ultra High Density Plantation' (UHDP) is brought to you by your trusted company Jain Irrigation System Ltd., Jalgaon.

UHDP is a great technical innovation

The 'UHDP' revolutionary technology is the result of years of on farm research and technological innovation by the scientists at Jain Irrigation. It is tested and perfected in the field.

- Ultra High density plantation: **674 nos** of mango trees in an acre as against 40 under traditional method.
- **Drip Irrigation & Fertigation** techniques are employed to manage UHD Mango.

- **TRIPLES YOUR YIELD.**
- **HIGHER INCOME.**
- **COMMERCIAL YIELD** in **3** years.
- **CROP REGULATION:** Fruit bearing can be regulated to get produce every year.
- **INTER CROPPING** is possible in initial years.
- **Easy harvest because of low plant height.**
- What is most exciting is that you can convert your existing orchard into an UHDP.

Comparison of income from UHD Mango Orchard & conventional Mango Orchard.		
Particular	**Planting Type**	
	Traditional	**UHDP ***
Expected annual income (Rs./acre)		
Prolific bearing varieties (Price Rs 10/kg)	Up to 50,000	Up to 1,20,000
Shy-bearing varieties (Price Rs 20/kg)	Up to 50,000	Up to 1,20,000
Estimated cultivation expense in Rs. / Acre		
Cost of Orchard establishment	Up to 20000	Up to 80000
Annual cost of maintaining bearing Orchard	Up to 20000	Up to 40000
Estimated Annual Profit in Rs. per Acre		
Prolific bearing varieties	Up to 30000	Up to 80000
Shy-bearing varieties	Up to 30000	Up to 80000
Estimated total Profit for the first 15 yrs. in Rs. per Acre **		
Prolific bearing varieties	Up to 1.25 Lacs	Up to 5.6 Lacs
Shy-bearing varieties	Up to 1.25 Lacs	Up to 5.6 Lacs

*** Taking into account the cost of establishement of the orchard. Possible profit from intercroping in the initial years is not accounted for.*

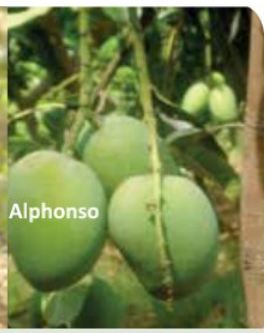
Mango varieties suitable for UHD cultivation	
State	Varieties
Andhra Pradesh	Alphonso, Alampur Baneshan, Banganapalli, Totapuri , Mallika.
Bihar	Bombai, Himsagar, Langra, Chausa.
Goa	Fernandin, Mankurad.
Gujarat	Alphonso, Kesar.
Karnataka	Alphonso, Bangalora, Neelum, Mallika.
Kerala	Mundappa, Olour, Pairi.
M.P.	Alphonso, Bombai, Langra.
Maharashtra	Alphonso, Kesar, Ratna.
Tamil Nadu	Alphonso, Banganapalli, Imampasand, Totapuri (Bangalora), Neelum.
Uttar Pradesh	Bombay Green, Dashehari, Langra, Lucknow Safeda, Mallika, Chausa.

Yield of UHD Mango & conventional Mango orchard		
Particular	**Traditional**	**UHDP**
Plant Spacing (metre)	10 x 10	3 x 2
Number of Plants /acre	40	674
Time to bear commercial level yield	7-9 yrs.	3-4 yrs
Years to reach full potential	12-15 yrs	4-5 yrs.
Commercial orchard life	Up to 50	25-30 yrs
Expected yield at maturity per Acre		
Prolific bearing varieties	4-5 Ton	10-12 Ton
Shy-bearing varieties	2 to 2.25 Ton	5-6 Ton

2 Year 7 months Old Plantation

2 Year 10 months Old Plantation

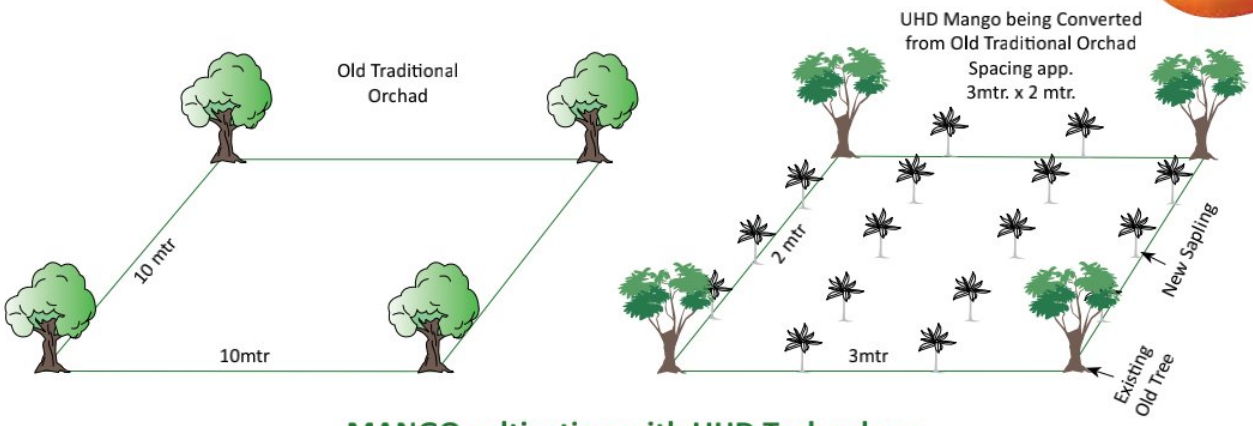
Ready to Harvest (2yr 10 Monts)



UHD Mango Plantation at Jain Irrigation Farm at Udumalpet, Tamil Nadu

How to convert your existing orchards into UHD Mango?

An existing orchard can be converted to an UHD orchard by planting new trees in between the old existing trees. For example, in a 10m x10m orchard, two additional rows between existing rows and three additional plants between two existing plants can be raised to make it an UHD Mango.

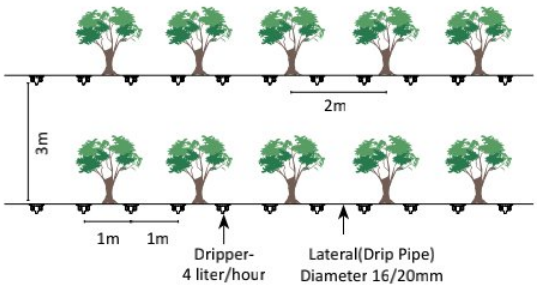


MANGO cultivation with UHD Technology

Drip Irrigation

Irrigation & fertilizer are the most critical inputs for UHDP cultivation. They should be applied through Drip Irrigation System for precise application. Proper irrigation and fertiliser application is a must to make the UHDP technology sucessful.

UHD Mango under Drip



The online drip system is recommended. Each tree is provided with one dripper of 4 LPH during initial two years, and 2 drippers of 4 LPH (placed 45/50 cm away from the trunk) from the 3rd year onward when the water requirement of the plant increases.

Managment of Flowring and Fruit Drop

Foliar spray for inducing Flowering and preventing premature Fruit Drop is required.

Training and Pruning

Pruning and training are very essential and critical operations of UHDP to maintain fruiting shoots and contain the canopy.

Crop Regulation

In case of traditional cultivation, Mango trees generally bear fruits every alternate year. But, under UHDP cultivation, it can be made to bear fruit every year by pruning and treatment with chemicals like Paclobutrazol.

Fertilizer

Fertigation (applying water soluble fertilizer with irrigation) is a much superior method of applying fertilizer. It saves water, labour, and increases the effectiveness of fertilizer, thereby boosting the yield.

Micronutrient application: Micronutrients are to be applied as & when needed.

Fertilizer Requirement

Age	g/tree			FYM kg/tree
	N	P	K	
1st year	35	15	25	5
2nd year	45	25	50	5
3rd year	75	50	75	10
4th year	120	75	100	15
Onwards	120	75	100	15

Age Fertigation Schedule & Quantity

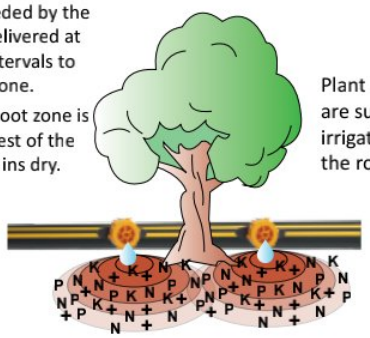
(kg/dose/acre)

Age	Month	Number of Doses	Urea	H_3PO_4	MOP	$MgSO_4$
1yr	July-Sept	12	1.4	0.5	0.8	-
	Jan-May	20	1.7	0.6	0.9	-
2yr	July-Sept	12	2.7	1.2	2.3	0.278
	Jan-May	20	1.6	0.7	1.4	0.167
3yr	15 June-Aug	12	4.5	2.3	3.5	0.555
	Sept	4	1.4	1.2	3.1	-
	Jan-May	20	3.2	1.2	1.5	0.333
4yr on-wards	15 June-Aug	12	7.2	3.5	4.6	0.833
	Sept	4	2.2	1.7	4.2	-
	Jan-March	12	5.1	1.7	3.2	0.833

Principle of Drip Irrigation & Fertigation

Exact volume of water needed by the plant is delivered at regular intervals to the root zone.

Only the root zone is wetted. Rest of the field remains dry.



Plant nutrients are supplied with irrigation water to the root zone.

N= Nitrogen, K=Potassium, P=Phosphorus, + =Micro elements

Benefit of Drip Irrigation

- **Much higher yield** due to precision in irrigation and fertilizer application.
- **Good & Uniform** fruit quality.
- Saving of Water up to **50%**
- Saving of Fertilizer up to **30%**
- Saving of Power.
- Less moisture & so, lesser incidence of weed and disease.
- Saving of labour used in irrigation, fertilizer application and weeding.

Daily Water requirement (WR) for Mango plantation under UHDP (3x2m), Udumalpet.						
Month	Evapo-ration, mm	Water Requirement L/plant/day				
		1st yr	2nd Yr	3rd yr	4th yr	5th yr
Jan	4.60	0.63	2.53	5.69	10.12	10.12
Feb	5.90	0.80	3.21	7.21	12.82	12.82
March	7.29	1.00	4.00	8.99	15.98	15.98
April	6.69	0.89	3.55	7.99	14.21	14.21
May	7.54	0.94	3.76	8.45	15.03	15.03
June	7.45	1.01	4.05	9.12	16.21	16.21
July	7.47	1.03	4.11	9.24	16.43	16.43
Aug	7.84	1.09	4.35	9.78	17.39	17.39
Sept	7.78	0.96	3.84	8.64	15.35	15.35
Oct	4.74	0.55	2.21	4.97	8.83	8.83
Nov	3.84	0.59	2.35	5.28	9.39	9.39
Dec	3.90	0.58	2.33	5.25	9.33	9.33
Avg.	6.02	0.93	3.73	8.39	14.92	14.92

***Based on the location the WR will vary.*

Unique Rejuvenation Technique

Rejuvenation Pruning *Growth of Plant after rejuvenetion*

This is a technique for rejuvenating old trees and thereby making them productive again. The old and non productive branches are cut at their point of origin; only one branch is allowed to support new growth. Fresh productive branches grow again and the plant starts fruit bearing.

What is more, even a new variety can be grafted on the new shoots which emerge after the above rejuvenating pruning.

If you have an old unproductive orchard, you can rejuvenate it to make it productive and at the same time convert it into an UHDP orchard by planting additional saplings. With this you will get a brand new highly productive and profitable orchard !!

NOTE: The Irrigation, Fertigation, and other Agricultural practices given here are part & parcel of the technology and following them is a must for successful adoption of this technology. The UHDP technology should be adopted in full (as a whole package) to get its full benefit. Please contact us for detail literature and guidance for you to adopt this technology.

Jain Drip More Crop Per Drop® | Jain Irrigation Systems Ltd. Small Ideas. Big Revolutions.® | More Crop per Drop

Jains Mobile App

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Toll Free: 1800 599 5000

JAiN ART/UHDP Mango_Eng_4pg/0117/YP

Irrigation Solution
MAIZE
With Jain Technology™

Jain Irrigation Systems Ltd.
Small Ideas. Big Revolutions.®

MAIZE - the miracle crop. It is the queen of cereals has highest genetic yield potential. In India , Maize ranks fifth in area (8.55 m ha) fourth in production (21.3 m.t) and third in productivity (2.54 t/ha) among Cereals. Maize has diverse uses ie., for human consumption (24%), as poultry feed (52%), as animal feed (11%), as raw material in many Industries (11%), as seed (1%) and for brewery (1%). Though maize can be grown in all the seasons because of the favourable climatic conditions, it is mainly grown as major Kharif crop in most States in India and rabi crop in Andhra Pradesh and Tamil Nadu . In the Telugu states 7.5 lakh hectares is grown with Maize and produces 40 lakh tons with a productivity of 5317 kg/ha.

Maize is preferred over other cereals because it has less water requirement compared to rice, least pest and disease problems and high demand for its by-products and export potential. Specialty corns like sweet corn, popcorn, baby corn and Quality Protein Maize etc. cultivation also ensures additional income to the farmers and there lies a bright future for the value added products, which can ensure additional income to the farmers.

Soils

Maize can be grown on a wide variety of soils ranging from heavy clays to light sandy ones. It grows best on deep fertile, organic matter rich, friable, well drained medium textured soils with good water holding capacity. Optimal pH range is 6.5 -7.5. Alkaline, Saline and waterlogged soils (low lying areas) should be avoided since the crop suffers adversely just after germination.

Climate

Maize can be successfully grown in wide range of agro-climatic conditions. Being warm weather loving crop, It is not grown in areas where the daily temperature is less than 19° C. It will be faster and less variable at a soil temperature of 16-18° C At 20° C, it takes 5-6 days to emerge. Critical temperature detrimentally affecting the yield is 32°C. Maize cannot with stand frost at any stage, frost can damage the plant at all growth stages. It can be successfully grown in areas with annual rainfall of 60cms, well distributed throughout the growing stages.

Season

Kharif : Where ever irrigation facility exist optimum time for kharif sowing is a fortnight before the monsoon so that the crop can establish well, overcoming initial weed competition. This practice has given 15% higher yield than those sown with or after onset of monsoon. The most suitable date of sowing is between June15th to July15th.

Rabi : For rabi maize, the most suitable date of sowing between 15th October to 15th November in Telangana state and up to the first week of January in the Coastal area of AP State. Wide variation in day and night temperatures during rabi helps in higher production. Pest and disease are less because day light is more.

Varieties

In areas receiving high rainfall, long and medium maturity hybrids can be chosen, whereas in areas of erratic rainfall districts, short duration hybrids can be sown in light soils.

Sowing

It is desirable to sow the crop on ridges to avoid damage due to waterlogging and to provide adequate moisture in the root zone. Sowing can also be done on a flat surface in lighter soils followed by earthing up as soon as the weather permits, to avoid lodging. For obtaining optimum plant density, it is desirable to use a seed rate of 8-10 kgs/acre.

Spacing& Planting

Under drip irrigation system two rows of maize on one lateral ie., 15-22 cms from drip lateral on either sides, as shown in the picture. Plant to plant spacing is 15 to 20 cms depends on the soil condition. Desired planting density to achieve maximal yield: 33,333 plats/acre. For silage, plant density may be increased to as high as 48000plants/acre.

Drip System Details

Lateral to lateral spacin-1.2mts of 16mm: Dripper discharge-4 lph: Dripper spacing-0.60mts (in black soils) & 0.40 to 0.50 mts in lighter soils.

Weed Control

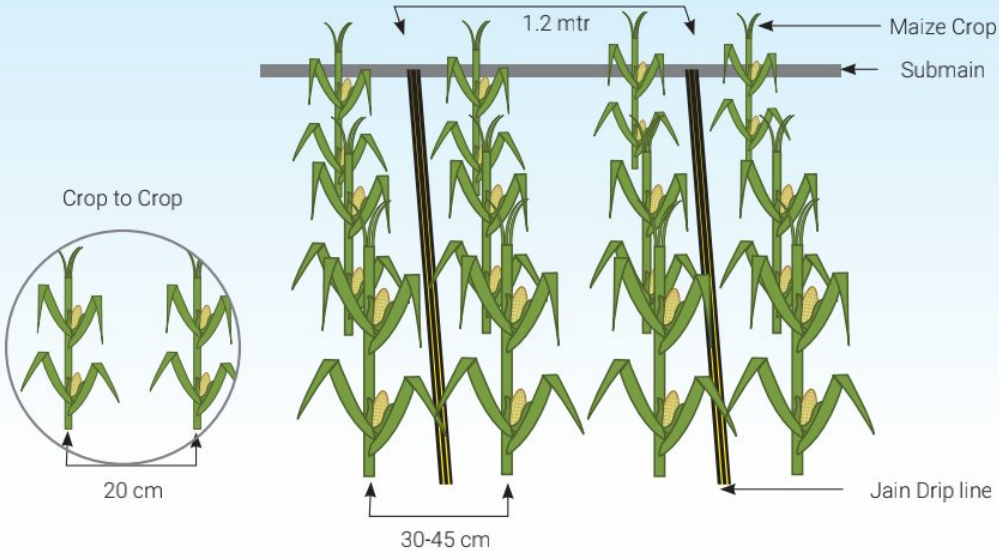
The critical period of weed competition in maize is generally up to 30-35 days from the date of sowing. The crop should be kept free up to 50 days. Yield reduction of 50% can be expected when weeds are allowed to remain during first 30 days after sowing.

Chemical control of weeds with pre-emergence of weedicide Atrazine 50% WP @ 2kg/ha in case of light soils and 3kg/ha in case of heavy soils is to be mixed in 500 liters of water and sprayed uniformly 2-3 days after sowing on moist condition of the soil. Followed by Inter- cultivation should be done at 35-40 days (knee high stage).Inter-cultivation should not be more than 3-5 cms deep to avoid root damage.

Water Management

- Maize is one of the most efficient grain crops in terms of water utilization as 10-16 kg grain is produced for each mm of water consumed. Maize is a sturdy, tall and fast growing plant with broad leaves, its water requirement is more. A total of 400 -500 mm of water would be enough for kharif maize and 450-600 mm water is required in rabi season.
- Monsoon rain, which is generally erratic, may cause either prolonged drought or waterlogged conditions both of which are highly detrimental to maize. Certain periods during crop growth are more sensitive to soil moisture stress and are called moisture sensitive periods.

Shematic Drip Layout for Maize



- The Critical stages for moisture stress in maize are flowering, grain filling and dough stages. Yield reduction of 40-50% was noticed due to moisture stress during flowering to milky stage. More than 50% of its total water requirement is needed in about 30-35 days after tasseling and inadequate soil moisture at grain filling results in poor yield of shriveled grains.
- Efficient water management is the key to increasing the productivity of maize.
- For Pre-sowing irrigation to field capacity is very important, as maize seed will not germinate unless it absorbs moisture to double its weight.
- Drip irrigation can save 25-30% of water, increases water use efficiency to 75 - 90% and results in 20-50% higher yields.

The month wise daily irrigation schedules for Kharif & Rabi maize are given below.

The water requirement will be vary from location to location and date of sowing. Pl contact Jain agronomist for further guidance.

Daily Irrigation schedules

DAILY IRRIGATION SCH. FOR RABI MAIZE CROP				
INLINE DRIP SYSTEM W.G. REGION				
Sr.	**Month**	**Days**	**WR, mm/ day**	**WR, Lit/ day/Acre**
1	Oct 15-30	15	0.73	2973
2	Nov 01-15	15	2.05	8313
3	Nov 16-30	15	3.26	13190
4	Dec 01-15	15	4.26	17238
5	Dec 16-30	15	5.26	21294
6	Jan 01-15	15	5.95	24089
7	Jan 16-30	15	4.33	17519

DAILY IRRIGATION SCH. FOR KHRIF MAIZE CROP			
INLINE DRIP SYSTEM - NIZAMABAD REGION			
Sr.	**Month**	**WR, mm/day**	**WR, Lit/day/Acre**
1	June 01 -15	0.77	3108
2	June 16-30	2.17	8785
3	July 01-15	3.09	12521
4	July 15-30	4.58	18538
5	August 1-15	6.02	24363
6	August 16-30	6.84	27681
7	Sept 1-15	4.50	18203
8	Sept 15-25	3.50	14165

* If the rain fall is 10cms stop irrigation for 2-3 days depends on the soil

* The daily irri.shc has to be followed after reaching the field capacity

* The daily irri.sch is vary from location to location and time of plating

Nutrient management

Maize, being an efficient harvester of solar energy and monocarpic nature, is an exhaustive crop. Sufficient fertilization will ensure the quality and quantity of the crop. Fertilization should be based on the soil tests.

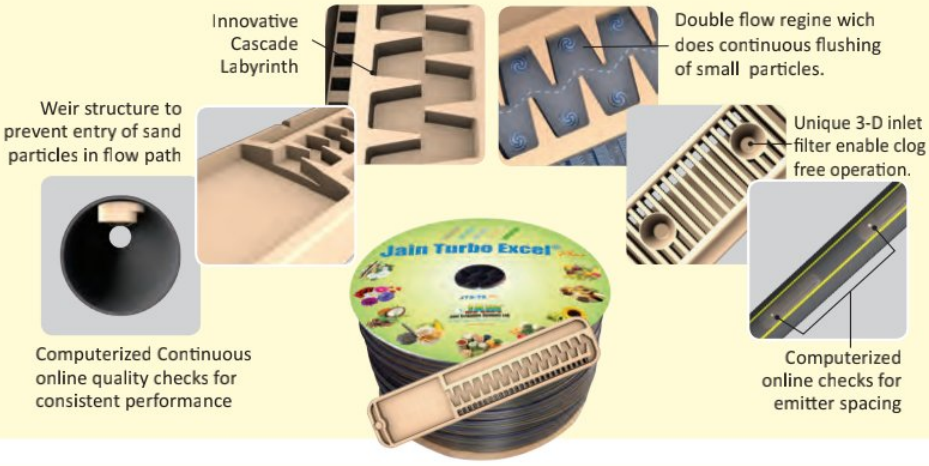
Each ton of gain produced removes 15-18 kg of N, 2.5-3 kg of P2O5 and 3-4 kg of K2O from the soil. Nutrient requirement differs with soil type, farming method (rainfed/irrigated) and season.

A crop producing grain yield of 6.27 t/ha is estimated to consume 168kg N, 57 kg P2O5 and 135 kg K2O and 30 kg ZnSo4. To maintain soil productivity on a sustainable basis, an integrated nutrient management approach, using both organic and inorganic sources of nutrient should be adopted.

ONE STOP SHOP for Your

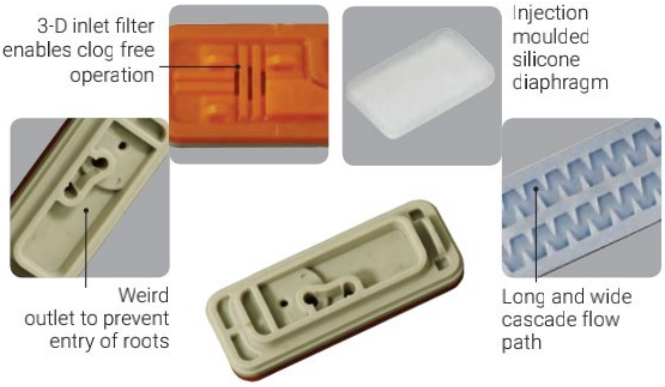
Jain Turbo Excel®

- Five Star rated dripline from worlds reknowned institute IRSTEA (Cemagref), France.
- Available discharge rates - 0.85, 1.2, 1.6, 2.1, 4 lph @ 1kg/cm².
- 12, 16, 20, 25 mm nominal diameter.
- Dripper Spacing 15, 20, 30, 40, 50, 60, 75,90 cms.



Jain Turbo Top®

- Available discharge rates – 1.1 & 1.7 lph
- Injection moulded silicone rubber compensates with pressure and discharge gives uniform performance.
- Anti Syphone feature (optional) prevents suction of sand and silt particles inside the dripper.
- Cascade labyrinth gives strong, self-cleaning turbulence.
- Available in 16 & 20mm nominal diameter. (12, 16 & 20 mm in Thin Wall option)
- Suitable for surface as well as subsurface installations.

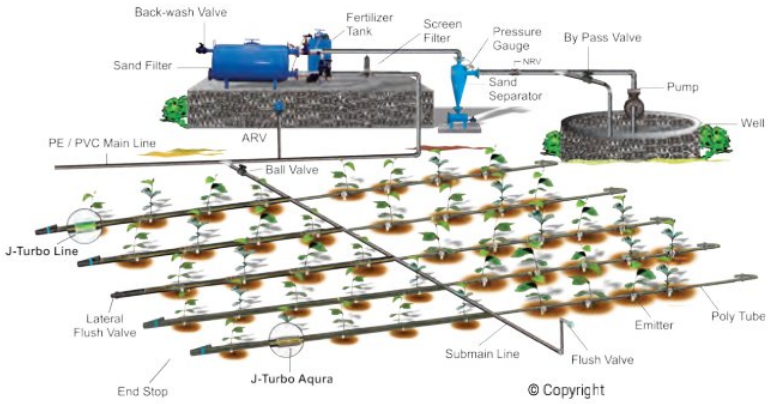


Why Jain Drip Irrigation ?

Water is not the only need of the plant. To uptake this water efficiently, it requires proper air-water balance within the root zone. Drip irrigation, with its low application rate, prevents the saturation of water within the root zone and continuously maintains field capacity. This provides a favorable condition for the growth of the plant. Drip irrigation also helps to use fertilizer efficiently. With drip irrigation water can be provided at frequent intervals which helps maintain required soil moisture level within the vicinity of the plant roots. Jain is the pioneer of drip irrigation. Ours is the only company in the world, which fulfills your entire irrigation system requirement under one roof.

Characteristics of drip irrigation

1. Water is applied at a low rate to maintain optimum air-water balance within the root zone.
2. Water is applied over a long period of time.
3. Water is applied to the plant and not to the land.
4. Water is applied at frequent intervals.
5. Water is applied via a low pressure network.

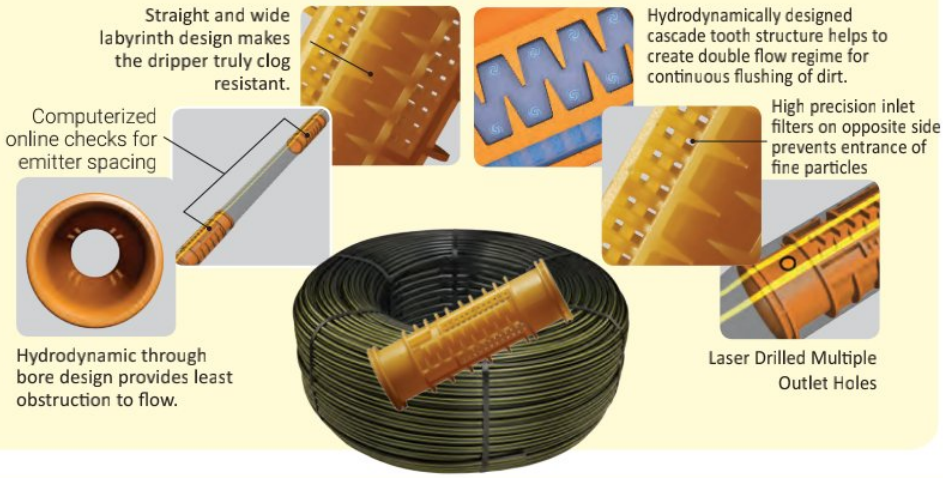


Jain Drip
More Crop Per Drop®

Micro Irrigation Needs

J-Turbo Line® Super

- Available discharge rates (at 1kg/cm²)
  - 12mm - 2.2, 4 lph
  - 16mm - 4, 8 lph
  - 20mm - 2.2, 4, 8 lph
- Availabe in 12, 16 & 20 mm nominal diameter.
- Suitable for surface as well as subsurface installations.



Turboline PC®

- Available discharge rates - 1.4, 1.8, 2.6 & 4.0 lph within pressure regulation range of 0.7 to 3 kg/cm².
- Injection moulded silicone rubber compensates with pressure and discharge gives uniform performance
- Application on undulating land/ Terrains/ Steep slopes.
- Available in 16 & 20 mm nominal diameter.
- Suitable for surface as well as sub-surface installation.
- Application where ever longer lateral length is necessary.
- Conforming to IS 13488, ISO 8261 Standard.

Largest Choice ! Customized Irrigation Solution

Online Dripper & Spray Heads

Jain Filtration Equipment

Jain Fertigation Equipment

Jain Rainport / Micro Sprinkler

Jain PVC/PE Pipes & Fittings

Automation Equipment

Jain® Drip
More Crop Per Drop®

DRIP IRRIGATION IN MAIZE

The most effective method of irrigation maize with the greatest benefits:

- Better uniformity
- Better irrigation efficiency-saving water and fertilisers.
- Lower operating pressure and energy
- Saving labour
- Reduction of foliar disease.
- Usage of the system during day and night
- Better uniformity and less water waste in plot edges
- Higher yields 20-30%, mainly due to uniformity and efficient fertigation.

Nutrient requirement for Maize Crop

crop	Nutrient requirement kg/acre		
	Nitrogen N	Phosphorus P2O5	Potash K2O
Kharif Maize	72– 80	24	20
Rabi Maize	80-100	32	32
Fodder Maize (rabi & kharif)	35- 75	16	16

Fertigation Schedule for rabi maize

FERTIGATION PROGRAME FOR MAIZE CROP (RABI)

Recommonded Dose of NPK : 100 : 32 :32 kgs/acre

Basal (Soil) Application (25 days before the sowing is ideal for good yield)	SSP	100	kgs
	Zinc Sulphate	20	Kgs
	FYM	6	tons

Period of application	Day	No of applica-tions @ once in 3 days	Qty of fertigation be given for every 3rd day (in kgs)			
			Urea	Phos. acid	White Potash (W)	Magni-sium Sulphate
15 to 30 DAG	15	5	9	3		
31 to 45 DAG	15	5	11	1	0.7	5.0
46 to 65 DAG	20	7	13		1.0	
66 to 75 DAG	10	3	10		2.5	

Note: The ferti.sch to be adjusted based on the soil analisis

The fertigation has to be given 20 mnts before the closure of the irrigation through drip

The nitrogen qty should be reduced for sweet corn & Heavy soils

Fertigation Schedule for Kharif maize:

FERTIGATION PROGRAME FOR MAIZE CROP (KHARIF)

Recommonded Dose of NPK : 80 : 24 : 20 kgs/acre

Basal (Soil) Application (25 days before the sowing is ideal for good yield)	SSP	75	kgs
	Zinc Sulphate	20	Kgs
	FYM	6	tons

Period of application	Day	No of applica-tions @ once in 3 days	Qty of fertigation be given for every 3rd day (in kgs)			
			UREA	Phos. acid	White Potash (W)	Magni-sium Sulphate
15 to 30 DAG	15	5	7	2		
31 to 45 DAG	15	5	9	1	0.4	5.0
46 to 65 DAG	20	7	10		0.6	
66 to 75 DAG	10	3	8		1.6	

Note: The ferti.sch to be adjusted based on the soil analisis

Harvesting

To avoid unnecessary losses in the field due to birds, insects, fungi, rodents, wild animals etc. harvesting should be done when the crop attains physiological maturity. Usually it I harvested when the dry matter content is maximum or 7-8 weeks after flowering or when the grain moisture is 25-30 %.

The right time for harvesting of fodder maize is the flowering stage. Quality is adversely affected if harvesting is done after anthesis. Depending on the duration of the variety, it can be harvested in 50-60 days.

Yield

Average yields are dependent on many parameters, such as the maize varieties, the region in which it is grown and the timing of planting. The Yield may vary from - 4.0-4.5 t/acre (???)

SUCCESS STORY

Name of Farmer	Shri Revender reddy
Address	At. post.Veleru,Darmasugar, Dist. Wrangal
Crop	Maize
Soil	Medium black
Drip	Inline
Area	4 acres
Date of sowing	10 - 06 - 2009
Lateral spacing	1.2mts X 16mm X .60 m X 4lph
Planting distance	30cmX20cms
Variety	kaveri
Cost of cultltivation Maize (4 acre)	
Land preparation (@ Rs 500/acre)	Rs.2000
Seed (@ 8 kg /acre)	Rs.12000
Sowing	Rs. 800
Inter cultivation exp.	Rs. 1200
Fertilizers(as per requirement) + appli	
FYM	Rs. 2000
Chemical fert.	Rs. 8000
Crop Management	Rs. 1000
Irrigation &Spervision	Rs .1600
Harvesting	Rs. 4400
Total cost of Cultivation for 4 acres	Rs. 33000
Cost per acre	Rs. 8250
Total Production qtls	160 qtls
Yield /acre)	40 qtls
Fodder (2.5q /acre)	10 qtls
Drip cost (for considering for 5 yrs)farmers contri	Rs.8000
Total cost of cultivation (inc. drip)	Rs.41000
Realisation @ Rs.1100/q)	Rs.176000
Fodder (2.5 qtls) Rs.1600/acre)	Rs. 6400
Total Realisation of the produce	**Rs.182400**
Net Profit	**Rs.141400**
Cost benefit ratio	**01:03.4**

The Corporation

There is more to Jain Irrigation than irrigation

Global Presence: Jain Irrigation Systems Ltd. (JISL) derives its name from the pioneering work it did for the Micro Irrigation Industry in India. However, there is more to Jain Irrigation than Irrigation. Now Jain Irrigation is a diversified entity with turnover in excess of Rs. 6000 crore. We have a Pan- India & Global presence with 30 manufacturing bases spread over 4 continents. Our products are supplied to over 116 countries with able assistance from more than 6700 dealers and distributors worldwide.

Micro Irrigation: The Corporation has pioneered and raised a new Micro Irrigation industry in India and thereby helped harbinger a Second Green Revolution. The Micro-Irrigation Division manufactures a full range of precision-irrigation products and provides services from soil/ topographical survey, engineering design, supply, installation and commissioning to agronomic support for millions of farmers worldwide. It is the only company in the world which has the largest basket of product and system solutions that can suit any climatic/topographical/ crop conditions. The division's pool of over 1000 agronomists, irrigation engineers and technicians are well equipped to support the farmer customers across the globe. The company nurtures a sprawling 2300 acre Hi-Tech Agri Demonstration farm and a training Institute.

Plastic Piping: Presently, JISL is the largest producer in Asia of PVC and PE piping systems for all conceivable applications with pipes ranging from as small as 3 mm to 2000 mm in diameter and in pressure ratings ranging from 1.00 kg/cm² to 25 kg/cm². JISL has a production capacity of over 5,00,000 tonne per annum or 8000 km/day of plastic pipes. The Piping Division includes a variety of PVC and PE Fittings catering to irrigation needs of the farmers apart from the urban and rural infrastructure needs. The pipes are manufactured conforming to BIS, DIN, ISO, ASTM, TEC, Australian Standards as well as other customised specifications.

Biotechnology: The Tissue Culture Division grows Banana, Pomegranate, Strawberry, Guava, Coffee, Sugarcane plantlets and has established vast primary and secondary hardening facilities and R&D labs.

Green Energy: JISL Pioneered Solar water pumping systems in the country. Jain Solar water pumping system is a standalone systems operating on power generated by Solar Photovoltaic panels which are also manufactured in house state-of-the-art facility. JISL has installed more than 15000 Solar Pumps. All these products are in harmony with the group's mission, "Leave This World Better Than You Found It".

Jain Green Energy division also offers Solar Thermal Water Heating Systems, Solar Photovoltaic, Bio-Gas and Bio-Energy alternate energy solutions.

Agricultural Processing: Agro Processed Products Division processes tropical fruits such as Mango, Banana, Guava, Pomegranate into Purees, Concentrates & Juices. The company also has a Dehydration facility which dehydrates Onions & Vegetables. Agricultural and Fruit processing wastes from these processing plants are converted to Bio-Energy to partially run the plants. The residue after the Bio-Energy generation is used as an Organic Manure.

Plastic sheet division's globally marketed products help conserve forests by providing alternatives to wood in the home building market.

Turn-key Projects: JISL undertakes Integrated Agricultural Development Projects on Turn-Key basis from Concept to Commissioning with value added services. JISL offers cost effective, down-to-earth solutions for complex challenges backed by our core strength of global knowledge and experience combined with local man-power which is an ideal combination of technology, intelligence and common sense. Whatever be the nature of the project requirement, JISL can assure Total Turn-Key solutions and maximum value for the farmers. It can also undertake Watershed or Wasteland development projects. Such projects normally begins with selection of site, survey of the command area, identification of appropriate crops, designing of the suitable irrigation systems, determination of agronomic practices, use of other hi-tech agro inputs, providing on-going technical services & training and pre & post harvesting techniques, provide assistance for operation and maintenance of the systems.

The Company has successfully executed large scale turn-key irrigation projects from conception to completion not only in India but also overseas.

Jain Irrigation offers following turn-key Solutions:

- Integrated irrigation solutions.
- Integrated agricultural development projects.
- Reuse of waste water for agriculture.
- Dust suppression.
- Lift & Gravity water pipelines.
- 24x7 Water Supply.
- Effluent conveyance & disposal systems.
- Gas distribution System.
- Industrial fluid conveying systems, sewerage lines etc.
- Marine On-shore & Off-shore piping.
- Relining and rehabilitation of existing pipelines.
- Plumbing Systems.
- Solar pumping systems.
- Non-conventional power water heating projects.

In a nutshell, the Corporation is the only 'one-stop shop' encompassing manufacturing and marketing of hi-tech agricultural inputs and piping services as well as processing of agri produce. No wonder, it has distinguished itself as a leader in the domestic as well as global markets. The corporate product range improves productivity and adds value to the agri-sector. Conservation of scarce Natural resources, protection and improvement of the environment emerge as a blessed outcome. The reward has been over millions of smiling farmers and scores of customers in more than 116 countries.

Jain Drip — More Crop Per Drop®

JAIN — Jain Irrigation Systems Ltd. — *Small Ideas. Big Revolutions.®*

More Crop per Drop

Jains Mobile App

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Toll Free: 1800 599 5000

Precision Farming
GROUNDNUT
With Jain Technology™

Jain Irrigation Systems Ltd.
Small Ideas. Big Revolutions.®

Groundnut (*Arachis hypogaea* L.) is believed to be native of Brazil from where it was introduced into to India via Chinese Pacific islands.

Groundnut, in general, has a short-statured plant, with the main axis being upright (15 to 40 cm long) but the major part of the plant consists of the primary branches. Secondary and tertiary branches are found in the semi-spreading and spreading (Virginia) types, giving them a prostrate stature.

About 7.5 million hectares is under ground nut annually in India and the production is about 6 million tonnes. 70% of the area and 75% of the production are concentrated in the four states of Gujarat, Andhra Pradesh, Tamil Nadu and Karnataka.

Soil

- Medium soils with very good drainage and loam soils are preferable. Heavy deep black cotton soils (clay) to be avoided.
- Lack of proper drainage adversely affects root growth ultimately affecting the crop.
- In the absence of adequate oxygen in the root zone, beneficial soil bacteria, especially the nitrogen - fixers become ineffective and uptake of nitrogen by roots is hampered.
- The pegs can penetrate the soil easily and pods can be harvested from such soils with minimum losses
- Adequate supply of calcium mineral in the soil is very essential for the production of groundnut pods .
- Heavy and fine - textured soils with stiff clay cause difficulties in groundnut harvesting .
- Where groundnuts must be grown on heavier - textured soils, runner varieties of groundnut are more suitable than the Virginia types.
- High yields are obtained on soils with moderate acidic reaction (soil pH 6.0 to 6.4), alkaline soils being undesirable. Yellowing of groundnut leaves and blackening of parts of pods occur when the pH was 7.5 - 8.5. Soils having pH less than 5.0 are also not suitable for groundnut cultivation.
- Application of gypsum alleviates soil salinity by improving leaching of salts below the root zone.

Climate

- Groundnut is grown in the Tropical and SubTropical countries lying between 45° North and 35° South and up to an altitude of 1000 meters and receiving a minimum rainfall of 500 mm and a maximum of 1250 mm.
- The groundnut crop however, can not stand frost for long and severe drought or water stagnation.

Varieties

Some of the recommended varieties are:

Andhra Pradesh : ICGS-11 (Bunch - Spanish); Kadiri 2, Kadiri 3, TMV-10, TG 1 (vikram) (Semi Spreading); Kadiri 71-1 (Spreading) TMV-2, JL-24, POLACHI, GG-20, Gangapuri & Narayani.

Tamil Nadu : Spanish Improved, S-206, DH 3-30, KRG-1, DH-8, ICGS-11 (Bunch- Spanish); S-230 (Spreading).

Karnataka : ICGS-11, TMV-2, TMV-5, TMV-7, POL-1, TMV-9, POL-2, TMV-12, CO-1, CO-2 (Bunch- Spanish); TMV-11 (Bunch-Valencia); TMV-6, TMV-8, TMV-10 (Semi Spreading); TMV-1, TMV-3, TMV-4 (Spreading).

Maharastra : AK 12-24, SB XI, JL 24, TG 17, ICGS-11 (Bunch - Spanish); Kopergaon (Bunch-Valencia); TG 1 (Vikram), Kopergaon 1, UF 70-103 (Semi Spreading); Karad, 11- Apr (Spreading), HD 11.

Orissa : Kisan, Jawan (Bunch - Spanish).

Madhya Pradesh : Jyoti, ICGS-11 (Bunch - Spanish); Gangapuri (Bunch- Valencia).

Gujarat : J 11, GAUG 1, GAUG 2, GG 2 (Bunch - Spanish); GAUG 10, GG 11, TMV-3, TMV-4 (Spreading), Ah 334.

Rajasthan:RSB 87s (Semi Spreading); RS 1 (Spreading).

Uttar Pradesh : T 28, T 64, Kaushal (G 201) (Semi Spreading); Chandra, Chitra (MA 10) (Spreading)

Bihar : BG 1 (Semi Spreading).

Haryana: MH 1 (Bunch - Spanish); MH 2 (Bunch- Valencia)

Punjab: SG 84(Bunch - Spanish); C 501, M 145, M 197 (Semi Spreading); PG 1, M 13, M 37, M 335 (Spreading), Punjab-1

Source: NRCG, Junagadh.

Seed rate

- Generally spreading and bunch varieties requires 90-120 kg/ha in *Kharif*, in rainfed situation.
- In *Rabi*, in irrigated conditions spreading varieties require 140-150 kg/ha.

Seed Treatment

- Treat the seed with Mancozeb or Thiram 3 g/kg of the seed.
- Chlorpyriphose @ 250 ml / 45 kg of seed to prevent the seed damage from soil insects at initial stages.

Seed Inoculation

- For incoculation 100 kg kernels of groundnut 800 ml jaggery (5% solution) and 200 g carrier based Bradyrhizobium culture (like NC- 92, IGR-6, IGR-40, TAL-1000 & TNAU - 14) is required. Seed are evenly spread over cement surface or polythene sheet and poured this slurry and gently smeared on the kernel surface. The treated seeds are then soon immediately.

Season and Sowing time

- Groundnut is raised mostly as a rainfed *Kharif* crop, being sown from May to June.
- As an irrigated crop it is grown between January and March and between May and July.

Land Preparation

- Optimum plant population of groundnut can be established with a seed bed having good tilth.
- After the harvest of the previous crop, soil is prepared by ploughing and harrowing several times before sowing of groundnut.
- Ploughing may be carried out after the receipt of pre-monsoon rains in May. The land is ploughed 2 to 3 times or more, followed by working with blade - harrow twice.
- A soil preparation depth of 15 - 20 cm is generally considered for groundnut cultivation.

Plant Spacing

- In rainfed condition, for the bunch varieties 30 x 10 cm
- For the spreading varieties 30 x 15 cm
- In Rabi, in irrigated conditions, for the bunch varieties 25 x 10 cm
- For the spreading varieties 30 x 10 cm

These plant spacings are easily accommodated on 1.2 m wide broad beds with 30 cm furrows on either side of the bed. Four rows of groundnut at 30 cm spacing is recommended per bed.

Earthing up

- Before flowering.
- Interculture after sowing before flowering.

Crop Rotation

- Groundnut in general should be rotated with cereals like maize, wheat, bajra, jowar or minor millets and tobacco. Some of the crop rotation is given below:

Rainfed (monocropping 2 years) :

Groundnut - Sorghum; Groundnut - Millet; Groundnut - Tobacco.

Residual mositure (Double cropping in 1 year) :

Groundnut - Bengal gram; Groundnut-Safflower; Groundnut- Sesame.

Irrigated (Double or Triple Cropping in 1 year) :

Groundnut-Maize; Groundnut-Wheat; Groundnut - Onion.

Weed control

- Spray Basalin (fluchloralin @ 1.5 l/ha in 500 ml water as a presowing at last ploughing.
- Pre-emergence application of Alachlor @ 1-2 kg a.i./ ha plus one hand – weeding, 30 days after sowing, effectively control weeds in groundnut.

Irrigation of Groundnut

- Groundnut is very sensitive to salinity of soil and irrigation water quality.
- The irrigation water for groundnut should have EC less than 4.0 mmhos/cm .
- Vigorous flowering is the period of greatest sensitivity to moisture stress which is 6-8 weeks after seeding.
- The pegs cannot enter the soil if the soil surface is hard due to prolonged dry-spell.
- Flowering, peg penetration and early pod formation are the moisture sensitive phases of groundnut growth.

Sprinkler Irrigation

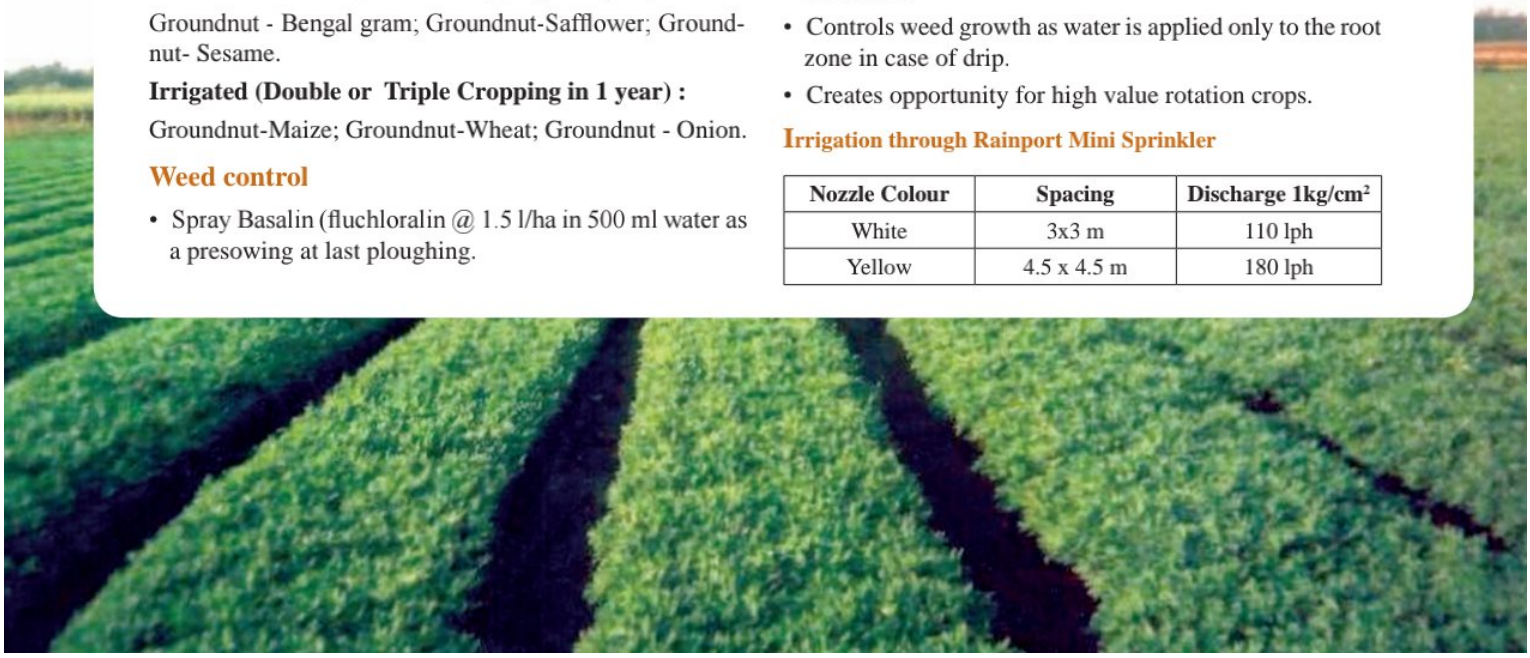
- Sprinkler irrigation is generally adopted for groundnut considering the crop height and the nature of fruiting.
- The costs are also low for sprinkler compared to drip. We recommend Rainport Minisprinkler and Rainport 5022-U Impact Sprinkler system for Groundnut.
- The irrigation quantum (mm) is decided after studying the soil texture and its infiltration capacity .
- Application rate per irrigation should be equivalent to the infiltration rate of the soil of each location approximately this would be 15-20 mm at a time for the soil types mentioned above.

Benefits of drip or sprinkler irrigation for groundnut

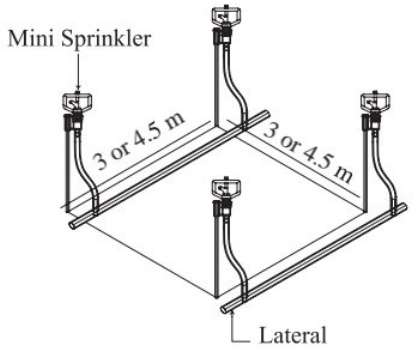
- Increases yield upto 100%
- Reduces water used for irrigation up to 55%
- Allows uniform high percentage of germination.
- Drip is suitable for any type of seed bed- flat, ridges and furrows and rise bed.
- Helps in early planting which is a pre-requisite for IPM
- Allows for a Summer crop (pest free environment)
- Early and uniform maturity
- Allows the user to control vegetative growth by precision irrigation and fertigation and increase flowering and nut formation.
- Controls weed growth as water is applied only to the root zone in case of drip.
- Creates opportunity for high value rotation crops.

Irrigation through Rainport Mini Sprinkler

Nozzle Colour	Spacing	Discharge 1kg/cm²
White	3x3 m	110 lph
Yellow	4.5 x 4.5 m	180 lph



Rainport Mini Sprinkler Layout



Groundnut Irrigation through Rainport Mini Sprinkler (spacing 3 or 4.5 m)

June Planting

Month	Water requirement		Irrigation duration (Min./day)	
	mm / day	L/ha/day	Nozzle Colour	
			White	Yellow
June	0.91-1.07	9100-10700	7-9	10-12
July	1.97-2.50	19700-25000	16-20	22-28
August	3.07-4.18	30700-41800	25-34	35-47
September	5.17-5.84	51700-58400	42-48	58-66
October	2.30-3.03	23000-30300	19-25	26-34

October Planting

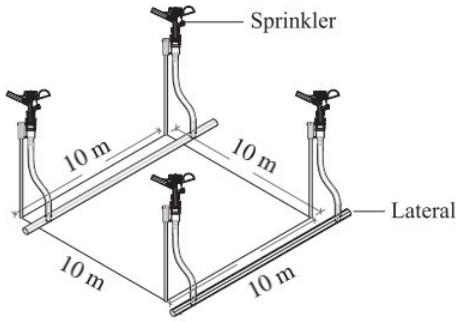
Month	Water requirement		Irrigation duration (Min./day)	
	mm / day	L/ha/day	Nozzle Colour	
			White	Yellow
October	0.82-0.98	8200-9800	7-8	9-11
November	2.10-2.44	21000-24400	17-20	24-27
December	2.90-3.65	29000-36500	24-30	33-41
January	4.59-5.21	45900-52100	38-43	52-59
February	2.30-3.30	23000-33000	19-27	26-37

January Planting

Month	Water requirement		Irrigation duration (Min./day)	
	mm / day	L/ha/day	Nozzle Colour	
			White	Yellow
January	0.7-0.85	7000-8500	6-7	8-10
February	2.0-2.5	20000-25000	16-20	23-28
March	4.8-5.2	48000-52000	39-43	54-59
April	6.5-7.3	65000-73000	53-60	73-82
May	3.4-3.8	34000-38000	28-31	38-43

Groundnut Irrigation through Rainport 5022-U. (520 lph at 2.5 kg/cm² pressure & spacing 10x10m)

Rainport Sprinkler Layout



June planting

Month	Water requirement		Irrigation duration
	mm/day	L/ha/day	Minutes/day
June	0.91-1.07	9100-10700	18-21
July	1.97-2.50	19700-25000	38-48
August	3.07-4.18	30700-41800	59-80
September	5.17-5.84	51700-58400	99-112
October	2.30-3.03	23000-30300	44-58

October planting

Month	Water requirement		Irrigation duration
	mm/day	L/ha/day	Minutes/day
October	0.82-0.98	8200-9800	16-19
November	2.10-2.44	21000-24400	40-47
December	2.90-3.65	29000-36500	56-70
January	4.59-5.21	45900-52100	88-100
February	2.30-3.30	23000-33000	44-63

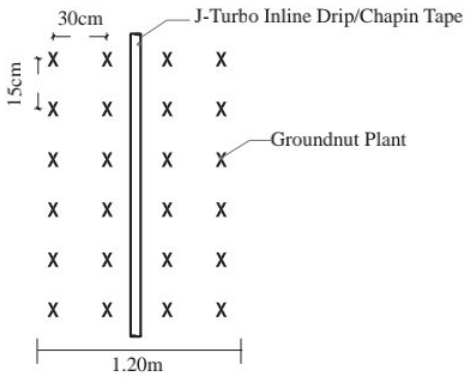
January planting

Month	Water requirement		Irrigation duration
	mm/day	L/ha/day	Minutes/day
January	0.7-0.85	7000-8500	13-16
February	2.0-2.5	20000-25000	38-48
March	4.8-5.2	48000-52000	92-100
April	6.5-7.3	65000-73000	125-140
May	3.4-3.8	34000-38000	65-73

Drip irrigation

Inline or tape is suitable for groundnut with 12mm or 16 mm lateral and drippers (4 lph) placed at 40 cm (sandy loam) 60 cm (clayey soils). One drip line on each bed (1.2m wide) is enough for adequate irrigation. The layout of drip irrigation is shown below.

Drip Layout



Groundnut irrigation through drip Irrigation - Inline or tape (Lateral to lateral - 40 or 60 cm and discharge- 4 lph)

June Panting

Month	Water requirement		Irrigation duration (Min./day)	
	mm / day	L/ha/day	Dripper Spacing	
			40 cm	60 cm
June	0.91-1.07	9100-10700	7-9	11-13
July	1.97-2.50	19700-25000	16-20	24-30
August	3.07-4.18	30700-41800	25-33	37-50
September	5.17-5.84	51700-58400	41-47	62-70
October	2.30-3.30	23000-30300	18-24	28-36

October planting

Month	Water requirement		Irrigation duration (Min./day)	
	mm / day	L/ha/day	Dripper Spacing	
			40 cm	60 cm
October	0.82-0.98	8200-9800	7-8	10-12
November	2.10-2.44	21000-24400	17-20	25-29
December	2.90-3.65	29000-36500	23-29	35-44
January	4.59-5.21	45900-52100	37-42	55-63
February	2.30-3.30	23000-33000	18-26	28-40

January Planting

Month	Water requirement		Irrigation duration (Min./day)	
	mm / day	L/ha/day	Dripper Spacing	
			40 cm	60 cm
January	0.7-0.85	7000-8500	6-7	8-10
February	2.0-2.5	20000-25000	16-20	24-30
March	4.8-5.2	48000-52000	38-42	58-62
April	6.5-7.3	65000-73000	52-58	78-88
May	3.4-3.8	34000-38000	27-30	41-46

Fertilizer Management

- Add 3 t FYM/acre to be applied at final ploughing
- An average crop of groundnut removes about 112 kg N, 27 kg P_2O_5 and 34 kg K_2O from 1 ha of land. It is capable of fixing atmospheric nitrogen by the root nodule bacteria.
- But a starter dose of N in small quantities has to be applied for early growth and vigour.
- A minimum of 50 Kg P_2O_5 /ha is required or as per soil test data.
- Recommendation for irrigated groundnut for Andhra Pradesh is 30: 60: 45 (NPK).
- Nitrogen is recommended in two equal split doses, i.e. half of the nitrogen at the time of sowing and the remaining half 35-40 days after sowing preferably after weeding. The common sources of N used for groundnut are given below:
  1. Ammonium Sulphate (20% N)
  2. Urea (46% N)
  3. Calcium ammonium nitrate (26% N)
- Furrow placement is the best method of phosphorus application in the soil as it minimizes the fixation of P_2O_5 with soil colloids.
- SSP is the preferred source of phosphorus. It contains 16% P_2O_5 besides Ca (19.5%) and sulphur (12.5%). Soil application is recommended.
- As for Potassium the two sources are given below:
  1. Potassium chloride-muriate of potash (KC1-60% K_2O).
  2. Potassium sulfate (K_2SO_4-50% K_2O)

Fertigation

50 % of N and all the K can be fertigated through drip system

Period	Quantity of fertilizer	Rate of fertigation
35-65 days after sowing	15 N (75 kg Ammonium Sulphate)	18.8 kg /week
	or (32 kg Urea)	8kg/week
	or (57.5 kg CAN)	14 kg/week

Special requirement of Calcium and Sulphur

- These two nutrients are taken up from the pod zone by the pegs and developing pods.
- Groundnut has the unique characteristic of uptake of Ca and S by the developing pegs and pods.
- The major function of calcium in groundnut is the improvement in the quality of the nuts as evidenced by thin strong shell besides well - filled pods.
- Sulphur is directly involved in the biosynthesis of oil and is usually deficient in the groundnut soils.
- Gypsum (24% Ca, 18.6% S) is the cheapest source for Calcium and Sulpher elements.
- Higher quantities of gypsum than necessary are applied at early flowering stage to ensure adequate calcium supply in the pod zone.

- Application of gypsum - 500 kg/ha at pod formation stage.
- Well - powdered gypsum (30 mesh) should be applied on soil surface when the crop is in peak flowering stage.

Micronutrients

- Apply 50kg Zinc sulphate/ha at last ploughing.
- Application of 10 kg / ha borax to the seed bed.
- Spraying of 0.5 - 1.0% $FeSO_4$ + 0.1% citric acid has been found to correct iron the deficiency.
- Application of 1 kg/ha Ammonium Molybdate to correct Molybdenum deficiency. Apply it along with basal application of Phosphorus.

Yield

Kernels yield and oil content of groundnut varies with variety, soil type, climate, sowing season and managment pratices. In general, it was notice that application of impact sprinkler for irrigation give 20-30 per cent additional yield.

Insect and disease control

Integrated pest and disease management is recommended.

IPM for insect control

- The cultural practices, starting from selecting the disease-free and robust planting material.
- Right sowing time.
- Deep tilling to weeding out unwanted vegetation and soil-borne pests and pathogens
- Crop hygiene, keeping clean field and practicing hygiene by workers will contribute significantly in controlling crop pests.
- The pest surveillance and monitoring exercises based on frequent visits to the fields and sweeping with insect nets,
- Observing the movement of the pests using pheromone traps, light traps and sticky traps, and deciding on a spraying schedule with botanical insecticides (neem-based products).
- The need-based application of safe botanical insecticides not only cuts the costs, but also helps in reducing the pollutant load in the environment.
- The use of biological agents to manage the pests is another important aspect of IPM. Spiders and preying mantises can be effectively used in managing pests.
- Friendly birds are good custodians of crops, and they help manage the number of serious insect pests within the thresholds. By providing suitable perches the birds could be encouraged to visit the crop fields.
- By growing ''antenna'' crops such as corn (maize) and sorghum (jowar or `cholam') have also helped in attracting the birds to crop fields as bio-control agents.
- Castor and sunflower planted around the field of groundnut acts as insect traps.
- Groundnut should not follow Soybean.
- By raising companion crops along the main crops the pest could be managed well. While, the trap crops help in trapping the pests in them, other plants with strong aroma, such as fennel and garlic, help in repelling the pests.
- The pests can be managed well by judiciously following the mixed-cropping groundnut (marigold or sorghum) , alley cropping (marigold, softwood trees like sesbanea) and border cropping (marigold, Castor) with suitable crop varieties.
- The light traps are mostly used for monitoring the pest movements in the fields.
- Use NPV for caterpillar Control.

Effective practices pest & Disease control.

- Deep Summer ploughing
- Bon firing against Red Hairy Caterpillar
- Seed treatment with chlorpyriphos 6 ml/kg of seed + mancozeb 3 g/kg of seed
- Groundnut + pigeon pea intercropping in 11 : 1 ratio
- Growing Bajra (pearl millet) as guard crop
- Removal of alternate weed hosts for virus.
- Pheromone trap- 10/ha
- Application of HNPV 250 LE/ha
- Spray : Carbendazim 0.05% and mancozeb 0.2% at 70 Days after sowing.

Diseases of Groundnut and their Control

IPM for Disease control

- The cultural practices, starting from selecting the disease-free and robust planting material.
- Right sowing time.
- Deep tilling to weeding out unwanted vegetation and soil-borne pests and pathogens
- Crop hygiene, keeping clean field and practicing hygiene by workers will contribute significantly in controlling crop pests.
- Promote early maturing groundnut varieties with resistance to groundnut rosette virus, or to the aphid vector.
- As a control of tikka disease intercropping with sorghum (7:1) ratio is recommended.
- Follow rotation with chickpea or Sorghum or Millet.
- Apply Trichoderma viride at the rate of 2kg in 50 kg FYM to the soil before sowing.

Chemical control of insects

Leafminer

Carbaryl 2ml/l water Fenitrothion 400 ml in 400 litres of water/ha. Monocrotophos 1.6 ml/l water

White grubs

Seed treatment with Chlorpyriphos 12.5 ml/kg of seed.

Soil application of Quinalphos 1.5 kg/ha.

Jassid

Plant Jassid resistant Variety Gimar - 1

Dimethoate 2ml/l water

Monocrotophos 1.6 ml/l water

Aphid

Plant aphid resistant variety - 1CGV-87160

Dimethoate 2ml/l water, Monocrotophos 1.6 ml/l water

Thrips

Dimethoate 2ml/l water.

Monocrotophos 1.6 ml/l water.

Apply a mixture of 1l neem oil 1 kg surf in 200 l water at 20 days after sowing.

Red hairy caterpillar

Carbaryl or Parathion @ 25-30 kg/ha Dichlorovos 2ml/l water. Quinalphos 1l mixed with Jaggery 1 kg plus rice bran placed around the field prevents entry of of this insect.

Tobacco caterpillar

Plant tobacco capler piller resistant Variety - Kadiri-3, BG-2

Quinolphos 1ml/l water Carbaryl 2ml/lwater Endosulfan 4ml/l water.

Over irrigation should not be done.

Gram caterpillar

Quinolphos 1ml/l water Carbaryl 2ml/lwater Endosulfan 4ml/l water.

Over irrigation should not be done.

Managment of Diseases

Early and late leaf spots

Spray application of Carbendazim (Bavistin) 0.5g/l water plus Mancozeb 2g/l water at 2-3 weeks interval, from 4-5 weeks after planting.

Rust

Plant rust resistant varieties - ICG FDRS-10, ICGV-86590, R-8808, R-9201, ICGV-92093, ICGV-92092.

Spray application of Tridemorph 7g/l water at 14-21 days interval 3-4 times after initiation of the infection.

Collar rot

Seed treatment with Captan 80% WP @ 3g/kg seed or Thiram 75% WP @ 3-5 g/kg seed or Carbendazim 2 g/kg seed.

Do not sow deep.

Stem rot / Sclerotium wilt

Dry seed treatment with Carbendazim/thiram/Captan @ 2-3 g.

Soil application of a mixture of fungicide viz., terrachlor + terrazole @ 20 kg/ha + 40 kg/ha at pegging stage.

Dry wilt or Dry root rot

Seed treatment with Captafol 0.2%.

Drenching with Brassicol 75% WP (0.5%) @ 1 l/m2 or soil application @ 25 kg/ha in two split, 12.5 kg/ha before sowing and the other 12.5 kg/ha 15 days after.

Bud necrosis

Thrips transmitted

Control vectors (thrips) with Dimethoate @ 400 ml/ha or Methyl demeton @ 360 ml/ha community basis.

Use bud necrosis resistant variety - 'ICGS- 11', 'ICGS-44'.

Peanut mottle

Aphid transmitted, seed-borne also

(0.1 to 3.5%) As above

Peanut clump

Soil application of Nemagon and Temik one week before planting.

Dos

- Ensure good drainage in the field.
- Adopt Rainport Mini-Sprinkler irrigation or Impact sprinkler system or Drip irriation Systems for irrigation.
- Compulsorily apply organic manure as per recommendation
- Select high yielding, disease and pest tolerant variety suitable for each location
- Strictly follow the irrigation schedule given by the engineer.
- Compulsorily weed/ inter-cultivate, timely operation helps in crop growth.
- Follow fertigation schedule as given by the engineer.
- Apply micronutrient as and when needed.
- Follow disease and pest control measures timely and effectively. Spray in the evening or early morning only.

Don'ts

- Don't over irrigate the crop at anytime.
- For fertigation don't mix solid fertilizers and dissolve them together. Prepare individual solutions and mix them before application.
- Don't spray the crop under hot sunlight.
- Don't use the fertigation unit for bulky organic manure and fertilizers that are not soluble in water.
- Don't add solid fertilizer from the fertilizer bag directly to the fertilizer tank. Prepare solution only in plastic buckets. Don't use metal container.
- Don't stir the solution with naked unprotected hand. Use wooden spoon or stick.
- Don't heat the fertilizer solution to increase solubility.

Frequently asked questions (FAQ's)

1. Whether the meare quantity of water supplied through irrigation system is enough?

- Irrigation rate is estimated based on the Evapotranspiration of the location and therefore it is enough.

2. Whether surface application of water will cause root accumulation near the surface and thereby affect the pod formation.

- The absorptive roots of groundnut are located near the surface and get directed by moisture and nutrient availability. Pod formation is not connected with the method of irrigation.

3. Can I prefer Sprinkler method of irrigation for Groundnut?

- Yes. Rainport system is most suitable for groundnut in terms of cost, and operation ease.

4. Can I take an intercrop with irrigation?

- Yes. As per the practice existing in the area. In case of Drip adoption use separate drip lines for the intercrop.

Crop yields depend on climate, soil and management and therefore can't be guaranteed by the company.

Jain Drip — More Crop Per Drop®

Jain Irrigation Systems Ltd. — *Small Ideas. Big Revolutions.®*

More Crop per Drop

Jains Mobile App

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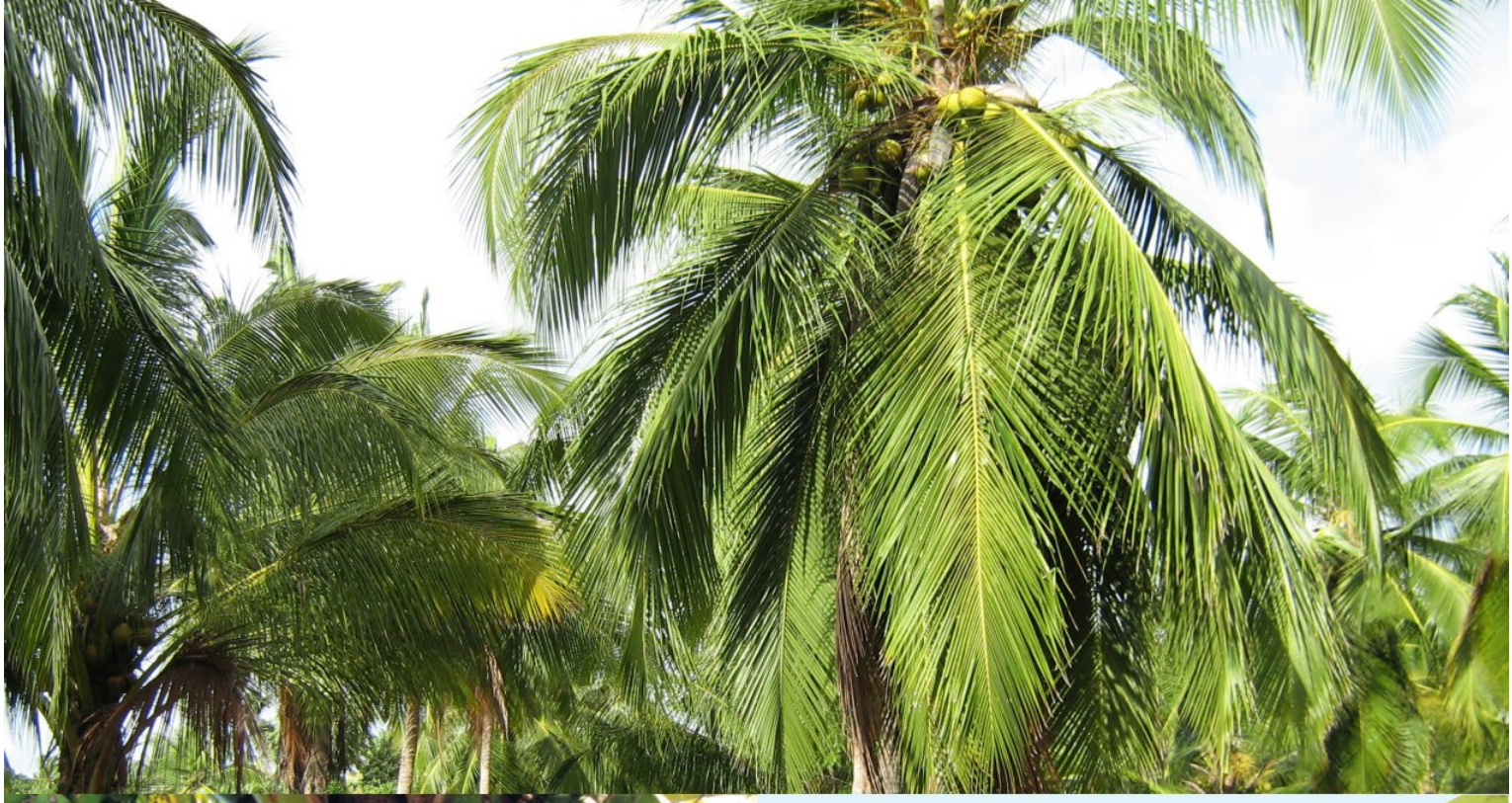


Precision Farming
COCONUT
With Jain Technology™

Jain Irrigation Systems Ltd.
Small Ideas. Big Revolutions.®

Coconut, Cocos nucifera is a monocot with large crown of fronds and fruits and inflorescence. Coconut is an integral part of daily diet in many of the tropical countries. It is one of the most important oil-yielding crops of the world grown in more than 80 countries of the tropics. Widely acknowledged as a multipurpose tree, it provides nutritious food and refreshing drink, oil for edible and non-edible purposes, fibre, cooking fuel and thatching material for the rural masses, timber and shell of commercial value and a variety of other products; every part of this tree is utilized.

In India coconut is grown over 1.9 million ha, third highest in the world with an average yield of 7800 nut/ha which is the highest productivity in the world.

Parts of an adult Palm

Trunk

Diameter- About 30 cm. Thickness depends on the vigour of the palm and the variety

Height- Tall varieties grow to a height of 20-25 m

Root- Roots are produced from the base of the palm called the bole.

Root System

- Coconut has an adventitious root system.
- In an adult palm, 4000-7000 or more roots may be present.
- The laterals and tips of the primaries constitute the bulk of the feeder roots.
- The roots which grow vertically downward are supposed to be 'water roots'.
- Roots have small protrusions called pneumatophores which act as 'breathing organs' for the exchange of gases.
- In basin-fertilized palms, roots are absent in the surface 25 cm soil layer.
- Over 80 % of the active roots lie in the soil cylinder of 2m radius around the palm.
- Under unfavourable conditions, root mattings develop at the base of the palm.

Leaf

- Length- 4.5-6.0 m
- Number of leaflets on a frond- 200-250
- Rate of production- Number of leaves; approximately, one leaf per month; 30-40 on a healthy palm
- Leaves are arranged in the crown in whorls

Inflorescence

Rate of production - One in each leaf axil.

Nut

- Nuts are produced in bunches; the shape, size, colour and weight of the nut vary with the variety.
- Nut has an outer fibrous husk inside which exist the kernel protected by a hard shell.
- Nut contains sweet water inside

Inflorescence Development

Male flower

- Male flowers open first, within 15 days of opening of the inflorescence
- Male phase (the period between the opening of the first male flower and the last male flower) lasts about 10-22 days
- In tall varieties, male flowers are shed before the female flowers become receptive
- In dwarf varieties, male and female phases overlap each other.

Female flower

- Compared to male flowers, the number of female flowers is very less
- Female phase lasts for 4-10 days; a female flower remains receptive for 1-3 days
- The receptivity of a female flower is judged by the presence of nectar on it.

Nut Development

- A female flower after pollination and fertilization develops into a nut
- A fertilized female flower takes about 11-12 months to develop into a mature nut
- Pollination is the deposition of the pollen (male gamete) from a male flower on the stigma of the female flower
- Fertilization is the fusion of the male gamete with female gamete

Climate

Coconut is a tropical crop. It is not affected by day length variations.

- **Rainfall-** 1000-3000 mm per year. Prefers evenly distributed rainfall
- **Temperature-** Optimum 27°C with a diurnal variation of 6-7 0C Cold spells are more limiting than high temperatures.
- **Light-** Coconut palm requires maximum sunlight.
- **Altitude-** Up to 600 m above mean sea level. If temperature remains favourable, the palm grows well up to an altitude of 800 m. The limiting factor determining the maximun altitude at which coconut can grow is temperature.
- **Humidity-** Needs warm and humid conditions

Soils

Coconut palm tolerates a wide range of soil conditions. It is particularly adapted to the coastal light sandy and sandy loam type soils. Coconuts also thrive well in laterite soils. Laterite soils usually have hard pan and therefore soil should be selected where the hard substratum is at least 1m deep. Periodical addition of lime to release the fixed P is also essential. The alluvial soils are also very good for coconut growth. It is highly porous, loose, and well drained. Highly clayey soils are not suitable for coconut.

Coconut Varieties - Table 1 : Varieties and their economic characters

COCONUT VARIETIES						
		Annual Yield (Nuts / tree)	**Copra /nut (g)**	**Copra / palm/yr (kg)**	**No of nuts to produce 1 t Copra**	**Oil Content (%)**
TALL	West Coast Tall (WCT)	67	180	12	5560	72
	Chandrakalpa (Lakshadeep Ordinary)	93	194	18	5160	72
	Andaman Ordinary	69	186	13	5380	66
DWARF	Chowghat Green Dwarf (CGD)	41	125			73
	Chowghat Orange Dwarf (COD)	47	163			66
	Malayan Yellow Dwarf (MYD)	68	130			68
	Gangabondam	60	189			68
HYBRIDS	Lakshaganga	108	195	21	5130	69
	Anandaganga	95	216	20	4630	68
	Kerashree	112	216	24	4630	66
	Kerashankra	108	187	20	5350	68
	Keraganga	100	201	20	4980	69
	Chandralaksha	109	195	21	5130	68
	Chandrashankara	116	215	25	4650	68
	Veppamkulam Hybrid -1	98	135	13	7400	70
	Veppamkulam Hybrid -2	107	152	16	6580	69
	Kerasowbhagyia	116	196	23	5100	65

There are several private Coconut breeders who have either selected varieties or produced hybrids with high yield (nuts per tree) or Oil content (%). The information about these private bred varieties are not available in public domain.

NURSERY

Coconut palm is a perennial crop with a life-span of over 70 years. It takes about 6-10 years to flower and another 5 years for yield stabilisation. If the quality of the seedlings used for planting is poor, the plantation will be producing low yield and less returns.

Seed nut selection

- Nut must be of medium size and oblong shape.
- Husked nut should weigh not less than 600 g
- The copra content should be 150 g or more
- Nut without water inside should be avoided
- Nut with rotten kernel must be rejected.
- Locate good mother palm for seed nut; the characters of good mother palm are;

Must be 20 years of age or more but not senile

- Yields 80 or more nuts per annum
- Has 30-40 fully opened leaves in the crown
- Has strong petioles and wide leaf base
- Has leaves firmly attached to the stem
- Bears nuts of medium size and oblong shape
- Carries at least 12 bunches of nuts
- Has strong bunch stalks
- Has nuts weighing not less than 600 g per nut
- Has nuts producing 150 g or more copra per nut

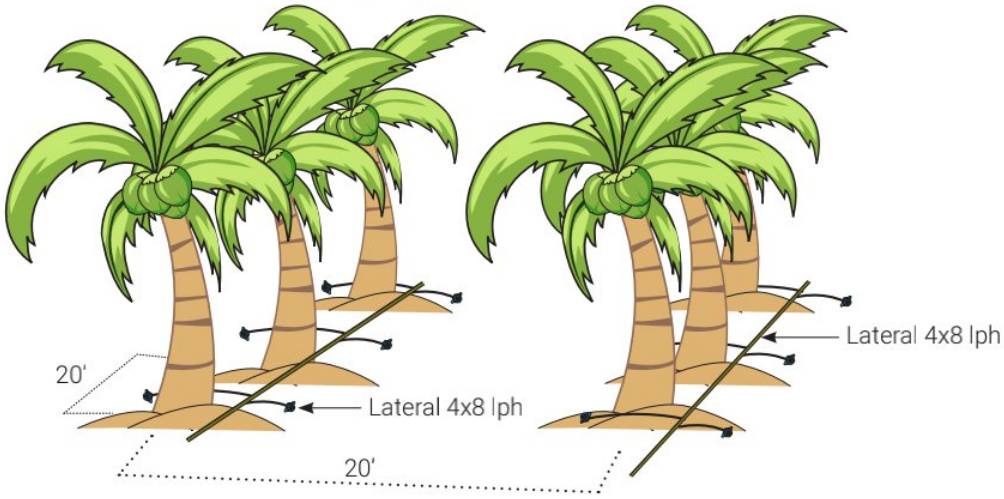
Seed nuts are collected at 11-12 month growth from trees during February – May period. Harvest the seed nut bunch carefully and lower the bunch carefully after harvest so that nuts won't hit the ground and get damaged.

Select light-textured soil and well drained areas for planting the nursery. The area should have adequate but not too much shade. Prepare beds of 1.5 m width and of convenient length. The beds must be spaced 75 cm apart. Treat the beds with Aldrin 10% dust at the rate of 12g per m^2 to guard against termites. Sandy soils are preferred for Nursery planting. If drainage is poor, prepare raised beds.

Take trenches of 25 to 30 cm deep on the seedbed. Sow the seed nuts vertically with the stalk-end up. Space the seed nuts 30 cm apart within the row and between rows of trenches. Cover the nuts with soil so that the upper portion of the husk alone is visible. Nursery raising is done generally along with the onset of monsoon. (by June first week). Nursery is protected by fencing and irrigated with sprinkler system.

Provide periodically fugal control by spraying 1% Bordeaux mixture.

Drip Layout for Coconut



Field Planting

Coconut nurseries are generally raised in situ in the farm or seedlings are obtained from commercial nurseries.

Spacing

In monoculture, the distance to be adopted vary with the nature of the variety.

For Tall varieties-9 m x 9 m (125 trees/ha) is recommended for dry areas and 8.2 m x 8.2 m (149 trees /ha) for coastal region.

For Dwarf and Hybrids-7.5 mx 7.5 m (178 trees/ha) is recommended for dry areas and 7 m x 7 m (204 trees/ ha) for coastal region.

The row should be North – South orientation to avail maximum sunlight.

In case of planned inter-cropping or multitier cropping the spacing should be more (9 to 12 m) to enable light penetration to the lower storey.

Planting

- Prepare the land by ploughing and harrowing
- Take Pits of 1 m^3 at the spacing determined before hand.
- Fill the pits with green manure, FYM, or compost, and top soil. Insert the seedling at the centre of the pit and pus the soil compost mixture around the base.
- The seedlings should be placed at least 45 cm deep in the mixture in the pit.
- Apply Carbaryl 10% dust as guard against termite.
- In dry regions, provide partial shade to the newly planted seedlings.

Irrigation management

- Coconut root system is very special and it has a specific bearing on the water relations and irrigation management.
- Root distribution zone of coconut is found to increase with the enlargement of the fertilizer area around the trunk.
- About 70% of total roots and 65% of fine roots are found within a radius of 1 m from the stem. Therefore the placement of drippers are critical.
- Similarly moisture should be maintained to a depth of 1 m of soil to provide moisture at 75% availability.
- In the coconut growing tract of the West coast a dry spell is generally observed for 4-6 months (December to May).
- Similarly, in other parts irrigation is necessary during non-monsoon periods.
- During this period irrigation is essential to maintain growth and productivity.
- Drip method of irrigation is most suitable for Coconut. Fertigation is also possible through the drip system.

Layout for Coconut Drip Loop

Water requirement

The peak water requirement of Coconut has been determined by several research agencies. It ranges from 80 l/tree/day to 120 l/tree/day depending upon the location.However, research trials at CPCRI, Kasargod indicated that drip irrigation at a rate of 32 l/ tree/day (66 % Eo) was comparable to 100% Eo under basin irrigation purely from the point of water saving.

Table 2. Water requirement# of coconut Palm (4 year plus)

Month	Water requirement	
	mm/day	Lt/plant/day
June	2.99-3.56	39-46
July	2.46-3.12	32-40
August	2.39-3.25	31-42
September	2.67-3.01	35-39
October	2.33-2.79	30-36
November	2.27-2.64	29-34
December	1.96-2.46	25-32
January	2.37-2.70	31-35
February	2.89-3.17	37-41
March	4.55-4.98	59-65
April	4.98-5.64	65-73
May	5.07-6.01	66-78

WR is a function of the Evaporation of the location. This table is only of an indicative nature. Actual WR is to be estimated for your location.

Fertigation

The optimum fertilizer requirement of coconut varies in different regions based on soil type and other factors. The recommendations of each State University varies accordingly.

Table 3. Fertilizer doses for Coconut##

Fertilizer recommendation for Coconut					
	N g/tree	P g/tree	K g/ tree	OM	
yr1	Planting in May June		12.5 t/ha		Apply before planting
yr1	50	40	135		Sep -Oct
yr2	50	40	135	25 kg/tree	Jun-Jul
	110	80	270	25 kg/tree	Sep-Oct
yr3	110	80	270	25 kg/tree	Jun-Jul
	220	160	540	25 kg/tree	Sep -Oct
yr4 plus	170	120	400	25kg/tree	Jun-Jul
	330	200	800	25 kg/tree	Sep-Oct

- Lime application for Coastal area
- 2 kg/tree per year up to 15 year
- 4 kg/tree per year after 15 yrs
- lime should be incorporated 15 days prior to fertilizer application in September
- ## Coconut Board.

Fertigation schedule

The schedule for perennials are very terse and different from year to year.

Year 1 palm

Phosphate ; SSP 250 g/tree as soil application

Apply 250 g SSP in the form of a ring around the tree 50 cm away from plant and 15 cm deep in September first week.

Fertigation of Urea and Potash

fert type	Rate g/ tree	Fertig rate	Duration	
Urea	110 g	20 g/tree/ wk	Sept 1wk to Oct 2wk	6 doses
MOP	225 g	40 g/tree/ wk	Sept 1wk to Oct 2wk	6 doses

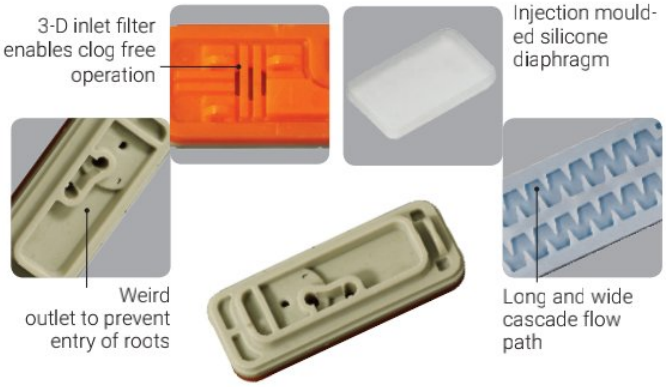
ONE STOP SHOP for Your

Jain Turbo Excel®

- Five Star rated dripline from worlds reknowned institute IRSTEA (Cemagref), France.
- Available discharge rates - 0.85, 1.2, 1.6, 2.1, 4 lph @ 1kg/cm².
- 12, 16, 20, 25 mm nominal diameter.
- Dripper Spacing 15, 20, 30, 40, 50, 60, 75,90 cms.

Jain Turbo Top™

- Available discharge rates – 1.1 & 1.7 lph
- Injection moulded silicone rubber compensates with pressure and discharge gives uniform performance.
- Anti Syphone feature (optional) prevents suction of sand and silt particles inside the dripper.
- Cascade labyrinth gives strong, self-cleaning turbulence.
- Available in 16 & 20mm nominal diameter. (12, 16 & 20 mm in Thin Wall option)
- Suitable for surface as well as subsurface installations.

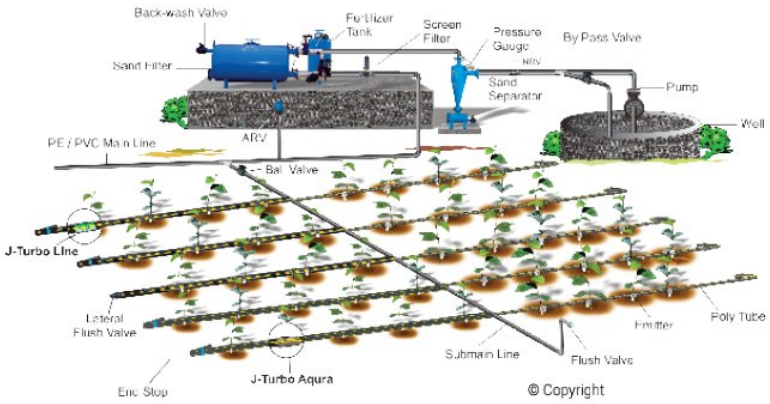


Why Jain Drip Irrigation ?

Water is not the only need of the plant. To uptake this water efficiently, it requires proper air-water balance within the root zone. Drip irrigation, with its low application rate, prevents the saturation of water within the root zone and continuously maintains field capacity. This provides a favorable condition for the growth of the plant. Drip irrigation also helps to use fertilizer efficiently. With drip irrigation water can be provided at frequent intervals which helps maintain required soil moisture level within the vicinity of the plant roots. Jain is the pioneer of drip irrigation. Ours is the only company in the world, which fulfills your entire irrigation system requirement under one roof.

Characteristics of drip irrigation

1) Water is applied at a low rate to maintain optimum air-water balance within the root zone.
2) Water is applied over a long period of time.
3) Water is applied to the plant and not to the land.
4) Water is applied at frequent intervals.
5) Water is applied via a low pressure network.

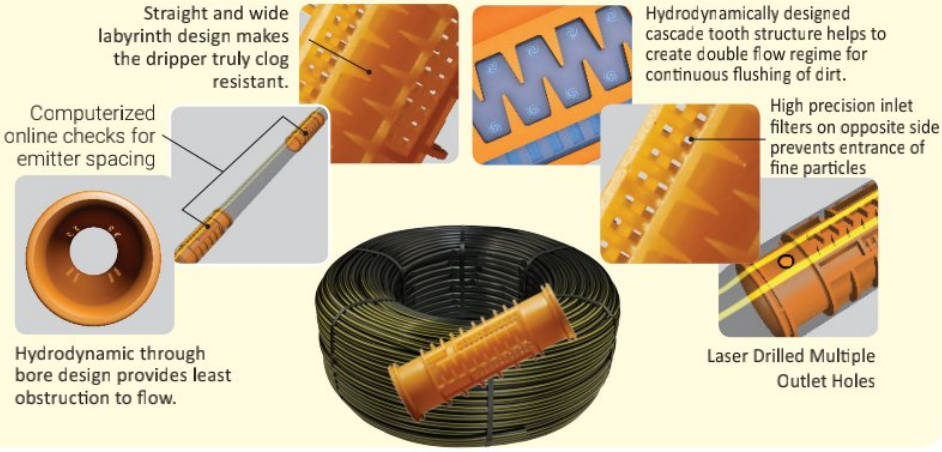


Jain Drip
More Crop Per Drop®

Micro Irrigation Needs

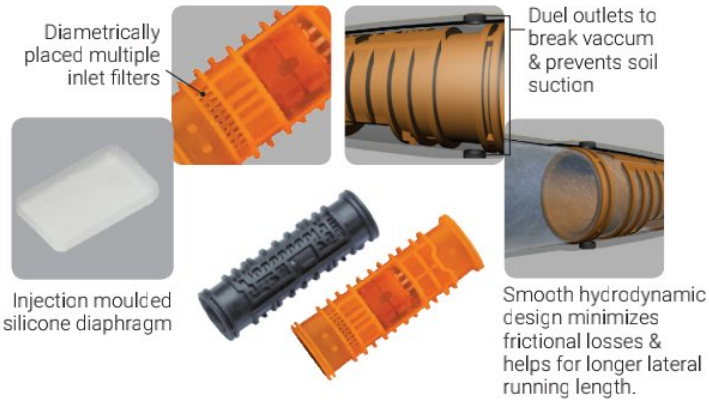
J-Turbo Line® Super

- Available discharge rates (at 1kg/cm²)
  12mm - 2.2, 4 lph
  16mm - 4, 8 lph
  20mm - 2.2, 4, 8 lph
- Availabe in 12, 16 & 20 mm nominal diameter.
- Suitable for surface as well as subsurface installations.



Turboline PC®

- Available discharge rates - 1.4, 1.8, 2.6 & 4.0 lph within pressure regulation range of 0.7 to 3 kg/cm².
- Injection moulded silicone rubber compensates with pressure and discharge gives uniform performance
- Application on undulating land/ Terrains/ Steep slopes.
- Available in 16 & 20 mm nominal diameter.
- Suitable for surface as well as sub-surface installation.
- Application where ever longer lateral length is necessary.
- Conforming to IS 13488, ISO 8261 Standard.



Widest Choice ! Customized Irrigation Solutions

Online Dripper & Spray Heads

Jain Filtration Equipment

Jain Fertigation Equipment

Jain Rainport / Micro Sprinkler

Jain PVC/PE Pipes & Fittings

Automation Equipment

Jain® Drip
More Crop Per Drop®

Benefits of Drip Irrigation

- Drip irrigation saves water, energy and labour and results in higher water use efficiency (WUE).
- In an experimental trial conducted in the command area of Kuttiyadi Irrigation project in Kozhikode, Kerala 67 % water saving was found.
- Yield of nuts under drip method at 30 l/tree/day was found to be equal with basin irrigation at 600l/tree/day.
- Other studies on drip irrigation in Coconut has shown yield increase up to 30% along with a water saving of 70%.
- Drip irrigation and mulching together is more beneficial to coconuts. A study on soil moisture in coconut plantation showed that available soil moisture under drip with mulch was higher by 22 to 29% compared to drip without mulch.
- Thus mulching with coconut husks, coir dust and dried coconut fronds on drip plots are becoming the best water conservation technology in coconut gardens.

Year 2 palm

50:40:135 g/tree in June-July
Phosphate ; SSP 250 g/tree

Apply 250 g SSP in the form of a ring around the tree 50 cm away from plant and 15 cm deep in June first week.

110:80:270 g/tree in September -October
Phosphate ; SSP 500 g/tree

Apply 500 g SSP in the form of a ring around the tree 50 cm away from plant and 15 cm deep in September first Week.

Fertigation of Urea and Potash

Fert type	Rate g/tree	Fertigation rate	Duration	
Urea	110 g	14 g/tree/wk	June 1 wk to July 4 wk	8 doses
MOP	225 g	28 g/tree/wk	June 1 wk to July 4 wk	8 doses
Urea	239 g	30 g/tree/wk	Sept 1wk to Oct 4wk	8 doses
MOP	450 g	56 g/tree/wk	Sept 1wk to Oct 4wk	8 doses

Yr 3 palm

110:80:270 g/tree in June July
Phosphate ; SSP 500 g/tree

Apply 500 g SSP in the form of a ring around the tree 50 cm away from trunk and 15 cm deep in first week of June

220:160:540 g/tree in September – October
Phosphate ; SSP 1000 g/tree

Apply 1000 g/tree of SSP in the form of a ring around the tree 50 cm away from the trunk and 15 cm deep.

500 g/tree in 1st week of September and 500 g/tree in Last week of October

Fertigation Of Urea and Potash

Fert type	Rate g/tree	Fertigation rate	Duration	
Urea	239 g	30 g/tree/wk	June 1 wk to July 4 wk	8 doses
MOP	450 g	56 g/tree/wk	June 1 wk to July 4 wk	8 doses
Urea	478 g	60 g/tree /week	Sept 1wk to Oct 4wk	8 doses
MOP	900 g	112 g/tree/week	Sept 1wk to Oct 4wk	8 doses

Yr4 palm

170:120:400 g/tree in June_ July.

330:200:800 g/tree in September - October.

170:120:400 g/tree in June_ July.

FERTIGATION OF N , P and K

Fert type	Rate g/tree	Fertigation rate	Duration	
Ammo. sulphate	810 g/ tree	27 g/tree/ 2 days	June 1wk to July 4 wk	30 doses
Phosphoric acid	200 g/ tree	6.7 g/tree/ 2 days	June 1wk to July 4 wk	30 doses
MOP	665 g/ tree	22.2 g/tree/ 2 days	June 1wk to July 4 wk	30 doses
Ammo sulphate	1571 g/tree	52 g/tree/ 2 days	Sept 1 wk to Oct 4 wk	30 doses
Phosphoric Acid	333 g/ tree	11.1 g/tree/ 2 days	Sept 1 wk to Oct 4 wk	30 doses
MOP	1333 g/tree	44.4 g/tree/ 2 days	Sept 1 wk to Oct 4 wk	30 doses

Secondary and Micronutrients

- Secondary nutrients like Mg is essential in acid soils where 500 g MgO is recommended per tree per year.
- Micronutrient borax at 50g/tree/year is recommended wherever crown choking occurs.
- In coastal areas lime application of 2kg/tree for trees up to 15 years and 4 kg/tree for plus 15 years is also recommended.

Multitier cropping

- Coconut gardens are generally planted with several intercrops.

  Similarly mutiple cropping and muti tier cropping is also practised in coconut gardens.
- Irrigation and fertilizer management practices should take care of the partner crops also for increasing productivity of these cropping systems.

COCONUT INSECT PESTS AND MANAGEMENT

Name of the Insect

Rhinoceros Beetle

Central spindle appears cut/ toppled/Holes with chewed fibre sticking out at the base of the spindle

Remove adult beetles from the infected fronds with a pointed curved hook. Fill the holes with Carbaryl and fine sand 1: 1 mixture.

Treat the breeding ground/fym pits in the farm with 10% Carbaryl 250 g/ 3 m³ volume.

Black Headed Caterpillar

Dried patches on leaflets of lower leaves. Galleries of silk and Floss underside of leaflets.

Remove affected leaflets and burn them, spray young palms with 40 g Carbaryl in 10 liter water ratio.

Release larval parasite (Perisierola or Bracon) at regular intervels; 10-12 parasites per palm

Red palm weevil

Holes on the trunk with Brownish ooze, Yellowing inner leaves; wilting of central shoot

Application of Carbaryl 50% WSP solution; 1500 ml/palm (40 g in 10 liter water) after opening the hole at the site of entrance of the grub.

Root grub

Leaves turn yellow; Immature nut shedding. Grubs get exposed at the base of the tree. Apply Phorate 10G at the rate of 25 kg/ha one month after peak adult emergence.

DISEASE AND THEIR MANAGEMENT

Stem bleeding


Gummy pinkish or reddish liquid ooze from the cracks on the trunk

Calaxin 20 g/10 liter water or Bordeaux paste 1 kg/10 liter water, -root feeding. Scrap the affected part till the healthy pat is exposed. Apply paste on the affected area.

Bud rot


Tender leaves and central shoot droop; leaves become pale; central unopened shoot dries and comes out with slight pull.

Bordeaux mixture 1% spray the plants; carefully pull up / cut the top leaf portion; clear the rotten tissue and drench the crown with the chemical solution.

Leaf Spot

Dark rectangular necrotic spot with yellow border; the centre of the spot is grey.

Copper Oxy chloride 30 g/10 liter water ; Or Mancozeb 20 g/10 liter water or Chlorothalonil 20 g.

Spray as soon the disease is noticed.

Nut drop

Shedding of Buttons and nuts at all stages.Stalk end of buttons brown and soft

Copper Oxy chloride 30 g/10 liter water ; Or Mancozeb 20 g/10 liter water or Chlorothalonil 20 g.

Spray as soon the disease is noticed.

Petiole end rot/Frond break

Dark chocolate brown irregular circular or elongated lesions on the adaxial surface of petioles.

Breaking of people at the distal end. Broken dry fronds hang down

Copper Oxy chloride 30 g/10 liter water ; Or Mancozeb 20 g/10 liter water or Chlorothalonil 20 g.Spray as soon the disease is noticed.

Dos

- Ensure good drainage in the field.
- Adopt drip irrigation for irrigation.
- Compulsorily apply organic manure (FYM or Compost)@ 25 kg/tree/yr.
- Irrigate with drip strictly following the schedule given by the engineer.
- Follow the drip system maintenance schedule given by the engineer.
- Compulsorily weed/ intercultivate, timely operation helps in coconut growth.
- Follow fertigation schedule as given by the engineer.
- Apply micronutrient as and when needed.
- Follow disease and pest control measures timely and effectively.

Don'ts

- Don't over irrigate the crop at anytime.
- For fertigation don't mix solid fertilizers and dissolve them together. Prepare individual solutions and mix them for application.
- Don't use the fertigation unit for bulky organic manure and fertilizers that are not soluble in water
- Don't add solid fertilizer from the bag directly to the fertilizer tank. Prepare solution separately and pour the solution to the fertilizer tank. Prepare solution only in plastic buckets. Don't use metal container.
- Don't stir the solution with naked unprotected hand. Use wooden spoon or stick.
- Don't heat the fertilizer solution to increase solubility.
- Don't spray coconuts or intercrop under hot sunlight.
- Don't make a fire in coconut field with Drip system.

Frequently asked questions (FAQ's)

1) Does coconut require irrigation?

- Coconut requires irrigation during the dry non monsoon periods for higher productivity.

2) Whether the meagre quantity of water supplied through drip irrigation is enough?

- Irrigation rate in Drip method is estimated based on the Evapotranspiration of the location and therefore it is enough. With conventional flood / channel irrigation water completely replaces the air in root zone thereby suffocating the plant. The last few days of the irrigation cycle the crop also suffers from water stress. The periodical water logging and stress affects growth and production on nuts.

3) In drip method water is applied to the surface of the root system at a very low rate. Whether this will cause root accumulation near the surface?

- The basin within a radius of 1 m and a depth of 1 m of coconut has most of the absorbing roots. The wetting depth and radius are maintained by a properly designed drip system to take care of this zone.

4) Can I prefer Sprinkler method of irrigation for Coconut?

- No. it is not suitable. The water jet from the sprinklers will be broken by the trunks and will result in non uniform water distribution and ponding. It will also cause excessive weed growth. Moreover wastage of water per irrigation will be high.

Crop yields depend on climate, soil and management and therefore can't be guaranteed by the company.

The Corporation

Global Presence: Jain Irrigation Systems Ltd. (JISL) derives its name from the pioneering work it did for the Micro Irrigation Industry in India. However, there is more to Jain Irrigation than Irrigation. Now Jain Irrigation is a diversified entity with turnover Rs. 7000 crore. We have a Pan- India & Global presence with 30 manufacturing bases spread over 4 continents. Our products are supplied to over 116 countries with a strong network of more than 6700 dealers and distributors worldwide.

Micro Irrigation: The Corporation has pioneered and raised a new Micro Irrigation industry in India and thereby helped harbinger a Second Green Revolution. The Micro-Irrigation Division manufactures a full range of precision-irrigation products and provides services from soil/topographical survey, engineering design, supply, installation and commissioning to agronomic support for millions of farmers worldwide. It is the only company in the world which has the largest basket of product and system solutions that can suit any climatic/topographical/crop conditions. The division's pool of over 1000 agronomists, irrigation engineers and technicians are well equipped to support the farmer customers across the globe. The company nurtures a sprawling 2300 acre Hi-Tech Agri Demonstration farm and a training Institute.

Plastic Piping: Presently, JISL is the largest producer in Asia of PVC and PE piping systems for all conceivable applications with pipes ranging from as small as 3 mm to 2500 mm in diameter and in pressure ratings ranging from 1.00 kg/cm² to 25 kg/cm². JISL has a production capacity of over 5,00,000 tonne per annum or 8000 km/day of plastic pipes. The Piping Division includes a variety of PVC and PE Fittings catering to irrigation needs of the farmers apart from the urban and rural infrastructure needs. The pipes are manufactured conforming to BIS, DIN, ISO, ASTM, TEC, Australian Standards as well as other customised specifications.

Plastic sheet division's globally marketed products help conserve forests by providing alternatives to wood in the home building market.

Biotechnology: The Tissue Culture Division produces Banana, Pomegranate, Strawberry, Guava, Coffee, Sugarcane plantlets and has established vast primary and secondary hardening facilities and R&D labs.

Green Energy: JISL Pioneered Solar water pumping systems in the country. Jain Solar water pumping system is a standalone system operating on power generated by Solar Photovoltaic panels which are also manufactured in house state-of-the-art facility. JISL has installed more than 20000 Solar Pumps. All these products are in harmony with the group's mission, "Leave This World Better Than You Found It".

Jain Green Energy division also offers Solar Thermal Water Heating Systems, Solar Photovoltaic, Bio-Gas and Bio-Energy alternate energy solutions.

Food Processing: Jain Farm Fresh Division processes tropical fruits such as Mango, Banana, Guava, Pomegranate into Purees, Concentrates & Juices. The company also has a Dehydration facility which dehydrates Onions & Vegetables. The Company has also launched a range of fruit pulp based retail FMCG Products under the brand of "Jain Frarm Fresh". Agricultural and Fruit processing wastes from these processing plants are converted to Bio-Energy to partially run the plants. The residue after the Bio-Energy generation is used as an Organic Manure.

Turn-key Projects: JISL undertakes Integrated Agricultural Development Projects on Turn-Key basis from Concept to Commissioning with value added services. JISL offers cost effective, down-to-earth solutions for complex challenges backed by our core strength of global knowledge and experience combined with local man-power which is an ideal combination of technology, intelligence and common sense. Whatever be the nature of the project requirement, JISL can assure Total Turn-Key solutions and maximum value for the farmers. It can also undertake Watershed or Wasteland development projects. Such projects normally begins with selection of site, survey of the command area, identification of appropriate crops, designing of the suitable irrigation systems, determination of agronomic practices, use of other hi-tech agro inputs, providing on-going technical services & training and pre & post harvesting techniques, provide assistance for operation and maintenance of the systems. The Company has successfully executed large scale turn-key irrigation projects from conception to completion not only in India but also overseas.

Jain Irrigation offers following turn-key Solutions:

- Integrated irrigation solutions
- Integrated agricultural development projects
- Reuse of waste water for agriculture
- Dust suppression
- Lift & Gravity water pipelines
- 24x7 Water Supply
- High-tech Urban Utilities Solutions
- Effluent conveyance & disposal systems
- Gas distribution System
- Industrial fluid conveying systems, sewerage lines etc.
- Marine On-shore & Off-shore piping
- Relining and rehabilitation of existing pipelines
- Plumbing Systems
- Solar pumping systems
- Solar water heating projects

In a nutshell, the Corporation is the only 'one-stop shop' encompassing manufacturing and marketing of hi-tech agricultural solutions/systems and piping services as well as processing of agri produce. No wonder, it has distinguished itself as a leader in the domestic as well as global markets. The corporate product range improves productivity and adds value to the agri-sector. Conservation of scarce Natural resources, protection and improvement of the environment emerge as a blessed outcome. The reward has been over millions of smiling farmers and scores of customers in more than 116 countries.

Sustainability: Every business of JAINS, ensures to create shared value, nurtures the environment and contributes significantly to the Water, Food and Energy security of the World.

Jain PVC Pipe Mobile App

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Precision Farming
GINGER
With Jain Technology™

Jain Irrigation Systems Ltd.
Small Ideas. Big Revolutions.®

Ginger *(Zingiber officinale)* is one of the important spices grown in India. Ginger of commerce is the dried rhizome. It is marketed in different forms such as raw ginger, dry ginger, bleached dry ginger, ginger powder, ginger oil, ginger oleoresin.

Ginger is a biennial or perennial reed-like herb, grown for the pungent, spicy underground stems or rhizomes. The stems reach a height of 3 feet, with lanceolate, smooth leaves up to 8 inches long.

Climate and Soil

Ginger is cultivated in almost all states in India. Kerala is the major ginger growing state. Other major ginger growing states are Orissa, Meghalaya, Himachal Pradesh and Karnataka. Ginger grows in warm and humid climate.

It is mainly cultivated in the tropics from sea level to an altitude of above 1500 MSL and it can be grown both under rainfed and irrigated conditions. Ginger thrives best in well drained soils like sandy or clay loam, red loam or latteritic soil.

A friable loam rich in humus is ideal.The crop cannot withstand waterlogging and hence soils with good drainage are preferred for its cultivation.

It is a shade tolerant crop with shallow roots and therefore suitable for intercropping and as a component in the homesteads where low to medium shade is available.

Seed

The plants are propagated by small divisions of the rhizomes. Carefully preserved seed rhizomes free from pests and diseases are selected.

The seed rate varies from 1500- 2500 kg/ha.

Seed treatment

Soak the selected rhizomes for 30 minutes in a solution of mancozeb and malathion to give terminal concentration of 0.3% for the former and 0.1% for the latter.

Dry the treated rhizomes in shade by spreading on the floor.

Preparation of land

Clear the field during February-March and burn the weeds, stubbles, roots etc. *in situ*. Prepare the land by ploughing or digging. Prepare beds of convenient length , 1 m wide, 25 cm high with 40 cm spacing between the beds. Provide drainage channels, one for every 25 beds on flat lands.

Season and method of planting

The best time for planting ginger is during the first fortnight of April, after receipt of pre-monsoon showers. For irrigated ginger, the best-suited time for planting is middle of February.

Plant rhizome bits of 15 g weight in small pits at a spacing of 20 x 20 cm to 25 x 25 cm and at a depth of 4-5 cm with at least one viable healthy bud facing upwards.

Mulching

Immediately after planting, mulch the beds thickly with green leaves @ 15 t/ha. Repeat mulching with green leaves twice @ 7.5 t/ha first 44-60 days and second 90-120 days after planting.

Grow green manure crops like daincha and sunhemp in the interspaces of beds, along with ginger and harvest the green manure crop during second mulching of ginger beds.

Irrigation management

Microirrigation is ideal for ginger. The suitable irrigation systems are minisprinkler, microjet and drip. All these 3 types of systems are very appropriate for the very shallow root system of ginger crop.

Water requirement of Ginger

Planting month-April.

Month	Water requirement	
	Mm/day	Lt/ha/day
April	1.56-1.77	15600-17700
May	2.86-3.39	28600-33900
June	3.21-3.77	32100-37700
July	3.00-3.81	30000-38100
August	3.89-5.30	38900-53000
September	4.90-5.53	49000-55300
October	4.61-5.51	46100-55100

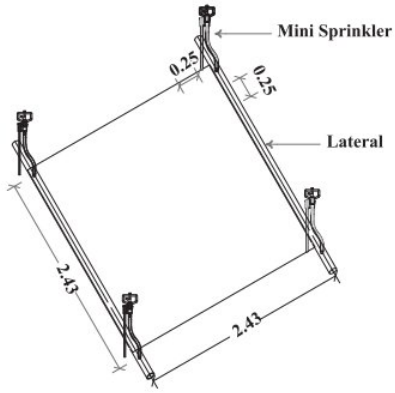
Planting month-May

Month	Water requirement	
	Mm/day	Lt/ha/day
May	1.59-1.88	15900-18800
June	2.05-2.44	20500-24400
July	2.64-3.34	26400-33400
August	2.91-3.97	29100-39700
September	4.65-5.25	46500-52500
October	4.61-5.51	46100-55100
November	4.50-5.23	45000-52300

The rainfall events are very erratic and therefore not adjusted on a daily basis. The general recommendation is that if rainfall exceeds 10mm in any one day, suspend drip irrigation for the next 2 to 3 days.

Irrigation System lay out

Minisprinklers or Jets are installed on 2.43 m row spacing on 16 mm lateral with jets placed on short plastic stakes.
Inline drip system is also suitable for ginger. The drip laterals are spaced on a skip row basis i.e. at 80 or 100 cm spacing. In case of inline the entire strip are wetted by placing drippers at 60 cm or 75 cm (based on soil texture) along the drip line.



Fertilizer Management

Apply manures and fertilizers at the following rates.

Fertigation of Ginger			
Fertilizer Recommendation 75:50:50 kg/ha/yr			
SSP-312.5; 163 urea; 83 MOP kg/ha/yr			
Fertigation Schedule			
Time	**fertilizer**	**quantity**	**Rate of fertigation**
At planting	SSP FYM	312.5kg 30t/ha	One time as Basal One time as Basal
31-60 DAG	Urea MOP	15kg 10kg	0.5kg/day for 30 days 0.25kg/day for 30 days
61-120 DAG	Urea MOP	50kg 30kg	0.8 kg/day for 60 days 0.5 kg/day for 60 days
120-220 DAG	Urea MOP	118kg 43kg	1.3kg/day for 90 days 0.5kg/day for 86 days

Intercultivation

Remove weeds by hand-weeding before each mulching. Repeat weeding according to weed growth during the fifth and sixth month after planting. Earth up the crop during the first mulching and avoid water stagnation.

Plant protection

1. For control of shoot borer spray dimethoate or quinalphos at 0.05%.
2. For control of rhizome rot adopt the following measures:
   a. Select sites having proper drainage.
   b. Select seed rhizomes from disease free areas.
   c. Treat seed rhizomes with 0.3% mancozeb.
   d. When incidence of rhizome rot is noted in the field, dig out the affected plants and drench the beds with cheshunt compound or 1% Bordeaux mixture or 0.3% mancozeb.
   e. Inoculation with native arbuscular mycorrhiza, Trichoderma and Pseudomonas fluorescens at the time of planting is recommended as a biocontrol measure.
3. For controlling the leaf spot disease, 1% Bordeaux mixture, 0.3% mancozeb or 0.2% thiram may be sprayed.
4. For control of nematode in endemic area, apply neem cake @ 1 t/ha at planting and carbofuran 1 kg ai/ha at 45 DAP.

Harvest and yield

The crop is ready to harvest in about eight to ten months depending upon the maturity of the variety. When fully mature leaves turn yellow and start drying up gradually. Clumps are lifted carefully with a spade or digging fork and rhizomes are separated from dried leaves, roots and adhering soil.
The average yield of fresh ginger per hectare varies with varieties ranging from 15 to 25 tonnes.
For making vegetable ginger, harvesting is done from the 6th month onwards. The rhizomes are thoroughly washed in water twice or thrice after harvest and sun-dried for a day.
For preparing dry ginger the produce is kept soaked in water overnight. Rhizomes are then rubbed well to clean them. After cleaning, rhizomes are removed from the water and the outer skin is removed with a bamboo splinter or wooden knife having pointed ends. Iron knife is not recommended, as colour will be faded. In order to get rid of the last bit of the skin or dirt, the dry rhizomes are rubbed together. The peeled rhizomes are washed and dried in the sun uniformly for one week. Rhizomes are to be dried to a moisture level of 11% and they are stored properly to avoid infestation by storage pests. The yield of dry ginger is 16-25 percent of the fresh ginger depending upon the variety and location where the crop is grown.

Dos

- Ensure good drainage in the field.
- Adopt Micro jet or Minisprinkler or drip irrigation.
- Compulsorily apply organic manure as per recommendation.
- Select high yielding, disease and pest tolerant variety suitable for each location.
- Strictly follow the irrigation schedule given by the engineer.
- Follow the irrigation system maintenance schedule given by the engineer.
- Compulsorily weed/ inter-cultivate, timely operation helps in crop growth.
- Follow fertigation schedule as given by the engineer.
- Follow disease and pest control measures timely and effectively.
- Apply sprays in the evening or early morning only.

Don'ts

- Don't over irrigate the crop at anytime.
- For fertigation don't mix solid fertilizers and dissolve them together. Prepare individual solutions and mix them for application.
- Don't use the fertigation unit for bulky organic manure and fertilizers that are not soluble in water.
- Don't add solid fertilizer from the bag directly to the fertilizer tank. Prepare solution separately and pour the solution to the fertilizer tank. Prepare solution only in plastic buckets. Don't use metal container.
- Don't stir the solution with naked unprotected hand. Use wooden spoon or stick.
- Don't heat the fertilizer solution to increase solubility.
- Do not spray the crop during hot sunny times.

Frequently asked questions (FAQ's)

1. Whether the meagre quantity of water supplied through micro irrigation is enough?

- Irrigation rate is estimated based on the Evapotranspiration of the location and therefore it is enough. With conventional flood / channel irrigation water completely replaces the air in root zone thereby suffocating the plant. The last few days of the irrigation cycle the crop also suffers from water stress. The periodical water logging and stress affects growth and production of ginger.

2. Can I prefer Sprinkler method of irrigation for Ginger ?

- It is also suitable and relatively less costly compared to

Crop yields depend on climate, soil and management and therefore can't be guaranteed by the company.

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Precision Farming
CHILLY
With Jain Technology™

Jain Irrigation Systems Ltd.
Small Ideas. Big Revolutions.®

Chilly is an annual herb, also called hot pepper or red pepper. The cultivated varieties in India belongs to *Capsicum annum*. India has many varieties of chilly with different quality factors. It is grown in almost all the states. Andhra Pradesh ranks first in India both in area and production with 2.4 lakh hectares producing 323 thousand tonnes.

The commercial value of of chilly comes from two distinct ingredients; 1. varieties with the red colour pigment, casanthin and 2. varieties with the biting pungency attributed to capsaicin.

Soil and Climatic Requirement

- Chilly requires deep fertile light loamy soils.
- The pH should be in the range of 6.5-7.5.
- Black soil is suitable for chilly cultivation especially rain-fed crop.
- Temperature range should be 25-32oC for hot chillies and 18-25oC for sweet varieties.
- Chilly will not tolerate frost.

Season

- Chilly can be grown through out the year under irrigated conditions.
- For Kharif, raising Nursery – July
- For Direct Sowing in Kharif- first week of July
- For Rabi, raising Nursery- September
- For Summer, raising Nursery- February

Varieties

G-3: It comes up well both under irrigated and rain fed conditions. Ideal for export, Fruits are medium in size with 44% seed to pod. 15-18 q/ha.

G-4 (Bhagyalakshmi) : It is grown extensively throughout AP particularly under irrigated areas. Fruits are medium with 40% seed to pod and olive green colour turning to bright red on ripening. Suitable for green chilly and tolerant to virus disease. 40-45 q/ha.

G-5 (Andhra Jyothi): Fruits are short and stout with conical shape. Seed content 42%. 35-40 q/ha.

Sindhur (CA-960): Early in bearing by two to three weeks. Suitable for suumer crop also. Pericarp light green turning to bright red on ripening. Seed content 38% and pungency is mild. 50-55 q/ha.

Kiran (X-200)(LCA 200): Fruits are long thin with light green pericarp and rose red colour on ripening. Fairly tolerant to thrips, mites and aphids. Seed content 42%. 40-45 q/ha.

Aparna : Plants tall growing and late in bearing by two weeks when compared to other varieties. Fruits yellow in colour on ripening. Seed content 42%. 35-40 q/ha Green Chilly.

Bhaskar: This Variety is characterized by compact plants with short internodes, small leaves and flowers with yellow anthers. Pods are olive green (5-6 cm long) with high seed content (45%) and high degree of pungency.Fairly tolerant to sucking pests like thrips, mites and aphids Fairly tolerant to virus. 55-60 q/ha Green Chilly.

Prakash(LCA 206) : Plants tall grown with light green leaves, fruits long and slender, fruits shining, red clour on ripening. Seed content 40%.45-50 q/ha Green Chilly.

Lam, 305 LCA: Pod larger than Bhaskar 235 with shining red colour plant bushy in type.Fruits 7-8 cm long and fairly tolerant to virus disease. 50-55 q/ha Green Chilly.

S.A-46: Plants dwarf and spreading with light green and broad leaves. Pods thin, 9-10 cm long and wrinkled. Seed content 35%. 200 q/ha Green Chilly.

Jwala 180: Pods are long (10-12 cm). Suitable for green chilly production. 180 q/ha Green Chilly.

Raising Nursery

- Raised beds of 1 m width and 10 m long in one or more bits according to the availability of space surrounded by drainage channels of 30 cm width are to be formed. The height of the bed should be 15 to 30 cm.
- Sowing of seeds uniformly using 650 g per 40 m2 bed area. Three such 40 m2 beds are required for planting one hectare transplanting.
- Consolidate the beds after sowing with a roller.
- Application of 100g of Furadan granules per 40 m2.
- Seed treatment with Thiram or Dithane M-45 is done at the rate of 3 g/kg seed.
- Spraying copper fungicide on 12th day and 19th day of sowing to prevent damping off disease.
- Only organic manures are to be applied.
- Six weeks old seedlings are to be used for transplantation.
- Top the seedlings on week prior to transplantation, if the seeding are more than 6 weeks.

Land preparation

- The field should be ploughed 3-4 times
- 25 t FYM /ha should be applied at the last ploughing
- Ridges and Furrows are to be formed at the required spacing.
- Spray 2 liter Basalin (Fluchloralin 1liter a.i./ ha) mixed in 500 liter water on the soil surface as pre emergent herbicide.
- Follow this by 6- 8 hr drip irrigation.

Plant Spacing

- At 75 cm x 45 cm(in light soils under low input management)
- 60 cm x 60 cm in fertile soils or light soils under intensive cultivation

Transplanting

- Transplanting 40-45 days old seedlings preferably on a cloudy day.

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- For cold weather crop, transplantation is to be done during the last fortnight of August or first fortnight of September.
- For Kharif July-August
- For Rabi- October- November.
- Transplant 2-3 seedlings per hill under rainfed.
- In irrigated crop 1-2 seedlings per hill.

Direct Sowing

Recommended for a rain-fed crop under residual moisture in black soils. This also can be irrigated by drip and use the system for rotation crop.

- Seeds are to be drilled by the end of July or first week of August by using 6.25 kg of seed per ha.
- Seed is to be treated as in the case of nursery before sowing.
- After 30-40 days of sowing, thinning and gap filling are to be done preferably on a cloudy day.
- Plant to plant distance is to be maintained at 15 cm in the rows of 60 cm apart.
- Drip line to be installed at 120 cm spacing, each line wetting two rows of chilly.

Irrigation management

Give 4-6 hour drip irrigation soon after transplanting.

Water requirement of Chilly in liters per day per ha

Planting Month - June

Month	Water requirement	
	Mm/day	Lt/ha/day
June	0.51-0.61	5100-6100
July	1.05-1.34	10500-13400
August	2.39-3.25	23900-32500
September	4.90-5.53	49000-55300
October	4.61-5.51	46100-55100
November	3.82-4.45	38200-44500

Planting month- September.

Month	Water requirement	
	Mm/day	Lt/ha/day
September	0.49-0.55	4900-5500
October	1.15-1.38	11500-13800
November	2.62-3.05	26200-30500
December	3.87-4.87	38700-48700
January	4.35-5.06	43500-50600
February	4.44-5.34	44400-53400

Planting month- February.

Month	Water requirement	
	Mm/day	Lt/ha/day
February	0.53-0.58	5300-5800
March	1.60-1.76	16000-17600
April	4.10-4.65	41000-46500
May	7.16-8.48	71600-84800
June	5.13-6.10	51300-61000
July	3.59-4.55	35900-45500

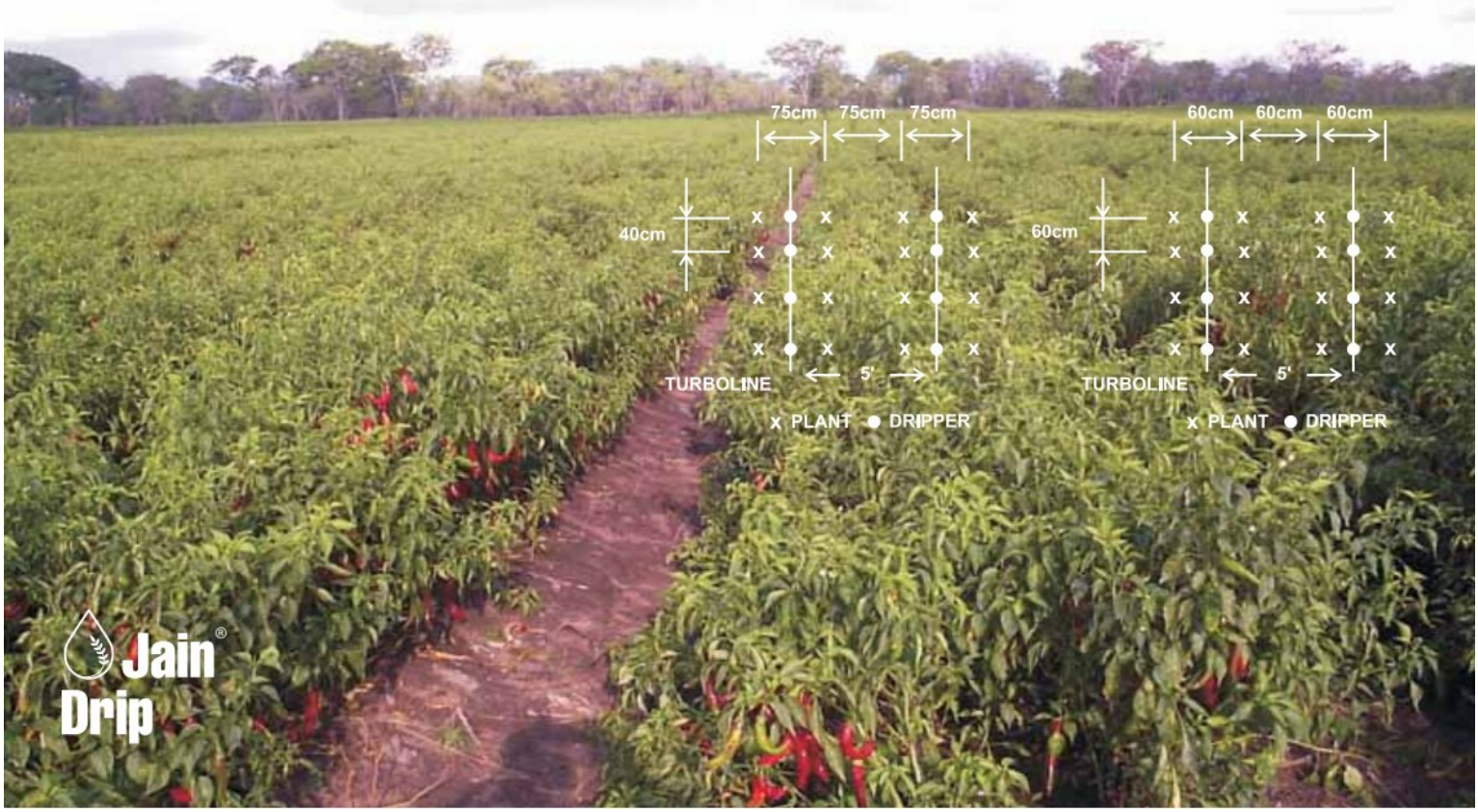
The rainfall events are very erratic and therefore not adjusted on a daily basis. The general recommendation is that if rainfall exceeds 10mm in any one day suspend drip irrigation for the next 2 to 3 days.

Drip system lay out

Inline drip system is suitable for Chilly. The drip laterals are spaced on a skip row basis i.e. at 120 cm spacing. In case of inline the entire strip (row of chilly plants) are wetted by placing drippers at 60 cm or 75 cm (based on soil texture) along the drip line.

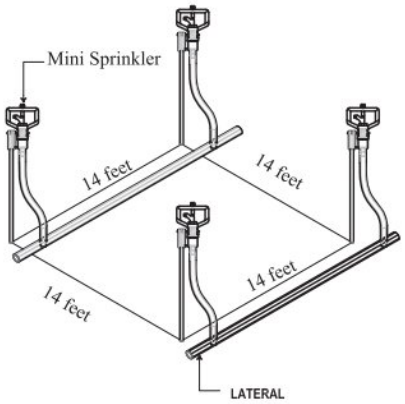
2. Rain port system. (give a drawing of rainport here).

Minisprinkler attached to metal risers are connected 16 mm or 20 mm laterals are provided in the Rainport system.



Water is applied every 3 or 5 days depending upon the soil texture and water holding duration of the soil. But irrigation with this system will create cyclic water excesses and shortages; both of which affect the growth and production of the crop. Irrigation efficiency is also lower (60%) than that of drip.

Nevertheless this system is less expensive and farmers may find this more affordable than drip system.



Application of fertilizer

- A basal dose of 25 t/ha of farmyard manure to be applied along with the last plough.
- Sheep penning (2500-3000 sheep/ha) is also recommended.
- Neem cake at 300-400 kg/ha preferably along with basal fertilizers at the time of final ploughing.
- Green manuring can be practised by sowing cowpea or sunhemp with early rains and incorporating it after 40 days growth.
- A basal dose of 60 kg N, 60 kg P2O5 and 30 kg K20 is to be applied at the time of final ploughing.
- After 45 days of planting three split doses of 20 kg N plus 10 kg K20 each at 15 days interval.
- Later on two more split doses of N alone at 20 kg/ha are to be given.

Fertigation Schedule

Time of application	Type of fertilizer	Quantity (Kg/ha)	Fertigation Schedule (kg/ha/week)
Basal	SSP Urea Potash (MOP)	375 130 50	All soil application All soil application All soil application
45 days after transplanting	Urea MOP	43.5 16.7	22 kg/ha/wk for 2 wks 8.5 kg/ha/wk for 2 wks
60 days after	Urea MOP	43.5 16.7	22 kg/ha/wk for 2 wks 8.5 kg/ha/wk for 2 wks
85 days after	Urea MOP	43.5 16.7	22 kg/ha/wk for 2 wks 8.5 kg/ha/wk for 2 wks
100 days after	Urea	43.5	43.5 kg/ha/wk
110 days after	Urea	43.5	43.5 kg/ha/wk

Foliar spray

Foliar application of 1% urea along with insecticidal or fungicidal spray can be given and at each time only 8 to 10 kg of Urea may be required.

Urea can be mixed with all insecticides and fungicides.

Micronutrients

In soils where Zinc deficiency is noticed, Zinc sulphate @ 50 kg/ha should be applied.

Inter cultivation

- Chilly requires frequent inter cultivation.
- In the direct sown crop blade harrow is to be worked starting from 30th day of sowing. Four inter cultivations are needed at 10 days intervals alternated with blade harrow (Guntaka) and tied harrow (danti) or gorru or Junior-how.
- Final inter cultivation is to be given by the country plough.
- For an irrigated crop, inter cultivation is to be given either by Junior hoe or light plough after each irrigation.
- Inter cultivation is to be followed by hand weeding to check the weed growth.

Pest and disease management

Thrips *(Scirtothrips drsalis)*

Young leaves and shoots are preferred but buds & flowersare also infested.

Spray Rogor 1ml/ l water,Phosalone or Monocrotophos 1.5 ml/l water.

Mites *(Polyohagotarsonemus latus)*

Back side of leaves infected,Causes “murda” disease ofchilli.

Miticide Ethion,Dicofol, 2ml/l water wettable sulphur are effective.

Aphids *(Aphis gossypii*

Present on under surface of leaves.

Spray Monocrtophos insecticide at 2ml/liter water.

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Pod borer *(Helicoverpa armigera)*

Infestation occur in Oct.-March leaves & seeds are infested.

Carbaryl, Endosulphan 2ml/liter water effective,HNPV can beused.

Ragi cutworm *(Spodoptera exigua)*

Leaves are infested.

Phosalone at 2ml/l water can be used.

Midge *(Asphondylia capsici)*

Ovary of the flower bud,floweror tender pod are infested.

Spray Triazophos,Chloro-pyriphos 3ml/liter.

Disease of Chilli

Damping off *(P. aphanidermatum)*

Proper cultural practiceseed treatment withThiram/Captan @3g/kg,seed treatment with *Trichoderma viride* @ 4g combined with 6g Apron is highly effective. Occur at seedlingstage.

Fruit rot or die-back *(Colletotrichum capsici)*

Use disease free seed,seed treatment with3g captan or mancozebper kg of seed,spray 2 times captan1.5g ormancozeb 3g/l water at flowering at 15days interval.

Appears when thefruit is mature and start ripening.

C. **Leaf spot** *(Cercospora capsici)*

Spray thrice at 10-15 with 2.5g mancozeb/1g carbendazim per litre of water.

leaf spot *(Alternaria solani)*

Destruction of crop debris, seed treatment with 2 gm mancozeb/kg of seed and foliar spray of mancozeb at 2g/ l.

High humidity, rain & dew are favourable for its spread .

Sclerotial wilt *(Sclerotium rolfsii)*

Infected plants should be rouged & destroyed.Apply 2g *Trichoderma viride* mixed with 50 kg of FYM. Disease occurs with sudden wilt of individual plant.

Fusarium wilt *(Fusarium oxysporum)*

Seed treatment with 4 gm *Trichoderma viride* or 2g carbendazimper kg of seed is effective.

Generally appears in localized area and scattered.

Bacterial leaf spot *(Xanthomonas compestris)*

Spray 200 ppm lantomycin mixed with 3g Cu-oxychloride per litre of water twice at 15 days interval. Leaf, fruit and stems are affected.

Chilli leaf curl Gemini virus

Avoid monoculturing, soaking seeds into solution of 150g Trisodium ortho -phosphate/l water for 30minutes.Spray the seed-ling in nursery with 1.5 ml/l monocrotophos. Leaves are infected.

Tips for Quality improvement of Chilly

- Timely harvest to improve quality. Delayed harvest will develop wrinkles on fruit.
- Heap the ripe fruits overnight to get uniform ripening
- Avoid insecticide sprays before picking to prevent pesticide residues.
- Dry the fruits till moisture reaches 10-11%.
- Dry them on cement floor to avoid Aflotoxins.
- Keep them free from dust and animals.
- Grade the fruits. Remove damaged ones.
- Store in Cold to retain colour and quality.
- Do not use any chemicals to enhance colour.

Dos

- Ensure good drainage in the field.
- Adopt drip or rainport system.
- Compulsorily apply organic manure as per recommendation
- Select high yielding, disease and pest tolerant variety suitable for each location.
- Practice drip irrigation from the beginning.
- Strictly follow the irrigation schedule given by the engineer.

- Follow the drip system maintenance schedule given by the engineer.
- Compulsorily weed/ inter-cultivate, timely operation helps in crop growth.
- Follow fertigation schedule as given by the engineer.
- Follow the precautions while operating the drip system as explained by the engineer.
- Apply micronutrient as and when needed.
- Follow disease and pest control measures timely and effectively.
- Apply sprays in the evening or early morning only.

Don'ts

- Don't over irrigate the crop at anytime.
- For fertigation don't mix solid fertilizers and dissolve them together. Prepare individual solutions and mix them for application.
- Don't spray the crop under hot sunlight.
- Don't use the fertigation unit for bulky organic manure and fertilizers that are not soluble in water
- Don't add solid fertilizer from the bag directly to the fertilizer tank. Prepare solution separately and pour the solution to the fertilizer tank. Prepare solution only in plastic buckets. Don't use metal container.
- Don't stir the solution with naked unprotected hand. Use wooden spoon or stick.
- Don't heat the fertilizer solution to increase solubility.

Frequently asked questions (FAQ's)

1. Whether the meagre quantity of water supplied through drip irrigation is enough?

- Irrigation rate in Drip method is estimated based on the Evapotranspiration of the location and therefore it is enough. With conventional flood / channel irrigation water completely replaces the air in root zone thereby suffocating the plant. The last few days of the irrigation cycle the crop also suffers from water stress. The periodical water logging and stress affects growth and production of chilly.

2. Can I prefer Sprinkler method of irrigation for Chilly ?

- The rain port system is less expensive and suitable.But it spreads water over the canopy. It may result in flower drop. Moreover wastage of water per irrigation will be high.

4. Can I go for rotation crops with drip irrigation?

- Yes. The crop spacing of the rotation crop has to be adjusted to suit the dripper line spacing to have more economic production.

Crop yields depend on climate, soil and management and therefore can't be guaranteed by the company.

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Irrigation Solution
POMEGRANATE
With Jain Technology™

JAIN®
Jain Irrigation Systems Ltd.
Small Ideas. Big Revolutions.®

Pomegranate, *Punica granatum* is commercially planted in Maharashtra, AP, Karnataka, TN, Gujarat and Madhya pradesh. This fruit crop can tolerate soil salinity and saline irrigation water and does well even in shallow stony soils. It can also tolerate drought. Pomegranate makes an excellent choice under arid and semi-arid condition.
The plant is hardy and bushy growing to a height of 2 to 4 m and is deciduous in cool climates. It can grow from sea level to 1850 m altitude.

Soil

- Pomegranate is very hardy crop and thrives well in shallow rocky soils.
- It can tolerate alkalinity and salinity.
- However best results are obtained in deep, heavy loam and well drained soils.
- It is sensitive to soil moisture fluctuation causing fruit cracking.

Climate

- It thrives best under hot dry summer and cold winter provided irrigation facilities are available.
- Humidity lowers the quality and proliferate diseases.
- It is fairly tolerant to low temperatures.
- However for proper fruit development, a temperature of 35-38° C is necessary.

Varieties

- **Ganesh,** soft seeds and pink flesh
- **Muskat red,** hard seed and reddish flesh
- **Jyothi,** soft seed and yellowish red flesh
- **Paper shell,** soft seed and reddish pink flesh
- **Jodhapur red,** hard seed, light pink flesh
- **Dholka,** soft seeds pinkish white flesh
- **Mridula**

Propagation

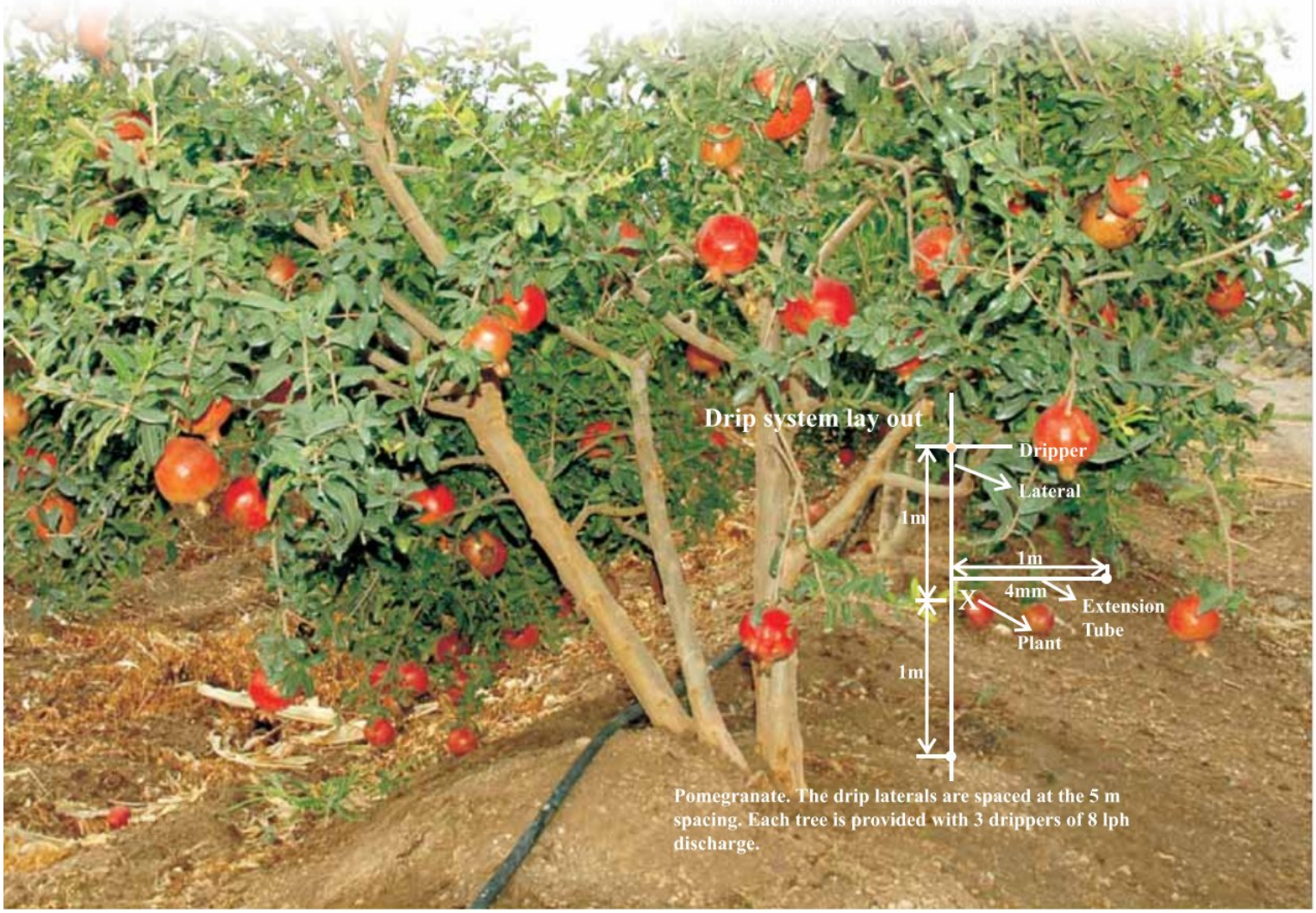
- Raised by cuttings or air or ground layering.
- 15-20 cm long hardwood cuttings taken from 1-2 years old plant, should be treated with Keradx 'B' rooting hormone or given a quick dip in 500 ppm IBA before planting.
- Plants will be ready in 55-66 days.
- Rainy season is the best time for rooting.

Planting

- Planting should be done during monsoon season.
- Different spacings are recommended based on soil richness; 5 x 2 m (400 plants/ac), 5 x 5 m (160 plants/ ac) or 5 x 4 m (200 plants/ac).
- Spacing of 5 m x 2 m, high density planting gives maximum return.
- Pits of 1 x 1 x 1m are dug at 5 m spacing in square system.
- Fill the pits with 20 kg FYM.
- Irrigation must be done immediately after planting.

Irrigation

In post monsoon period copious and regular irrigation is essential for better development of fruits and to avoid fruit cracking.
A drip irrigation of 50-60 l per day per tree is essential at peak growth.



Pomegranate. The drip laterals are spaced at the 5 m spacing. Each tree is provided with 3 drippers of 8 lph discharge.

Water requirement for Pomegranate

mature trees at 5m x 5m.

Month	Water requirement	
	Mm/day	Lt/plant/day
June	2.39-3.99	59.75-99.75
July	1.97-3.32	49.25-83.00
August	1.91-3.47	47.75-86.75
September	2.28-3.66	57.00-91.50
October	2.15-3.54	53.75-88.50
November	2.1-3.22	52.50-80.50
December	1.8-3.09	45.00-77.25
January	2.03-3.22	50.75-80.50
February	2.48-3.74	62.00-93.50
March	2.99-4.35	74.75-108.75
April	3.28-4.80	82.00-120.00
May	3.34-5.12	83.50-128.00

Stop irrigation if it rains more than 20 mm. Similarly irrigation is suspended for induction of flowering and fruiting.

Fertigation

The recommended fertilizer doses for Pomegranate are given below. Estimation of fertilizer requirement based on soil analysis will be more accurate.

1st year tree

All of SSP per tree is applied directly to the soil in two equal splits, in January and June, respectively. Apply in the form of a ring 40 cm away from trunk and 10 cm below the soil surface. Cover with top soil.

SSP can also be mixed with FYM/ Compost and applied together.

Fertilizers	Quantity	Fertigation rate	Duration
Urea	100g/tree	50g/tree/week	Jan1st wk-Jan 2nd wk
	100g/tree	"	June1st wk-June 2nd wk
MOP	50g/tree	25g/tree/week	Jan1st wk-Jan 2nd wk
	50g/tree	25g/tree/week	Jun1st wk-June 2nd wk

4th year tree

All SSP to be applied in two splits, January and June (200 g /tree each), as soil application. Apply the SSP in rings around the tree 1m away from the trunk. Place the fertilizer at a depth of 10-15 cm below the soil surface and cover with top soil.

Fertilizer	Quantity	Fertigation rate	Duration
Urea	400g/tree	100g/tree/week	Jan1st wk-Jan 4th wk
	400g/tree	100g/tree/week	June1st wk-June 4th wk
MOP	200g/tree	50g/tree/week	Jan1st wk-Jan 4th wk
	200g/tree	50g/tree/week	June1st wk-June 4th wk

SSP can also be mixed with the FYM/Compost and apply as per the above schedule.

Benefits of Drip irrigation for Pomegranate

- Increases leaf yield upto 50%.
- Reduces water used for irrigation up to 60%.
- Increased fertilizer uptake by plants when fertigation is practiced increased fertilizer use efficiency through fertigation.
- Consequently a reduction of up to 30% of applied fertilizer from the recommended dose is possible.
- Reduces NO3-nitrogen leaching (thereby nitrate pollution) by 50% when fertigation is practised.
- Controls weed growth as water is applied only to the root zone.
- Allows for intercropping during the early years.

Pruning

Pomegranate is trained as bush. The plant should be allowed to retain 4 main stems from the ground level. Extra suckers should be removed continuously. The main stem should be topped at a height of about 70 cm to reduce branching. The tree is given a balanced shape during the initial 2-3 years by the proper selection of secondary and tertiary branches. Downward growing branches and crossing branches should be removed.

After the tree is trained, much pruning is not required as the fruits are borne on one year old branches. However water sprouts and dry branches should be removed. After 10 years, old main stems should be removed by cutting back to make it more productive.

Regulation of Flowers (Bahar treatments)

Pomegranate flowers in three distinct phases with maximum intensity in the rainy season.

These are traditionally indicated as Bahar treatments

1. **Ambe Bahar -** Flowering in Jan-Feb; suspend irrigation in Nov-Dec for 45 days till leaves drop.
2. **Mrig Bahar -** Flowering in Jun-Jul; suspend irrigation in Dec end-April beginning.
3. **Hasta Bahar -** Actually this season is not suitable as fruit sucking moths finish of the fruits. It is however practiced in some parts of Maharashtra. Suspend irrigation during Aug-Sept and flowering happens in Oct.
4. **Ambe and Mrig Bahar** treatments also leads Fertigation to be practiced during Jun (Mrig Bahar) and Jan (Ambe Bahar).

Harvest

5-6 months after flowering when fruits change in skin color and gives a metallic sound when tapped. Yields 100-150 fruits/annum. High density planting 1000 plants/ha (5 X 2m) is profitable.

Post harvest

Fruits can cured in shade for about a week so that the skin becomes hard and fruit can stand transportation. When stored at 0c to 4.5c with 80-85% R.H. can be safe for 7 months.

Intercropping

Since pomegranate plants take 3-4 years to come into good bearing low growing vegetables, pulses or green manure crops can be taken up as intercrops.

Provide additional drip line for the intercrop.

Insect and disease pests of Pomegranate

IPM for Pomegranate

Cultural: eg. Crop rotation to avoid insect build up.
Mechanical eg. Cultivation to remove weeds.
Biological eg. Release of parasitic wasps for Anar butterfly control
Chemical eg. Herbicides, insecticides, fungicides (given below)

Diseases of Pomegranate

Fruit spot *(Cercospora spp.)*

Brown to balck spots on the fruit

Spray Dithane M-45 or Captan 500g in Gloeospoirides 200 liter water at fruit spp. formation. Repeat the spray 3-4 times at 15 day interval.

Fruit rot *(Phomopsis spp.)*

Occurs in Rainy young fruits drop Yellow black spots on fruit

seasonSpray Dithane M-45 or Captan as above.

Fruit Cracking

young fruits crack due to Boron deficiency as one reason and drought.

maintain soil moisture Early harvest Spray Calcium Hydroxide on leaves and fruits after fruit set.

Insect pests of Pomegranate

Anar Butterfly *(Infestedfruits)*

Virachola isocrates rot, Fruit drop

Larve bores fruits, Spray carbaryl3ml/lat every 15 days. Special care should be taken if it rains during the fruiting period.

Bark eating *(Caterpillar)*

dies later Bores bark Tree

Clean the Bore hole Swab with cotton Inderbela soaked in Kerosene or tetraonis petrol or Carbon disulphide.

Dos

- Ensure good drainage in the field.
- Adopt drip for irrigation.
- Prepare pits and fill it with the mixture as recommended.
- Compulsorily apply organic manure as per recommendation
- Select high yielding, disease and pest tolerant variety suitable for each location.
- Practice drip irrigation from the beginning of the orchard.
- Irrigate with drip strictly following the schedule given by the engineer.
- Compulsorily weed/ intercultivate, timely operation helps in crop growth.
- Follow fertigation schedule as given by the engineer.
- Apply micronutrient as and when needed.
- Follow disease and pest control measures timely and effectively.
- Apply sprays in the evening or early morning only.

Don'ts

- Don't over irrigate the crop at anytime.
- For fertigation don't mix solid fertilizers and dissolve them together. Prepare individual solutions and mix them for application.
- Don't use the fertigation unit for bulky organic manure and fertilizers that are not soluble in water.
- Don't add solid fertilizer from the bag directly to the fertilizer tank. Prepare solution separately and pour the solution to the fertilizer tank. Prepare solution only in plastic buckets. Don't use metal container.
- Don't stir the solution with naked unprotected hand. Use wooden spoon or stick.
- Don't heat the fertilizer solution to increase solubility.
- Do not spray pesticide under hot sun.

Crop yields depend on climate, soil and management and therefore can't be guaranteed by the company.

Jain Drip — More Crop Per Drop®
Jain Irrigation Systems Ltd. — Small Ideas. Big Revolutions.®
More Crop per Drop
Jains Mobile App

Tel: +91-257-2258011; **Fax:** +91-257-2258111; **E-mail:** jisl@jains.com; **Website:** www.jains.com;
Toll Free: 1800 599 5000

Irrigation Solution

Sugarcane

With Jain Technology™

Jain Irrigation Systems Ltd.

Small Ideas. Big Revolutions.®

Sugarcane (Saccharum officianarum) is a multiproduct crop. Sugar is only one of the product of importance. As shown in the table below the crop provides a variety of products and is a major source for generating electric energy. The yield levels achieved in India are lower compared to those of other major cane growing countries. However, adoption of modern technologies for water and fertilizer management and related Agronomic practices have resulted in substantial yield improvements.

EVERY 100 t of Sugarcane gives	
10 t	of sugar
3 t	of filter mud
30 t	of bagasse
4 t	of molasses
0.3 t	of furnace ash
1500 kWh	of Electricity

Climate

In India sugarcane is grown in two major climatic regions- Sub-Tropical (UP, Punjab, Haryana, Rajasthan, parts of MP, West Bengal and Assam and Tropical- Maharashtra, Karnataka, AP, TN, Gujarat, and Orissa.

In subtropics its growing season is restricted by extreme climates- hot summer and very cold winter. Yields and recovery of sugar are also restricted.

In Tropical region, the crop requirements are met by climate and results in high yields relatively high recoveries. Generally crop cycle is of 10-14 months. However the adsali crop of Maharashtra and Karnataka and part of AP extends to 16-18 months.

Soil

- Sugarcane can be grown in all types of soils ranging from sandy loam to clay loam.
- It thrives best on well drained soils. Water logging conditions are detrimental for cane growth.
- It can also be raised successfully on lighter soils provided there is adequate irrigation facilities and on heavy clays with proper drainage and addition of organic matter.
- Saline, alkaline and acidic soils are not suitable for sugarcane.

Season

- Planting is done in January to March in many states.
- In Telengana districts of AP, it is in December to January.
- In some parts of TN planting is done through out the year.

Land preparation

- The field should be ploughed 3-4 times
- 25 tonnes FYM /ha should be applied at the last ploughing
- Ridges and Furrows or bed and furrow are formed at the required spacing.

Varieties

10 Month Duration	11 Month Duration	12 Month Duration
CO- 6907		
CO- 8014		
CO- A 89081(81A99)	CO-A8201	
CO- A 88081(84A125)	CO A7602	
CO- A 89085 (85A265)	CO-7805	CO-7219
81 V-48	CO-86032	CO-7706
91V87	85 R 186	CO- 8011
83R23	86 A 146	CO R 8001
93V297	CO- 8021	87 A 380
81V48	83 V 288	CO94012
83A30	83V15	
93A145	88 A 162	
90A272		
87 A 298		
CO- 7219		
CO- 7706		

- Variety CO 86032 was found to be highly suited for drip fertigation.

Plant Spacing

- At 130-150 cm (4'-5') for single row spacing
- Paired row 2.5' x 3.5' x 2.5 or 2.5' x 4' x 2.5' for intensive cultivation
- In deep and medium black soil (vertisol) regions of Maharashtra the paired row spacing adopted is 3'x 6' x 3' or even 2.5' x 5.0' x 2.5'.
- In pit method pits are spaced 5'x5'

Planting Material preparation

- For setts the seed cane from nursery crops are harvested at appropriate age (7-8months).
- The trash and green leaves are hand stripped to avoid damage to the buds.
- The setts with either two / three eye buds are cut using a sharp knife placing the cane on a small wooden log.
- 2 budded setts are found to be more appropriate.
- The cuts should be slanting.
- It is desirable to prepare the setts just before planting may be a day before.
- A two budded sett is usually 20 to 25 cm long.
- To prevent the seed setts being attacked by fungal diseases and also to improve germination, the seed setts are dipped into 0.5 per cent solution of Agallol (3%) or 0.25 percent solution of Aretan (6%) or Tafasan (6%) or In 300 lt of water 150 g bavistin and600 ml malathion of solution in 15 min. before planting.
- Under normal planting, if the quality of setts is good about 60,000 two-bud setts or 40,000 three-bud-setts would be sufficient to plant one hectare of land and raises a good crop.

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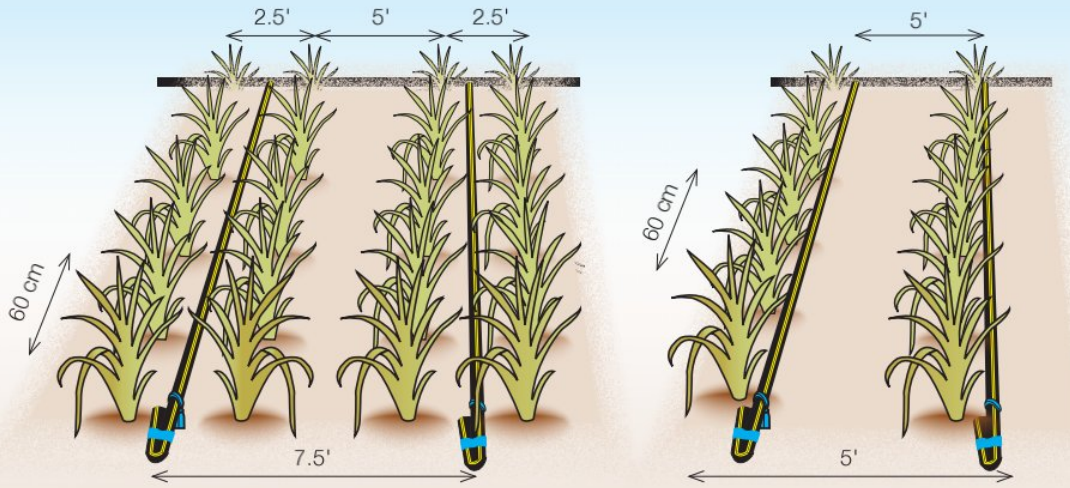
Jain Drip layout for Sugarcane Crop



Irrigation management

Germination Irrigation

- Presence of moist soil around the "eye" bud for a period of 7-10 days is essential for good germination.
- To ensure uniform & high germination, from Planting to sprouting period it is recommended that drip irrigation is applied daily as to reach soil saturation.
- Alternatively one can use shiftable sprinkler irrigation system only for the germination period and then switch over to again drip irrigation as per the irrigation schedule given in the following tables.
- The rainfall events are very erratic and therefore not adjusted on a daily basis. The general recommendation is that if rain fall exceeds 10mm in any one day suspend drip irrigation for the next 2 to 3 days.

Drip system layout

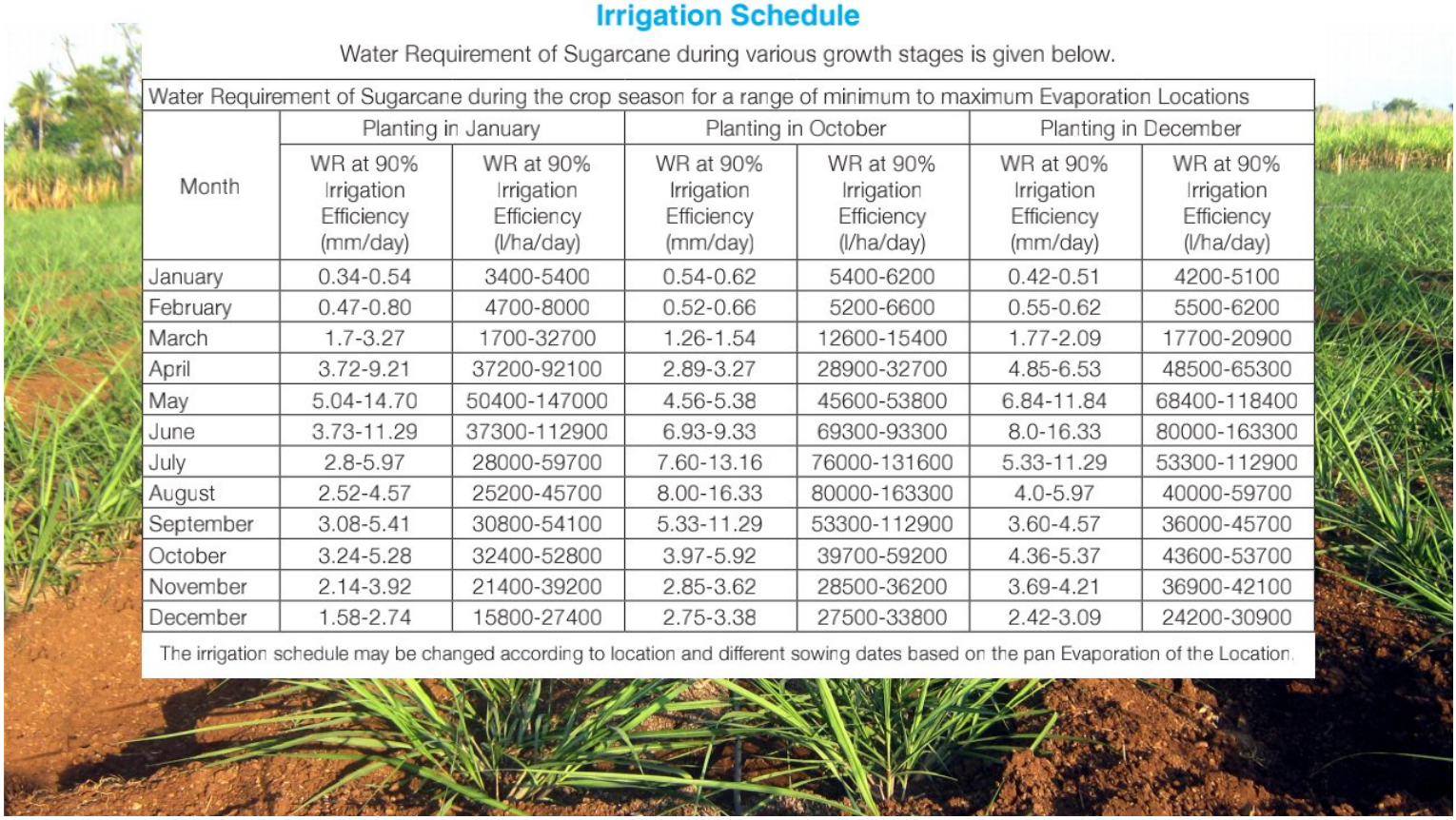
- Inline drip system is suitable for Sugarcane.
- The drip laterals are spaced on a skip row basis ie. at 225 cm spacing in 75 cm (2.5') row planting.
- A drip line is placed between the two rows of a pair in paired row planting.
- In pit method online drippers on 8mm microtube connected to polylateral tube is used. Each pit will receive one dripper. The polylateral is placed between two rows of pits.

Irrigation Schedule

Water Requirement of Sugarcane during various growth stages is given below.

Water Requirement of Sugarcane during the crop season for a range of minimum to maximum Evaporation Locations						
Month	Planting in January		Planting in October		Planting in December	
	WR at 90% Irrigation Efficiency (mm/day)	WR at 90% Irrigation Efficiency (l/ha/day)	WR at 90% Irrigation Efficiency (mm/day)	WR at 90% Irrigation Efficiency (l/ha/day)	WR at 90% Irrigation Efficiency (mm/day)	WR at 90% Irrigation Efficiency (l/ha/day)
January	0.34-0.54	3400-5400	0.54-0.62	5400-6200	0.42-0.51	4200-5100
February	0.47-0.80	4700-8000	0.52-0.66	5200-6600	0.55-0.62	5500-6200
March	1.7-3.27	1700-32700	1.26-1.54	12600-15400	1.77-2.09	17700-20900
April	3.72-9.21	37200-92100	2.89-3.27	28900-32700	4.85-6.53	48500-65300
May	5.04-14.70	50400-147000	4.56-5.38	45600-53800	6.84-11.84	68400-118400
June	3.73-11.29	37300-112900	6.93-9.33	69300-93300	8.0-16.33	80000-163300
July	2.8-5.97	28000-59700	7.60-13.16	76000-131600	5.33-11.29	53300-112900
August	2.52-4.57	25200-45700	8.00-16.33	80000-163300	4.0-5.97	40000-59700
September	3.08-5.41	30800-54100	5.33-11.29	53300-112900	3.60-4.57	36000-45700
October	3.24-5.28	32400-52800	3.97-5.92	39700-59200	4.36-5.37	43600-53700
November	2.14-3.92	21400-39200	2.85-3.62	28500-36200	3.69-4.21	36900-42100
December	1.58-2.74	15800-27400	2.75-3.38	27500-33800	2.42-3.09	24200-30900

The irrigation schedule may be changed according to location and different sowing dates based on the pan Evaporation of the Location.

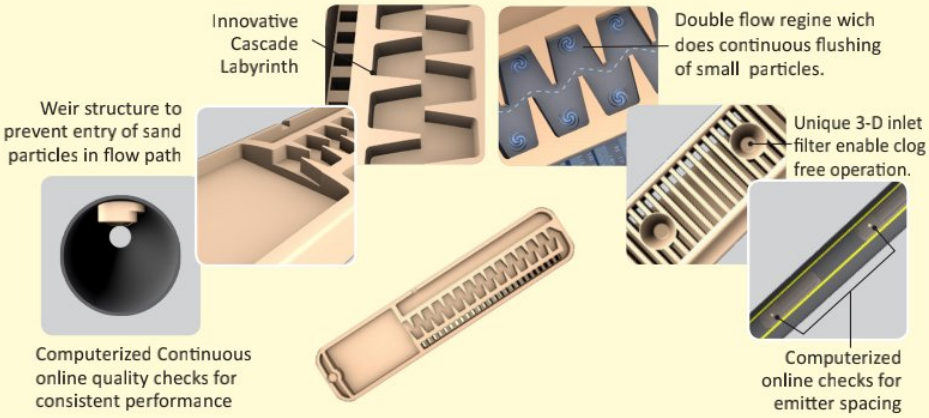


ONE STOP SHOP for Your

World's Only 5 Star Dripline

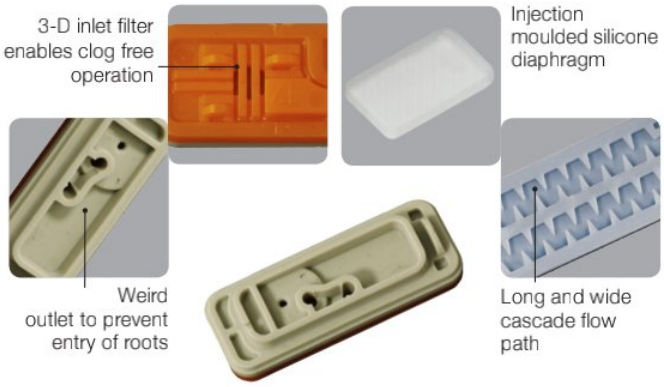
Jain Turbo Excel®

- Five Star rated dripline from worlds reknowned institute IRSTEA (Cemagref), France.
- Available discharge rates - 0.85, 1.2, 1.6, 2.1, 4 lph @ 1kg/cm².
- 12, 16, 20, 25 mm nominal diameter.
- Dripper Spacing 15, 20, 30, 40, 50, 60, 75,90 cms.



Jain Turbo Top®

- Available discharge rates – 1.1 & 1.7 lph
- Injection moulded silicone rubber compensates with pressure and discharge gives uniform performance.
- Anti Syphone feature (optional) prevents suction of sand and silt particles inside the dripper.
- Cascade labyrinth gives strong, self-cleaning turbulence.
- Available in 16 & 20mm nominal diameter. (12, 16 & 20 mm in Thin Wall option)
- Suitable for surface as well as subsurface installations.

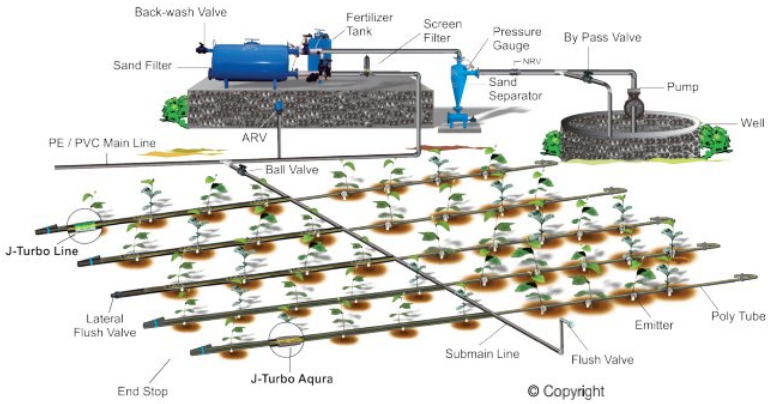


Why Jain Drip Irrigation ?

Water is not the only need of the plant. To uptake this water efficiently, it requires proper air-water balance within the root zone. Drip irrigation, with its low application rate, prevents the saturation of water within the root zone and continuously maintains field capacity. This provides a favorable condition for the growth of the plant. Drip irrigation also helps to use fertilizer efficiently. With drip irrigation water can be provided at frequent intervals which helps maintain required soil moisture level within the vicinity of the plant roots. Jain is the pioneer of drip irrigation. Ours is the only company in the world, which fulfills your entire irrigation system requirement under one roof.

Characteristics of drip irrigation

1. Water is applied at a low rate to maintain optimum air-water balance within the root zone.
2. Water is applied over a long period of time.
3. Water is applied to the plant and not to the land.
4. Water is applied at frequent intervals.
5. Water is applied via a low pressure network.

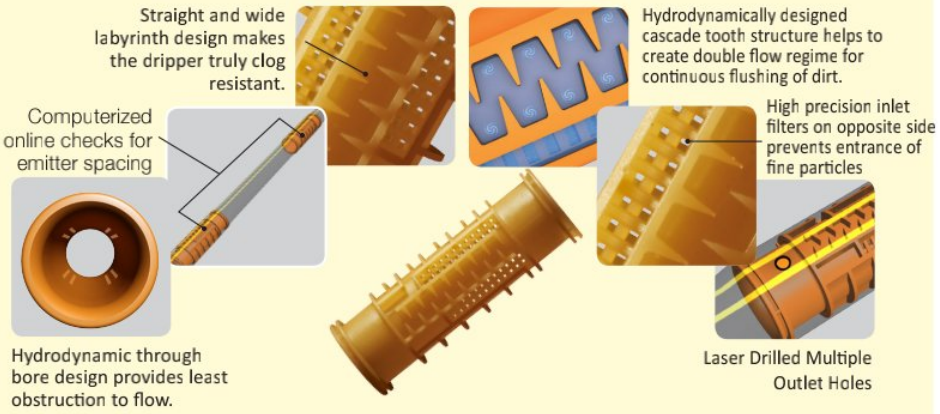


Jain Drip
More Crop Per Drop®

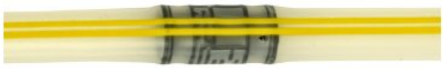
Micro Irrigation Needs

J-Turbo Line® Super

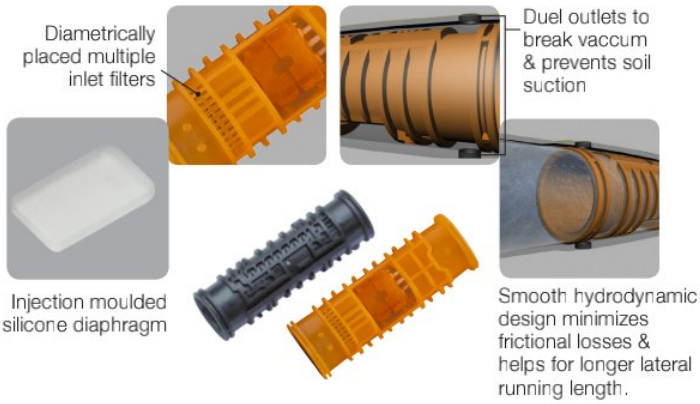
- Available discharge rates (at 1kg/cm²)
  - 12mm - 2.2, 4 lph
  - 16mm - 4, 8 lph
  - 20mm - 2.2, 4, 8 lph
- Availabe in 12, 16 & 20 mm nominal diameter.
- Suitable for surface as well as subsurface installations.



Turboline PC®



- Available discharge rates - 1.4, 1.8, 2.6 & 4.0 lph within pressure regulation range of 0.7 to 3 kg/cm².
- Injection moulded silicone rubber compensates with pressure and discharge gives uniform performance
- Application on undulating land/ Terrains/ Steep slopes.
- Available in 16 & 20 mm nominal diameter.
- Suitable for surface as well as sub-surface installation.
- Application where ever longer lateral length is necessary.
- Conforming to IS 13488, ISO 8261 Standard.



Largest Choice ! Customized Irrigation Solution

Online Dripper & Spray Heads

Jain Filtration Equipment

Jain Fertigation Equipment

Jain Rainport / Micro Sprinkler

Jain PVC/PE Pipes & Fittings

Automation Equipment

Jain® Drip
More Crop Per Drop®

Fertilizer Management

A crop of 125 t/ha removes 83 kg nitrogen, 37.2kg phosphorus and 168 kg potassium per hectare from soil.

Fertigation Schedule

A model fertigation schedule is given below:

Fertigation Schedule For Sugarcane

Fertilizer recommendation 110N:60P:60K (kg/acre)				
Time	**Fertilizer**	**Fertigation rate kg/ac**	**Fertilizer**	**Fertigation rate kg/ac**
At	SSP (50%)	187.5	Soil application at final planting land preparation stage	
Days after planting (DAP)				
15	Urea	27.9	MOP	3.9
30	Urea	27.9	MOP	3.9
45	Urea	27.9	MOP	3.9
60	Urea	31.9	MOP	3.9
	Total	115.6		15.6
65	SSP (25%)	93.75	Drilling into the rootzone /pocket placement	
75	Urea	31.9	MOP	3.9
90	Urea	31.9	MOP	3.9
105	Urea	6.0	MOP	4.4
120	Urea	6.0	MOP	4.4
	Total	75.8		16.6
125	SSP (25%)	93.75	Drilling into the rootzone / pocket placement	
135	Urea	6.0	MOP	4.4
150	Urea	6.0	MOP	4.4
165	Urea	6.0	MOP	5.9
180	Urea	6.0	MOP	5.9
195	Urea	6.0	MOP	5.9
210	Urea	6.0	MOP	13.7
225	Urea	6.0	MOP	13.7
240	Urea	6.0	MOP	13.7
		48.0		67.6
TOTAL	SSP 375	UREA 239	MOP 100	kg/ac

Foliar spray

Foliar nutrition of urea and potassium (2.5%) when moisture availability is less. This will help improve yield and quality.

Micro nutrients

- Iron Chlorosis particularly lime induced Chlorosis in calcareous soil leads to intervenal Chlorosis, stunted growth.
- This could be corrected by repeated spray application of Ferrous Sulphate at 0.5% - 2% concentration.
- Zinc deficiency is another important micronutrient problem in soils where paddy is grown in rotation. To overcome zinc deficiency 0.2-0.5 ZnSO4, spray can be done.
- Zinc Sulphate can also be applied to soil at 50 kg each per hectare.
- Borax 5kg/ha is recommended for soil application.

Inter cultivation and weeding

- Greengram, Groundnut, Vegetables can be grown as inter crops.
- Unchecked weed growth in sugarcane cause yield loss to the extent of 15-70 percent depending upon the nature, density and time of weed infestation.
- Post-emergence application of 2,4 - D at 4.5 g/ha+grmaxone 1lt in 450lt of water - to control dicot and broad leaved weeds.
- Pre-emergence application of Simazine at 5 kg/ha - to control both monocot and dicot weeds.
- One weeding and one post emergence application of Isoproturcon at 0.95 kg a.i/ha gave increased cane yields.

Major Diseases of Sugarcane

Red rot *(Colletotrichum falcatum)*

Infection occurs in setts.

Removal of infected debris, deep tillage,steeping sets into 1g/l Carbendazim sol. before planting, hot water treatment at 50°C for 2 hours & dipping in 1g/l for 30 minutes Carbendazim solution.

***Wilt** (Cephalosporium sacchari)*

4-5 month stage crop.

Dip setts in organomercurial fungicides before planting, & Mancojeb @ 3g/l and irrigate at closer inervals

***Rust** (Puccinia melanocephala)*

Infection occurs at leaves.

Tridemefon 1ml/l incorporated in hot water bath at 50°C for 2hrs. is effective.Malathion 2ml/l is also recommended.

***Red stripe** (Peudomonas rubrilineans)*

Ratoon suffers most.

Spray copper fungicide or 500 ppm (500mg/l) streptomycin.

Ratoon stunting *(Clavibacter xyli)*

Infection occurs in setts.

Hot water treatment at 52 °C for30 mins., & dipping in 1g/l Carbendazim solution

Pests of sugarcane

Early shoot borer *(Chilo infuscatellus)*

Attacks in early stage of crop growth.

Application of Endosulphan 2ml/l at 4,6,9, weeks after planting

Internode borer *(Chilo saccharifagusindicus)*

Nodal region of cane gets infection.

Spray Endosulphan or Carbofuran (1g/l) twice at fortnightly at 4 months age of crop, egg parasitoid Trichogramma chilonis @ 20,000/acre to be applied.

Top shoot borer *(Scirpophaga nivella)*

Cane beyond three month stage are infested.

Spray Endosulphan or Carbofuran (1g/l) twice at fortnightly at 4 months age of crop, egg parasitoid Trichogramma chilonis @ 20,000/acre to be applied.

Mealy bug *(Saccharicoccus sacchari)*

Lower nodes of young canes are infested.

Spray Endosulphan or Carbofuran (1g/l).

Whitefly *(Aleurobus barodensis)*

Leaves are infested.

Endosulphan @ 2ml/l is to be sprayed.

Termites *(Microtermes obesi)*

Internal tissues are eaten up.

Termetaria should be dugged up,queen removed & killed, drenching with Chloropyriphos @ 10ml/l of water.

White grub *(Holotrichia spp.)*

Root & rootlets are damaged.

Application of Phorate granules 8-10 kg/ha

Mites *(Paratetranychus indicus)*

Attacks leaves.

Wettable Sulphar @ 3g/l is recommended.

Dos

- Ensure good drainage in the field.
- Adopt drip irrigation.
- Compulsorily apply organic manure as per recommendation
- Select high yielding, disease and pest tolerant variety suitable for each location.
- Practice drip irrigation from the beginning.
- Strictly follow the irrigation schedule given by the engineer.
- Follow the drip system maintenance schedule given by the engineer.
- Compulsorily weed/ inter-cultivate, timely operation helps in crop growth.
- Follow fertigation schedule as given by the agronomist.
- Follow the precautions while operating the drip system as explained by the engineer.
- Apply micronutrient as and when needed.
- Follow disease and pest control measures timely and effectively.
- Apply sprays in the evening or early morning only.

Don'ts

- Don't over irrigate the crop at anytime.
- For fertigation don't mix solid fertilizers and dissolve them together. Prepare individual solutions and mix them for application.
- Don't use the fertigation unit for bulky organic manure and fertilizers that are not soluble in water.
- Don't add solid fertilizer from the bag directly to the fertilizer tank. Prepare solution separately and pour the solution to the fertilizer tank. Prepare solution only in plastic buckets.
- Don't use metal container.
- Don't stir the solution with naked unprotected hand. Use wooden spoon or stick.
- Don't heat the fertilizer solution to increase solubility.
- Don't spray the crop under hot sunlight.
- Don't make a fire in the field with Drip system.

The Company

Jain Irrigation Systems Ltd. (JISL) derives its name from the pioneering work it did for the Micro Irrigation Industry in India. However, there is more to Jain Irrigation than Irrigation. Now Jain Irrigation is a diversified entity with turnover in excess of Rs. 5000 crore. We have a Pan-India & Global presence with 30 manufacturing bases spread over 4 continents. Our products are supplied to over 116 countries with able assistance from more than 6700 dealers and distributors worldwide.

Jain Piping Division is the largest producer of Thermoplastic piping systems for all conceivable applications with pipes ranging from 3 mm to 1600 mm in diameter and in pressure ratings ranging from 1.00 kgf/cm² to 16 kgf/cm² and above. JISL has a production capacity of over 5,00,000 M.T. per annum or 5000 km/day

JISL is the only manufacturer to own DSIR approved R&D setup with state-of-the-art facilities.

The pipes are manufactured confirming to IS, DIN, ISO, ASTM, TEC and other customised specifications.

The Piping Division includes PE, PVC Pipes and Fittings catering to the urban and rural infrastructure needs of the country apart from irrigation needs of the farmers.

Micro-Irrigation Division manufactures a full range of precision-irrigation products, provides services from soil survey, engineering design to agronomic support and nurtures a sprawling 2300 acre Hi-Tech Agri Institute. It undertakes turnkey projects for total agricultural development. The division's pool of over 800 agri scientists, technologists and technicians are well equipped to render consultancy for complete or partial project planning and implementation e.g. Watershed or Wasteland and/or Crop Selection and Rotation.

Tissue Culture Division grows Grand Nain Banana plantlets and has established vast primary and secondary hardening facilities and R&D labs.

Agricultural and Fruit processing wastes are converted into Organic Manure. Neem-based pesticides are also formulated. Both are critical inputs for Organic Farming.

Agro Processed Products Division processes tropical fruits into Purees, Concentrates & Juices. The Dehydration facility dehydrates Onions & Vegetables.

Plastic sheet division's globally marketed products help conserve forests by providing alternatives to wood in the home building market.

Solar Energy Heating, Lighting Equipments, Solar Pump and Bio-Energy sources are new additions.

In a nutshell, the Corporation is the only 'one-stop-shop' encompassing manufacturing and marketing of hi-tech agricultural inputs and piping services as well as processing of agri produce. No wonder, it has distinguished itself as a leader in the domestic as well as global markets.

The corporate product range improves productivity and adds value to the agri-sector. Conservation of scarce Natural resources, protection and improvement of the environment emerge as a blessed outcome.

The Corporation has pioneered and raised a new Micro Irrigation industry in India and thereby helped harbinger a Second Green Revolution.

The reward has been over millions of smiling farmers and scores of customers in 116 countries.

Crop yields depend on climate, soil and management and therefore can't be guaranteed by the company.

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JAINART/ Sugarcane_Bpg_Eng/0315/YP_V2

Precision Farming
BANANA
With Jain Technology™

Jain Irrigation Systems Ltd.
Small Ideas. Big Revolutions.®

Banana is one of the most important fruit crops grown in India. The banana culture in India is as old as our civilization. Bananas were grown in Southern Asia even before the prehistoric periods and the world's largest diversity in banana population is found in this area. It is generally agreed that all the edible bananas and plantains are indigenous to the warm, moist regions of tropical Asia comprising the regions of India, Burma, Thailand and Indo China. India leads the world in banana production with an annual output of about 16,820 thousand M.T. from 680,000 ha. Within India, Tamil Nadu leads in total area and production with 2514729t from 71088 ha.

The productivity is very low, the National average is 14t/ac when a high-tech yield of 50 t/ac is possible.

Habit of the Plant

Banana is an annual crop that can be ratooned by judicious selection of suckers and maintaining a follower crop. Under drip irrigation two ratoons can be taken for every fresh planting. The advent of Tissue Culture generated planting material has revolutionized banana cultivation.

Climatic Requirement of Banana

Banana is a humid tropical plant growing well in a temperature range of 10 to 40 ^{o}C. Low temperatures during flower emergence can be a problem. It grows up to an altitude of 1500m. Wind velocity of more than 80 kmph will damage the crop especially at the bearing stage. An average rainfall of 100mm per month is good for the crop.

State	Latitude	Temp °N	Region °C	Rainfall (cm)
Andhra Pradesh	16-18	16-43	Coastal	100
			Telangana	81
			Rayalaseema	68
Assam	25-27	16-38	-	252
Bihar	22-25	10-46	-	137
Karnataka	14-28	13-18	Coastal	326
			South	124
			North	69
Kerala	10-14	16-38	-	301
Maharashtra	19-22	13-41	-	92
Tamil Nadu	10-12	16-41	-	102
Uttar Pradesh	25-28	7-43	East	102
			West	96

Soil Management

Banana can be grown in all types of soil that have good water holding capacity. Ill drained and poorly aerated soils are not suitable. Soil should be at least 1m in depth. Soil pH should be less than 8.0. In slightly alkaline soils (pH 7.5 to 8.0) banana wilt disease does not occur.

State	Soil Type
Maharashtra Coastal Areas Plains	 Sandy soil Black cotton soil
Tamil Nadu Cauveri Delta Hill slopes	 Clay soil; Alluvial Loamy type
Central India Gangetic delta	 Alluvial soil
Andhra Pradesh	Alluvial, clay
Kerala Coastal area Plain & Low hill slope	 Sandy loam tract Red latterite

Soil amendments may be used to correct the soil to get required pH. The quantity of gypsum to be applied in different cases are as mentioned below. A soil test is compulsory before deciding on soil amendment.

Soil pH	Gypsum(t/ac)
7.4 to 7.8	1.0
7.9 to 8.4	2.0
8.5 to 9.0	3.6

To bring soil pH to 6.8

The powdered gypsum is mixed well with soil and irrigated to stagnation for 48-72hrs. Later the water is leached out by drainage and allow for drying before ploughing.

Land preparation

The land is prepared by deep ploughing and harrowing and soil is brought to a fine tilth. Farmyard manure is added at 100 cart loads per hectare at the time of ploughing.

If green manure crop is raised in the field, cut and incorporate it by primary ploughing one month before planting banana.

Banana varieties

The banana belongs to the family Musaceae.

Cultivars

There are about 300 recorded cultivars of banana. The important cultivars are described below.

Poovan (TN)- Tall, medium fruit size, yellow skin; good keeping quality. Average bunch 15 kg.

Nendran (Kerala)- Comes under plantain. Dual purpose cultivar; good keeping quality, bunch not compact; average buch 15 kg.

Kanchkela (WB) - Culinary variety; tall , bunch weight 15 kg.

Harichal (Bombay green) (MS)- Semi-tall; large fruit with thick skin; good keeping quality; Average bunch weight 20 kg.

Hill banana (Virupakshi) (TN)- Perennial; susceptible to bunchy top and leaf spot. Average bunch weight 12 kg.

Rasthali (TN)- Amruthapani (AP) Rassabale (Karntaka) Tall table variety; medium size fruit; susceptible to Panama wilt; easy dropping of fruits from bunch. Average bunch weight 15 kg.

Safed velchi (south India and MS)- Intercrop in coconut fields; medium size plants; small fruits.

Kannan (Kerala)- Slender medium height; good taste and keeping quality; firm pulp.

Chakkarakeli (AP coast and Orissa)- Yellowish green highly priced fruits. Immune to Panama wilt.

Karpuravalli (Sugandhi) (TN and AP)- Popular table variety; hardy and vigorous; immune to Panama wilt and leaf spot.

Bontha - Culinary variety; with thick rind.

Vamankeli (Basrai) - Widespread distribution; dwarf plants; heavy bunches; fruits with pale yellow flesh.

Tissue culture banana

Tissue culture (TC) plants of variety Grand Naine is available. Jain irrigation Company supplies secondary hardened ready to plant TC plants to farmers. They have the following characteristics:

- High Yield
- Long Cylindrical fruits with less curvature
- Less sweet than conventional types
- Good keeping quality
- Attractive yellowish green colour at maturity
- Internationally acceptable, both as fresh fruit and in processed form
- Pulp to peel ratio is high and suitable for processing

Plant Spacing

Traditionally banana is panted at,

- 1.65 mx 1.65 m (for Basrai)
- 1.8m x 1.8 m (for Poovan, Amruthapani and Robusta).
- For TC plants of variety Grand Naine a spacing of 1.82 m x 1.52 m (6' x 5') is recommended with 3614 plants per hectare.

Planting seasons in different States in India

States	Season of planting
Maharashtra	August-December
Tamil Nadu	April-December
Kerala	November-January May-September
West bengal	August-December March-April
Bihar	July-October
Andhra Pradesh	December-April (East Godavari) August-September (West Godavari)
Gujrat	August-January
Assam	May-September
Karnataka	April-June September-March
Tripura	August & September

Planting

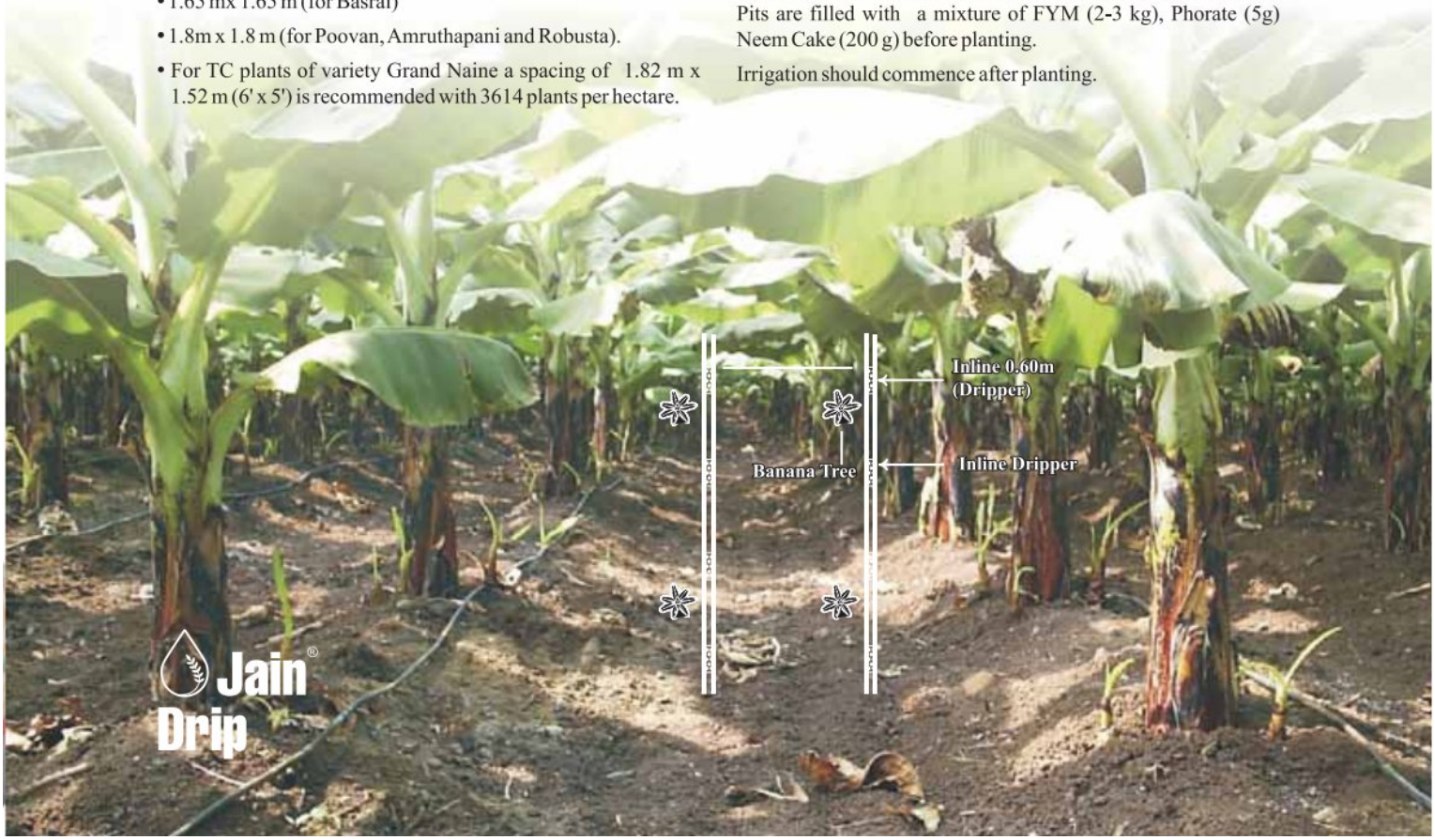
In banana, the material commonly used for planting is sucker. Sword suckers have a well-developed base with narrow sword-shaped leaf blades at the early stages.

The second type is the water sucker with broad leaves, which do not produce a healthy banana clump and should not be selected.

In case of TC plant, Secondary hardened plant lets are planted. Split open the polybag and remove the plant carefully with the ball of earth intact. Place the plant in the centre of the pit without disturbing the roots. Deep planting should be avoided. While planting, soil around each plant should be pressed well. In case of TC plant the ball of earth around the base of the plant should not break while planting.

Pits of 0.3 x 0.3 x 0.3 m (1' x 1' x 1') are dug at desired spacing. Pits are filled with a mixture of FYM (2-3 kg), Phorate (5g) Neem Cake (200 g) before planting.

Irrigation should commence after planting.



Irrigation management

Water requirement of Banana in liters per day per plant

Month	Water (lpd)	Month	Water (lpd)
June (planting)	05	October (Planting)	04-06
July	04	November	04
August	05	December	04
September	06	January	05
October	08-10	February	06
November	08	March	10-12
December	06	April	14-16
January	09	May	18-20
February	11	June	18
March	16-18	July	16
April	20-25	August	12

The rainfall events are very erratic & therefore not adjusted on a daily basis. The general recommendation is that if rainfall exceeds 10mm in any one day suspend drip irrigation for the next 2 to 3 days.

Drip system layout

Both online and inline drip systems are found to be suitable for Banana. The drip laterals are spaced at the relevant row spacing. Each plant is provided with 2 drippers (online) placed on either side of the trunk on the lateral. In case of inline the entire strip (row of banana plants) are wetted by placing drippers at 60 cm or 75 cm (based on soil texture) along the drip line.

Fertilizer Management

Tissue culture banana is a modern phenomenon of banana cultivation hence it should be supported with other hi-tech inputs like drip irrigation and fertigation. Tissue Culture banana plants do not have any store food material unlike suckers. Hence the plants should be nourish by doing fertigation immediately after 5 days from planting up to 315 days.

Fertigation Schedule

A. Conventional Fertilizers

Days after planting	Source	Quantity (g/plant)	Quantity/acre and Fertigation rate
Basal dose	SSP## MOP##	125 105	181.5 152.5
30 days	Urea	62	90 (3kg/ day)
75 days	Urea SSP##	62 125	90 (3kg/ day) 181.5
125 days	Urea SSP##	62 125	90 (3kg/day) 181.5
165 days	Urea MOP	62 105	90 (3 kg /day) 152.5 (5kg /day)
210 days	Urea	62	90 (3kg/day)
255 days	Urea MOP	62 105	90 (3kg/day) 152.5 (5 kg /day)
300 days	Urea MOP	62 105	90(6kg/day) 152.5 (10kg/day)

the basal dose and the SSP in the top dressings should be applied directly to the soil.

B. Water Souble Fertilizer

Time of Application	Fertilizer Grade	Total Qty. (kg)	Quantity (kg/Acre/Day)
5 days to 65 days	Urea 12:61:0	82.60 60.00	1.02 0.17
Ater 65 days to 125 days	Urea 12:61:0 0:0:50 MgSO4	135 40.00 100 75.00	1.62 0.50 1.25 0.62
After 135 days to 165 days	Urea 0:0:50	65.00 60.00	1.62 1.50
After 165 dyas to 315 days	Urea 0:0:50	150 300	0.75 1.50

The above tabe are given as guide line, it will vary as per soil type climate.

Micro nutrients

Micronutrient deficiencies in Banana and their remedies

Zinc

Chlorosis in strip. Chlorotic bands parallel to veins. Young leaves totally chlorotic. Stunted plants, bunched foliage.

Soil Application of 50-100 g Zinc Sulphate per plant. Foliar spray of 5g/l water Zinc Sulphate.

Iron

Deficiency in young leaves. Turn straw yellow with green veins. Leaf tip burning appearance, General Chlorosis.

Spray of 5 gm/ l water of Ferrous sulphate.

Boron

Cholorotic streaks perpendicular to the veins. Incomplete leaf formation. Flower formation inhibited. Bunch size reduced.

Spray boric acid 5gm/l two times; 120 days after planting and at bunch emergence.

Intercropping in Banana plantation

Intercrops such as vegetables, pulses, onion etc. can be grown in the inter row space of banana till the canopy closes, for first 3-4 months. An additional dripline is to be provided for irrigating these intercrops to maximize productivity.

Benefits of Drip irrigation for Banana

- Increases yield up to 50%, from 57 t/ha under flood irrigation to 87t/ha under drip.
- Reduces water used for irrigation up to 70%
- Increased fertilizer uptake by plants and increased fertilizer use efficiency.
- Consequently a reduction of up to 30% of applied fertilizer from the recommended dose is possible.
- Reduces NO3-nitrogen leaching (thereby nitrate pollution) by 50% when fertigation is practised.
- Allows fertilizer application as per the physiological need of the crop.
- Controls weed growth as water is applied only to the root zone.
- Allows for intercropping during the first 3 months.
- Saves labour cost.
- Saves power consumption

Jain® Drip

Weeding/Earthing up

- Weeding is done either through a light digging of surface soil, by mulching or by manual weeding. Presently, in commercial banana gardens, weedicides, are also used extensively to control the weeds.
- Pre-emergence application of Diuron at 4kg a.i/ha was effective in checking both monocot and dicot weed growth. Diuron treatment did not reduce banana quality.
- Among the post-emergence sprays, the combination of Diuron and Gramaxone at 4 kg/ha and 1.5 l/ha gave good control of weed population.
- Earthing up should be done during the rainy season to provide drainage, and to avoid waterlogging at the base. During summer and winter, the plants should be in furrow and on ridges during rainy season.

IPM for Banana

- Avoid injury to roots and pseudostem to refuse entry of disease agents to the plant.
- Treat suckers in Carbendazim solution at planting
- Eradicate any virus infected plant and burn them
- Practice clean cultivation practices.

Major Diseases of banana and their control measures

Panama wilt (*Fusarium oxysporum):*

Yellowing & withering of leaf, entire foliage wilt in 2-3 days, emittance of rotten fish smell when cut, brown & red streaks are seen on pseudostem.

Avoid injury to root, eradication of infected plants, liming of infected pits, dipping suckers in carbendazim 1g/l before planting followed by bimonthly drenching.

Sigatoka leaf spot *(Cercospora musae):*

Small lesions on the leaf parallel to vein, some spots develop to form dark, brown to black linear oblong area, eye shaped spots may appear.

Destruction of infected leaf desuckering and optimal spacing, spraying of 1ml/l carbendazim, 1ml/l Bordeaux mixture and dithane M-45 at 15 days interval.

Bunchy top *(Virus):*

Size of the leaf is reduced, rosseting of reduced leaves, dark green streak along the vein, dark leaves.

Eradication of infected plants spray systemic insecticides like-Metasystox or Nuvacron @ 1.25ml/l to control the vector.

Anthracnose *(Gloeosporium musarum):*

Circular black,sunken spots surrounded by yellow halo, premature ripening.

Spraying chlorothanil 2g/l at 15 days interval is effective.

Mosaic *(Mosaic virus):*

Light green streak run parallel to veins, loss of green colour of the leaves and mosaic patch appear.

Treating suckers at 40 deg.C for 1day followed by treatment with120ppm (120mg/l) Aurefungin.

Bacterial wilt *(P. solanacearum):*

Less rapid wilting, discolouration, blackening of the suckers, bacterial oozing & drooping of the leaves.

Can be minimized by exposing soil to sunlight, eradication of infected plants.

Insect pests of Banana and their control measures

Rhizome weevil *(Cosmopolitus sordidus):*

Rhizome is infested.

Application of phorate 20g or neem cake 200g/ pit.

Nematode *(Radpholus similis):*

Black lesion in the root, decaying of root and stunted growth of plant.

Application of furadon 10g or Phorate 5g or neem cake 200g per pit.

Desuckering

- Suckers which are produced by the plant in excess, are removed periodically to ensure better growth and bunch development of mother plant.
- In perennial system of banana culture, the 'setting of followers' at proper time will ensure good ratoon crop to the banana growers.

Denavelling

- The part of the inflorescence which consists of male flowers only, should be removed. This part is more often pruned off in many places, where intensive and efficient cultivation is practiced.

Covering of bunches

- Bagging is a cultural technique used by planters in the French West Indies, Latin America, Africa, Australia, etc., particularly, where export bananas are grown. It is strongly recommended to our growers.
- The main purposes are the protection of bunches against cold, sun scorching, against attack of thrips and scarring beetle.

Harvesting

Bananas are harvested at various stages of its maturity depending upon the purpose for which it is cultivated, such as culinary, table purpose etc., and distance to the market (3/4 full maturity in Robusta for distant markets, while full maturity for local market etc.). Banana can be stored at a temperature 0f 13 oC and RH 85-90 for about 3 weeks before ripening.

Yield ranges from 12-25 kg/bunch. It ranges from 25-40 kg/bunch for Tissue culture plants of Grand Naine.

Dos

- Ensure good drainage in the field.
- Adopt drip irrigation.
- Prepare pits and fill it with the mixture as recommended.
- Compulsorily apply organic manure as per recommendation.
- Select high yielding, disease and pest tolerant variety suitable for each location.
- Practice drip irrigation from the beginning of the orchard.
- Strictly follow the irrigation schedule given by the engineer.
- Follow the drip system maintenance schedule given by the engineer.
- Compulsorily weed/ inter-cultivate, timely operation helps in crop growth.
- Follow fertigation schedule as given by the engineer.
- Follow the precautions while operating the drip system as explained by the engineer.
- Apply micronutrient as and when needed.
- Follow disease and pest control measures timely and effectively.
- Apply sprays in the evening or early morning only.

Don'ts

- Don't over irrigate the crop at anytime.
- For fertigation don't mix solid fertilizers and dissolve them together. Prepare individual solutions and mix them for application.
- Don't make a fire in the field with Drip system.
- Don't use the fertigation unit for bulky organic manure and fertilizers that are not soluble in water.
- Don't add solid fertilizer from the bag directly to the fertilizer tank. Prepare solution separately and pour the solution to the fertilizer tank. Prepare solution only in plastic buckets. Don't use metal container.
- Don't stir the solution with naked unprotected hand. Use wooden spoon or stick.
- Don't heat the fertilizer solution to increase solubility.
- Don't spray the crop under hot sunlight.

Crop yields depend on climate, soil and management and therefore can't be guaranteed by the company.

Jain Drip More Crop Per Drop® | JAIN Jain Irrigation Systems Ltd. Small Ideas. Big Revolutions.® | More Crop per Drop

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Toll Free: 1800 599 5000

Irrigation Solution
RICE
With Jain Technology™

JAIN®
Jain Irrigation Systems Ltd.
Small Ideas. Big Revolutions.®

Rice is the main grain that is consumed in India and other South Asian countries. A hectare of rice in conventional puddle cultivation uses 1300-1600 mm of water per season as per the literature. But in practice, farmers use a grater volume (up to 2000 mm) in many delta areas in India.

The future of rice production which consumes a lion's share of water (85%) used in irrigated agriculture will therefore depend heavily on developing and adopting technologies and practices which will use less water with highest use efficiency. Rice is cultivated usually in a puddled condition with large volumes of water and grown in standing water. The water productivity is hardly 0.15 kg/m³ water, which is very low. Even in SRI (Sustainable rice Initiative) method the total water use is 745-800 mm per ha though this method does away with standing water during the major crop phase.

Similarly, productivity of rice is stagnant (Table.1) and how a change can be brought to this situation. A comprehensive package was tested that could reduce resource use and increase productivity in direct seeded rice which form 28% of the Indian rice cultivation. Jain Irrigation, the most highly water conscious Corporate in the country is working towards food security thru water and energy securities have now tested and released an innovative method for cultivating rice.

Status of rice production in India

Table 1 : Rice production scenario in different states of India

States/UTs	Area (x000 ha)	Irrigated area under rice (x000 ha)	Average Yield (t/ha)
Andhra Pradesh	3982	1041	3.1
Assam	2420	111	1.6
Bihar	3252	1663	1.1
Chhatisgarh	3854	1169	1.1
Gujarat	666	383	1.8
Haryana	1041	1024	3
Himachal Pradesh	79	48	1.4
Jammu & Kashmir	259	-	1.9
Jharkhand	1355	76	1.5
Karnataka	1478	1120	2.4
Kerala	276	160	2.6
Madhya Pradesh	1700	232	0.87
Maharashtra	1513	434	1.5
Orissa	4479	1908	1.6
Punjab	2649	2624	4
Rajasthan	107	43	1.5
Tamil Nadu	2050	1907	3.1
Uttar Pradesh	5578	4073	2.1
Uttaranchal	302	196	2.1
West Bengal	5783	2878	2.6
India	42806	21107	2.04

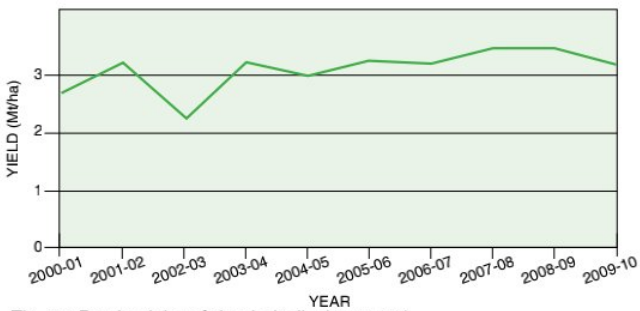


Fig 1 : Productivity of rice in India (2000-10)

Precision farming

Precision farming is farming where 1) Timeliness of operations and 2) Precision in quantities of inputs and control measures are practised.

The different steps followed in precision farming varies from crop to crop and differences of these practises from conventional practises also varies from crop to crop. In Precision farming of rice we recommend the following steps: Planting on raised beds, adopting a plant spacing of 0.2 m x 0.15 m, irrigating with drip following an irrigation schedule and fertilizer thru fertigation scheduling and weed control by weedicide.

Cultivation Method

Based on the experience Jain Irrigation garnered over a number of field trials, the cultivation method and drip system for rice should have the following components:

- Adopt dry seeded aerobic method of rice cultivation
- Disc plough the field twice; first East-West and second time North-South directions
- For rainy season crop, it is advisable to prepare broad bed and furrow (BBF) system that will take care of drainage during heavy rain. For rabi and summer crops even flat seed bed is appropriate.
- For BBF system for seeding; Bed width of 1 m, and height of 0.15 m and furrow width of 0.2-0.3 m.
- Sow rice in rows on a broad bed or on flat seed bed.
- Rotavate to break clods on the bed surface to achieve fine tilth.
- Sow seeds at 0.2 m x 0.15 m spacing; 5 rows per bed (in BBF).
- Install drip system.
- Mulch the seeded surface with rice husk.

Rice varieties

Identification of varieties suitable for drip irrigation would take a large number of time consuming experimental trials. However, it is an intelligent assumption that all the varieties so far found suitable for dry seeded cultivation would also be suitable for drip.

Varieities tested under drip irrigation and fertigation by Jain irrigation. More such varieties will be tested and recommended.

Varieties tested under drip fertigation

US 311, Arise 6129, SBH 999 (basmati), 25P25, 25P31, Try -R (2), BPT, Pusa sugandha (basmati), ADT -45, Pusa-2, WGL 32100

Irrigation

Table 2 :Water requirement of drip irrigated rice

Month	Pan E (mm/day)	Total water Reqt. (lit/Day/ha)
Feb 16-28	6.68	18704
Mar 1-15	6.73	40044
16-31	6.82	47740
April 1-15	6.09	56840
16-30	6.53	60947
May 1-15	7.44	70019
16-31	7.57	58878

**Water requirement will vary with location and pan E and crop planting date*

For each location Jain irrigation agronomist will estimate water requirement and based on the design flow will prepare irrigation schedule and train the farmer to apply this precisely.

Traditional (Puddling) Cultivation Method

Rice fields are first flooded before tillage. Tillage of flooded field is referred to as puddling. In puddling, the top soil is subjected to repeated fine grinding with water. Besides saturating the top soil, an overlying water layer is created and maintained during the transplanting period. Apart from high water use the procedure of puddling has many disadvantages;

- Puddling destroys soil structure
- It reduces percolation rate
- It results in loss of water (Puddling accounts for 20-40% of total water use of rice culture).
- Most of the water used for puddling is lost by drainage.
- It induces high resistance to root penetration
- It causes low porosity and permeability
- It results in the formation of a soil plow pan
- All the above factors restrict root growth.
- It also causes emission of Methane gas. Thus it is suppose to be the creator of Green House Gases.

The only known advantage of flooding for tillage (Puddling) seems to be the control on weed germination.

Because of the demand on water modern technology high light dry sowing of paddy seeds into wet soil (no standing water). Drip irrigation makes the soil wetting easy and water use restricted to crop water requirement alone.

Drip Irrigation - The concept

Drip irrigation is the slow, even application of water at low pressure to the root –zone using a net work of plastic tubing placed above the rooting zone (surface drip) or buried among the root branches inside the rhizospherical soil at a certain depth from surface. (subsurface drip).

In drip irrigation method, crops are irrigated daily to the precise volume of water equivalent to the evapo-transpiration (ET) of the crop. It is estimated from daily Evaporation data using crop and canopy coefficients, the latter two factors vary with the age of the crop and the size of its canopy. These are the two factors that affect the volume of transpiration of the plant/ crop that changes with growth of the crop. Factoring in of these two coefficients is what makes the water requirement estimate unique to that particular crop at that particular stage of its growth.

Sowing and germination Irrigation

It is essential to pre irrigate and fully wet the broad bed before sowing the seeds. Keep the bed uniformly wet till germination and crop establishment.

Mulching

One of the main issue in dry seeded and drip irrigated rice is the germination and growth of weeds. The standing water in the conventional flooded rice will suppress the weed germination.

We recommend use of rice husk mulch on the beds after seeding. Mulch is applied 2-3 cm thick on the bed surface.

Besides reducing weed growth it also helps reduce evaporation from the soil surface. However this is an optional recommendation.

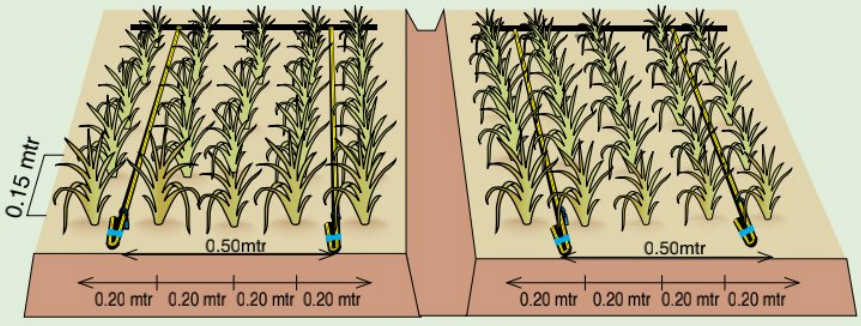
Weedicide application

Use of weedicide to prevent weed growth is also plausible. Studies have shown that a pre-emergence weedicide, Pretilachlor sprayed to the seed bed at 1250 ml/ha rate within 72 hours of sowing controls weed infestation effectively.

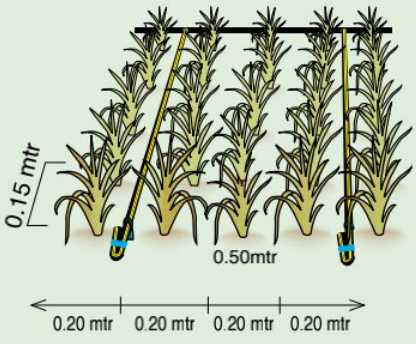
Fertilizer application through Fertigation

Use of drip technology provides a golden opportunity to apply nutrients as per the need of the crop at each growth stages. In rice also this technology enhances nutrient use efficiency.

Jain Drip layout system



BBF System



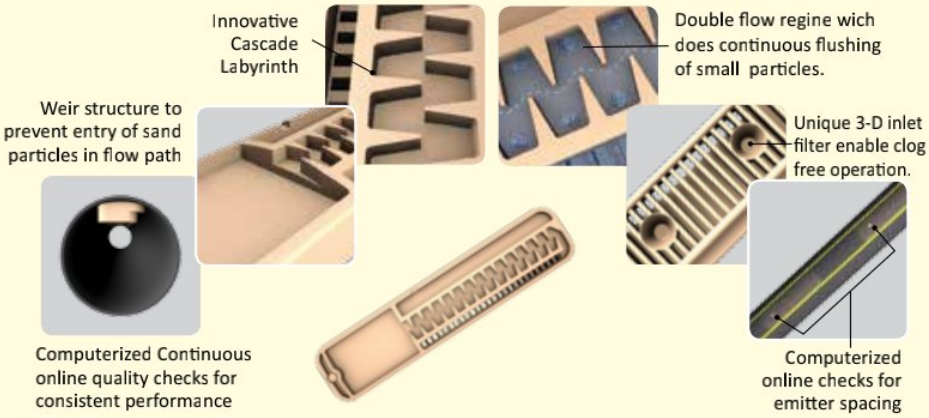
Flat System

Jain Drip
More Crop Per Drop®

ONE STOP SHOP for Your

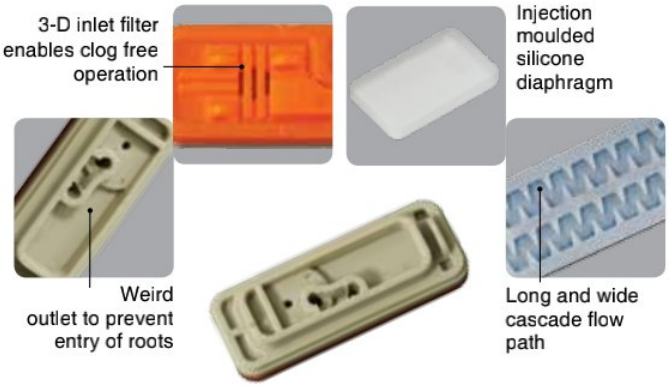
Jain Turbo Excel®

- Five Star rated dripline from worlds reknowned institute IRSTEA (Cemagref), France.
- Available discharge rates - 0.85, 1.2, 1.6, 2.1, 4 lph @ 1kg/cm².
- 12, 16, 20, 25 mm nominal diameter.
- Dripper Spacing 15, 20, 30, 40, 50, 60, 75,90 cms.



Jain Turbo Top™

- Available discharge rates – 1.1 & 1.7 lph
- Injection moulded silicone rubber compensates with pressure and discharge gives uniform performance.
- Anti Syphone feature (optional) prevents suction of sand and silt particles inside the dripper.
- Cascade labyrinth gives strong, self-cleaning turbulence.
- Available in 16 & 20mm nominal diameter. (12, 16 & 20 mm in Thin Wall option)
- Suitable for surface as well as subsurface installations.

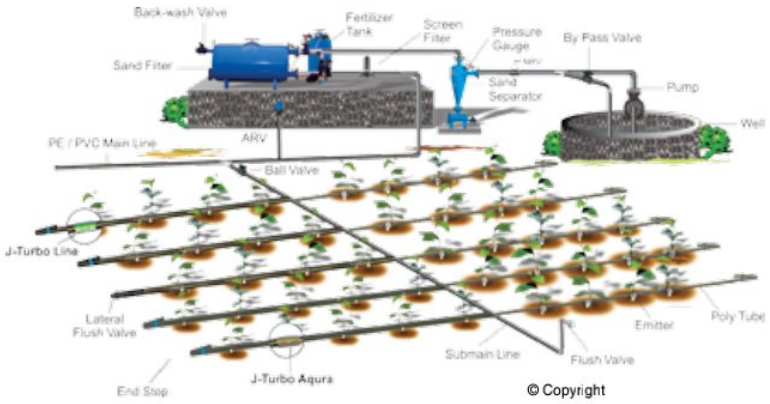


Why Jain Drip Irrigation ?

Water is not the only need of the plant. To uptake this water efficiently, it requires proper air-water balance within the root zone. Drip irrigation, with its low application rate, prevents the saturation of water within the root zone and continuously maintains field capacity. This provides a favorable condition for the growth of the plant. Drip irrigation also helps to use fertilizer efficiently. With drip irrigation water can be provided at frequent intervals which helps maintain required soil moisture level within the vicinity of the plant roots. Jain is the pioneer of drip irrigation. Ours is the only company in the world, which fulfills your entire irrigation system requirement under one roof.

Characteristics of drip irrigation

1) Water is applied at a low rate to maintain optimum air-water balance within the root zone.
2) Water is applied over a long period of time.
3) Water is applied to the plant and not to the land.
4) Water is applied at frequent intervals.
5) Water is applied via a low pressure network.

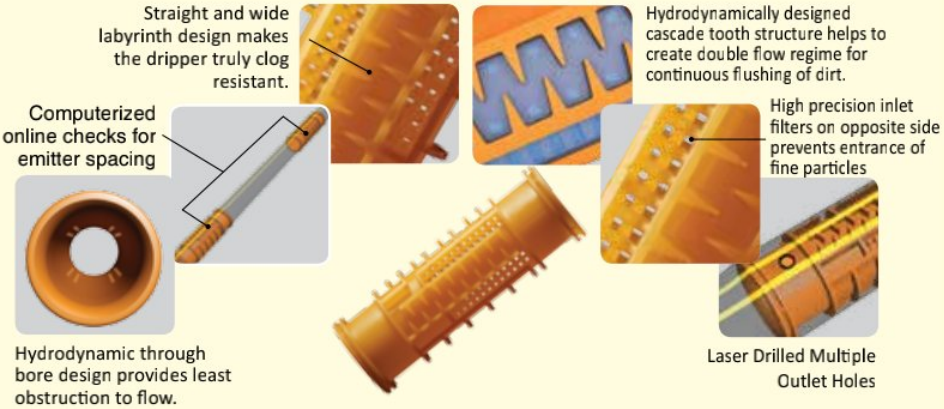


Jain Drip
More Crop Per Drop®

Micro Irrigation Needs

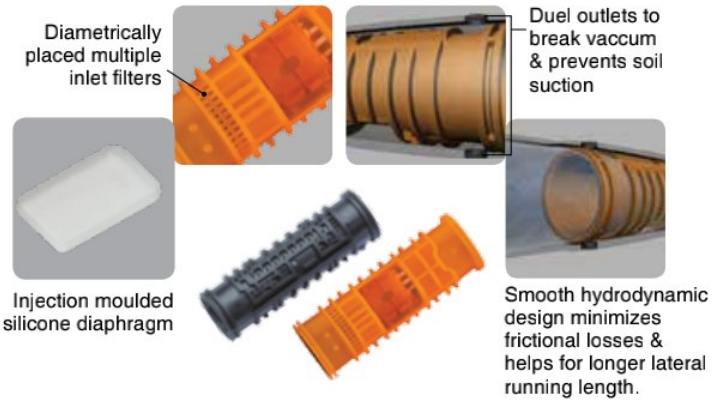
J-Turbo Line® Super

- Available discharge rates (at 1kg/cm²)
  12mm - 2.2, 4 lph
  16mm - 4, 8 lph
  20mm - 2.2, 4, 8 lph
- Availabe in 12, 16 & 20 mm nominal diameter.
- Suitable for surface as well as subsurface installations.



Turboline PC®

- Available discharge rates - 1.4, 1.8, 2.6 & 4.0 lph within pressure regulation range of 0.7 to 3 kg/cm².
- Injection moulded silicone rubber compensates with pressure and discharge gives uniform performance
- Application on undulating land/ Terrains/ Steep slopes.
- Available in 16 & 20 mm nominal diameter.
- Suitable for surface as well as sub-surface installation.
- Application where ever longer lateral length is necessary.
- Conforming to IS 13488, ISO 8261 Standard.



Widest Choice ! Customized Irrigation Solutions

Jain Drip
More Crop Per Drop®

Benefits of Jain Drip in Rice Cultivation

- Enhanced yield upto 50% .
- Higher and cleaner straw production.
- Conserving irrigation water up to 66%
- Conserving energy use for pumping up to 52%.
- Higher water and fertilizer use efficiency.
- Incidence of diseases and insects significantly low
- Early Maturity
- More Productive tillers
- Reduced chaffiness & shattering of grains
- No need for land leveling (prerequisite for flow irrigation).
- No need for labour use for trimming bunds and plugging breaches to contain water.
- Intercropping and rotation cropping is possible. Pulse rotation crop will be beneficial.
- When Direct Seeding (DSR), reduces seed cost.
- Soil structure is maintained (absence of puddling operation that destroys soil structure).
- Maintains aerobic condition in the soil.
- Prevents Nitrous oxide formation .
- Prevents Methane emission and protects environment as there is no standing water
- Absence of pollution from leached and washed Nitrate.
- Reduced humidity in micro climate .
- Lower mosquito population in the ecosystem as there is no standing water.
- Improves human health.
- More sustainable production of Rice.

Crop rotation

Drip irrigated rice can be followed by drip irrigated wheat. The rotation crops can be, a second rice, mustard, vegetables, or seed spices. Both the rotation crops are adjusted in their spacing to suit the drip system on the ground.

Fertigation schedule

Table 3 : Fertigation schedule adopted in drip irrigated rice in AP (Fertilizer dose 180:80:80 kg NPK per acre)*

	Urea	SSP	MOP	$ZnSO_4$	Schedule (urea) kg/day/ac	Schedule (MOP) kg/day/ac
Basal (soil)		500	0	10	-	-
till 10 DAP$	65	0	0	-	6.5	-
11-35 DAP	196	0	16	-	7.8	0.64
36-55 DAP	65	0	17	-	3.3	0.85
55-65 DAP	65	0	50	-	6.5	5
65- 70 DAP	0	0	17	-	-	3.4

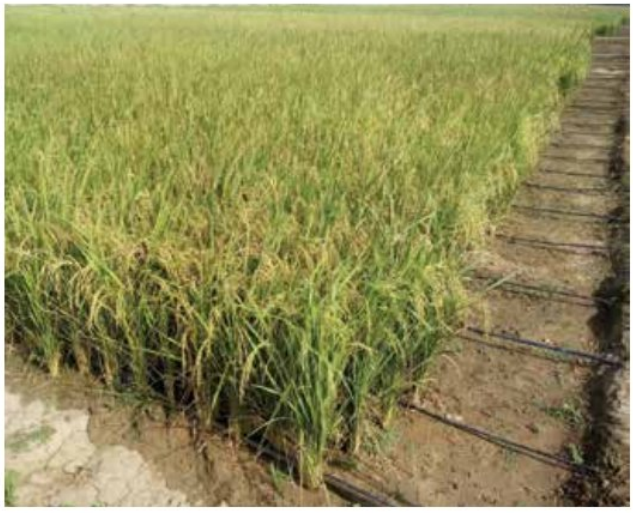
*$DAP-days after Germination * Schedule will vary with location.*

Integrated Nutrient management

- Incorporate green manures/bio fertilizers
- Nitrogen management by leaf colour chart (LCC)
- Practice fertigation daily.

Integrated Pest Management for Rice under drip irrigation

- Seed treatment with Pseudomonas fluorescens @ 10 gm/ kg of seed
- Nursery – Application of Neem Seed Kernel extract (NSKE)@ 5% or neem oil 2 %
- Seedling dipping in Pseudomonas fluorescens @2.5 kg/ha
- Adoption of cultural practices
  a. Selection of Variety
  b. Removal and burning of stubbles of previous crop.
  c. Spacing based on season, variety and location
  d. Leave Rogueing space of 30cm for every 2.5 mtr.
- Use of Pheromone traps for rice stem borer @ 4 per acre.
- Use of light traps for monitoring of pests.
- Release of bio control agents : *Trichogramma japonicum* for stem borer @ 5 card/ha at weekly interval for 3 times on 28 DAT onwards and *Trichogramma chilonis* for leaf folder @ 5 card/ha at weekly interval for three times on 42 DAT onwards.



Diseases and control measure

Disease	Visual symptoms	Control Measures
Bacterial Leaf Blight: *Xanthomonas oryzae pv. oryzae*	Yellowish stripes on leaf blades. Appearance of bacterial ooze on young leaves.	Use optimum doses of fertilizers. (Drip irrigation reduces incidence). Spraying streptomycin sulphate and tetracycline combination 300g +copper oxychloride 1.25 kg/ha
Blast : *Pyricularia grisea (P.oryzae)*	Infect leaf, neck and node and severe in neck infections spindle shaped spots with ashy center.	Fertigate nitrogen fertilizer. Burning of straw and stubbles after harvest. Seed treatment with Pseudomonas fluorescens @10g/kg of seed or 2.0 g/kg seed with Captan Spraying of Tricyclazole at 1g/lit of water or Carbendazim at 1.0 gm/ lit.3 to 4 sprays each at nursery, tillering stage and panicle emergence stage.
Rice tungro virus *(RTSV, RTBV)*	stunted growth with yellow or orange-yellow leaves. Discoloration of leaf starts from tip downwards. Affects panicle emergence. Most panicles sterile or partially filled grains	In epidemic areas follow rotation with pulses or oil seeds. In nursery use Carbofuran granules @ 1 kg a.i./ha to control vector population. Spray Mancozeb at 2.5 gm/lit.
Sheath Blight: *Rhizoctonia solani*	Lesions on leaf sheaths.	Soil application of P. fluorescens @ 2.5 kg/ha mixed with 50 kg FYM after 30 days of transplanting Foliar spraying of P. fluorescens @0.2% at boot leaf stage and 10 days late.

Insects and control measure

pest	Visual symptoms	Control Measures
Rice Stem Borer *Scirpophaga incertulus*	Deadhearts,White (grainless)heads wilted tillers,and weak plants.	Use of *Trichogramma japonicum* @5 card /ha on 30 & 37 days after planting Spray Monocrotophos or Quinalphos@1000ml / ha on 58,65,and 72 days after planting
Brown Plant hopper *Nilaparvata lugens*	Nymphs and adults congregate at the base of the plant above the water level (in wet rice) Affected plants dries up and gives appearance called "hopper burn".	Use optimum doses of nitrogenous fertilizers Apply Carbofuran 3G @17.5 kg/ha or Spray Imidacloprid 18.5@ 100 ml/ha.
Leaf folder (or) leaf roller *Cnaphalocrocis mainsails* *Marasmia patnalis*	Leaves fold longitudinally and larvae remains inside. Severe infestation leads to scorchy appearance resulting in crop loss	Clipping of the affected leaves Use optimum doses of nitrogenous fertilizers Release *Trichogramma chilonis* @ 1, 25,000/ ha thrice Spray carbaryl 50 WP 1 Kg.

Sustainable Rice Production

With drip- fertigation one achieves a sustainable method for rice production. Conservation of water, energy and fertilizer while enhancing yield by 1 to 1.5 ton per ha or more results in a Win-Win situation.

We produced 22% more rice using 66% less water; (water use in drip is 8 million liter per ha compared to flood irrigation where it is 23.75 million liter per ha) and using 52% less power for pumping water.

More rice is produced per unit input; Water productivity also improved to 500 to 1000 g/1000 liter from a figure of 120 to 290 g/1000 liter.

Table 4 : Sustainable use of water resources

Irrigation	Flood	Drip
Area, ha	1	1
Water Use, m^3/ha	23,750	8,000
Yield, kg/ha	7,000	8,500
WUE (Water Use Efficiency), kg/m^3	0.29	1.06
Selling Price of Rice, ₹/Kg	20	20
Income ₹/acre	1,40,000	1,70,000
Value Creation Efficiency, ₹/m^3	5.89	21.25

- Improving yields of rice is imperative to addressing growing food security challenges
- Improves water use efficiency of rice crop and the value of water. The value creation efficiency in flood method is only ₹ 5.89 per 1000 liter water compared to ₹ 21.25 per 1000 liter in drip.
- Smallholder farmers have an impact on biodiversity and ecosystems and are dependent on them
- At the same time, improving their practices and water productivity can help better preserve and protect natural resources
- Improves yield, income and reduces water, energy and fertilizer use of the follower crop after rice also.
- Thus drip-fertigation ensures water, energy and food security in a sustainable manner.

Jain Drip
More Crop Per Drop®

The Corporation

Global Presence: Jain Irrigation Systems Ltd. (JISL) derives its name from the pioneering work it did for the Micro Irrigation Industry in India. However, there is more to Jain Irrigation than Irrigation. Now Jain Irrigation is a diversified entity with turnover Rs. 8000 crore. We have a Pan- India & Global presence with 33 manufacturing bases spread over 4 continents. Our products are supplied to over 126 countries with a strong network of more than 11000 dealers and distributors worldwide.

Micro Irrigation: The Corporation has pioneered and raised a new Micro Irrigation industry in India and thereby helped harbinger a Second Green Revolution. The Micro-Irrigation Division manufactures a full range of precision-irrigation products and provides services from soil/topographical survey, engineering design, supply, installation and commissioning to agronomic support for millions of farmers worldwide. It is the only company in the world which has the largest basket of product and system solutions that can suit any climatic/topographical/crop conditions. The division's pool of over 1000 agronomists, irrigation engineers and technicians are well equipped to support the farmer customers across the globe. The company nurtures a sprawling 2300 acre Hi-Tech Agri Demonstration farm and a training Institute.

Plastic Piping: Presently, JISL is the largest producer in Asia of PVC and PE piping systems for all conceivable applications with pipes ranging from as small as 3 mm to 2500 mm in diameter and in pressure ratings ranging from 1.00 kg/cm² to 25 kg/cm². JISL has a production capacity of over 5,00,000 tonne per annum or 8000 km/day of plastic pipes. The Piping Division includes a variety of PVC and PE Fittings catering to irrigation needs of the farmers apart from the urban and rural infrastructure needs. The pipes are manufactured conforming to BIS, DIN, ISO, ASTM, TEC, Australian Standards as well as other customised specifications.

Plastic sheet division's globally marketed products help conserve forests by providing alternatives to wood in the home building market.

Biotechnology: The Tissue Culture Division produces Banana, Pomegranate, Strawberry, Guava, Coffee, Sugarcane plantlets and has established vast primary and secondary hardening facilities and R&D labs.

Green Energy: JISL Pioneered Solar water pumping systems in the country. Jain Solar water pumping system is a standalone system operating on power generated by Solar Photovoltaic panels which are also manufactured in house state-of-the-art facility. JISL has installed more than 20000 Solar Pumps. All these products are in harmony with the group's mission, "Leave This World Better Than You Found It".

Jain Green Energy division also offers Solar Thermal Water Heating Systems, Solar Photovoltaic, Bio-Gas and Bio-Energy alternate energy solutions.

Food Processing: Jain Farm Fresh Division processes tropical fruits such as Mango, Banana, Guava, Pomegranate into Purees, Concentrates & Juices. The company also has a Dehydration facility which dehydrates Onions & Vegetables. The Company has also launched a range of fruit pulp based retail FMCG Products under the brand of "Jain Frarm Fresh".

Agricultural and Fruit processing wastes from these processing plants are converted to Bio-Energy to partially run the plants. The residue after the Bio-Energy generation is used as an Organic Manure.

Turn-key Projects: JISL undertakes Integrated Agricultural Development Projects on Turn-Key basis from Concept to Commissioning with value added services. JISL offers cost effective, down-to-earth solutions for complex challenges backed by our core strength of global knowledge and experience combined with local man-power which is an ideal combination of technology, intelligence and common sense. Whatever be the nature of the project requirement, JISL can assure Total Turn-Key solutions and maximum value for the farmers. It can also undertake Watershed or Wasteland development projects. Such projects normally begins with selection of site, survey of the command area, identification of appropriate crops, designing of the suitable irrigation systems, determination of agronomic practices, use of other hi-tech agro inputs, providing on-going technical services & training and pre & post harvesting techniques, provide assistance for operation and maintenance of the systems. The Company has successfully executed large scale turn-key irrigation projects from conception to completion not only in India but also overseas.

Jain Irrigation offers following turn-key Solutions:

- Integrated irrigation solutions
- Integrated agricultural development projects
- Reuse of waste water for agriculture
- Dust suppression
- Lift & Gravity water pipelines
- 24x7 Water Supply
- High-tech Urban Utilities Solutions
- Effluent conveyance & disposal systems
- Gas distribution System
- Industrial fluid conveying systems, sewerage lines etc.
- Marine On-shore & Off-shore piping
- Relining and rehabilitation of existing pipelines
- Plumbing Systems
- Solar pumping systems
- Solar water heating projects

In a nutshell, the Corporation is the only 'one-stop shop' encompassing manufacturing and marketing of hi-tech agricultural solutions/systems and piping services as well as processing of agri produce. No wonder, it has distinguished itself as a leader in the domestic as well as global markets. The corporate product range improves productivity and adds value to the agri-sector. Conservation of scarce Natural resources, protection and improvement of the environment emerge as a blessed outcome. The reward has been over millions of smiling farmers and scores of customers in more than 126 countries.

Sustainability: Every business of JAINS, ensures to create shared value, nurtures the environment and contributes significantly to the Water, Food and Energy security of the World.

Crop yields depend on climate, soil and management and therefore can't be guaranteed by the company.

Jain Drip — More Crop Per Drop®

JAIN — Jain Irrigation Systems Ltd. — *Small Ideas. Big Revolutions.®*

More Crop per Drop

Jains Mobile App

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Precision Farming
COTTON
With Jain Technology™

Jain Irrigation Systems Ltd.
Small Ideas. Big Revolutions.®



Cotton Cultivation - Jain Technology™



Jain® Drip
More Crop Per Drop®


Cotton is one of the important plant fibre used since the beginning of civilization. India is growing cotton and manufacturing yarn and cloth from the very olden days. India has been an important exporter in cotton since when trading among countries started.

Cotton is *Gossypium* sp. belonging to Malvaceae family. The cultivated species; G. herbaceum and G. arboreum and G. hirsutum and G. barbedense.

Habit of the Crop:

Cotton is a perennial crop which can be grown continuously like trees. It stays evergreen in tropical conditions and produces continuously. However, all commercial production is grown as an annual crop which is planted every year, to maintain high yields, and to keep the insect population under check by destroying all plant residues after each growing season. **Management of soil fertility & irrigation water will play a major role** in increasing Cotton productivity.

Cotton Life Cycle:

The life cycle can be divided into 4 main stages:

1. Germination to first true leaf
2. First true leaf to first square
3. First square to opening of first flower
4. First flower to end of boll opening

Every stage of this cycle is affected by climate- temperature, evaporation, precipitation or irrigation etc. and the very complex interactions of these factors.

Accumulated heat units decide the duration of each growth stage and therefore the calendar time of each stage is different for different sowing dates (see Table 1). **Because of this the cultivation practices can not be standardized universally.**

Table 1 – Relation between sowing date and crop duration in Cotton. Duration of each growth stage of Cotton with different dates of sowing, an Example:

Date of Sowing	Intervals of plant growth and development from sowing date to;			
	True leaf	Square	Flower	Open boll
Apr-01	27	74	98	156
Apr-15	25	68	89	145
Apr-29	23	63	81	141
May-13	19	56	75	133
May-27	18	50	71	135

Sunshine is vital to cotton and areas with more than 50% cloud cover is not suitable for cotton production.

As for moisture availability cotton requires at least 500 mm of water to grow a crop of minimum acceptable yield. Yield level is a function of water supply at successive growth stages when other factors are optimum. **With the adoption of drip irrigation, yields can be doubled with actual water use halved.**

Soil type and management:

Cotton can grow in any soil type. However highly clayey and very sandy soils are not suitable for high yields. The management of drainage is critical in clayey soils to avoid water saturation and lack of oxygen. Cotton roots stop functioning when soil oxygen falls below 10%. In sandy soils shorter water holding duration makes frequent small irrigations a necessity . Poor drainage in clayey soils also results in K deficiency even when soil K is sufficient. **Actually with drip irrigation both these types of soils can be put for cotton cultivation.**

Crop rotation:

In drip irrigated situation using the same drip line a high value crop like vegetables like Tomato, Chilly, Capsicum (short duration), banana (long duration) etc. can be taken up as rotation crops.

Seedbed preparation:

Soil should be plowed to a depth of 30-40 cm. Once in 3-4 years a sub-soiler should be used to loosen up to a depth of 70 cm. After plowing or discing a harrow should run to make the soil level and friable without clods. **In drip irrigated cotton, seed-beds should not contain any clods that will obstruct moisture movement.**

Sowing can be done on flat bed, ridges or on raised broad beds. Ridge or bed system will allow rapid soil drainage in heavier clay situations and maintenance of optimum temperature for germination, which is in the range of 15 to 42 oC. **By practising drip irrigation soil crusting can be prevented which acts as a barrier for seedling emergence.**

Cotton varieties:

- For irrigated Cotton production varieties from G. hirsutum or hybrids of G. hirsutum X G. hirsutum or G. hirsuitum X G. barbedense are preferred for AP and southern states.
  DCH-32, Varalaxmi, Savita, Suvin, HB 224, MCU 5 are ideal for AP.
- For Mungari (May end sowing);
  Aravinda, Srisailam, Pandarpur Mundari.
- For Late Kharif (Sowing in August)
  Raghavendra, Jayadhar, Narasimha, MCU 5, and LRA 5166. NHH 44, Nhh 390, JKHY-1.

Seeds:

Certified seeds should only be used. 1 to 1.2 kg seed per acre is recommended. Seed should be treated with Thiram @ 2g/kg seed.

Plant Spacing and drip line alignment:

The recommended spacing for drip irrigated Cotton is as follows: For heavy soils it is 3' x 6'x 3' (3200 plants/acre) and for light soils it is 2'x 6'x 2' (5000 plants/acre) as paired row to optimize the drip system cost. Extra seeds after planting should be used to raise polybag seedlings for gap filling.

The above spacing considers high canopy Indian hybrids. If Puma based varieties or Hybrids, which have low canopies are used the spacing between plants can be reduced to 1'(2' x 6 x 1') or (3' x 6' x 1'). Here also the space between paired rows is not reduced because of the restriction imposed by the lateral spacing which is also fixed at 1.82 m.

Planting season:

Actually Cotton can be grown in all three seasons.

- Kharif (June-July),
- Rabi (Sept.- Oct.) and
- Summer (Jan-Feb).

Rabi and Summer crops will give high quality lint. In irrigated cotton planting date is crucial. In case of delayed planting, the crop suffers increased pest attack and loss in yield.

Timely sowing is critical for cotton:

Summer crop will usually have less pest problems. Still sowing should be early as the temperatures will exceed 42 ^{0}C at boll opening time if sowing is delayed.

- Kharif- Sowing before June 10.
- Rabi- Sowing before September 5
- Summer- Sowing before Jan 5.

Irrigation Management:

Drip method of irrigation is most suitable for Cotton:

If water application method is precise and regular, an average of 4mm daily irrigation is sufficient for cotton. This precision is achieved by adopting quality drip system. **If drip is utilized properly precision irrigation can result up to 2.4kg lint/acre/mm water used. i.e 120 days irrigation with average 4mm daily will give about a ton lint per acre,** provided manuring and fertigation are followed strictly as per schedule and an IPM approach is adopted for pest control.

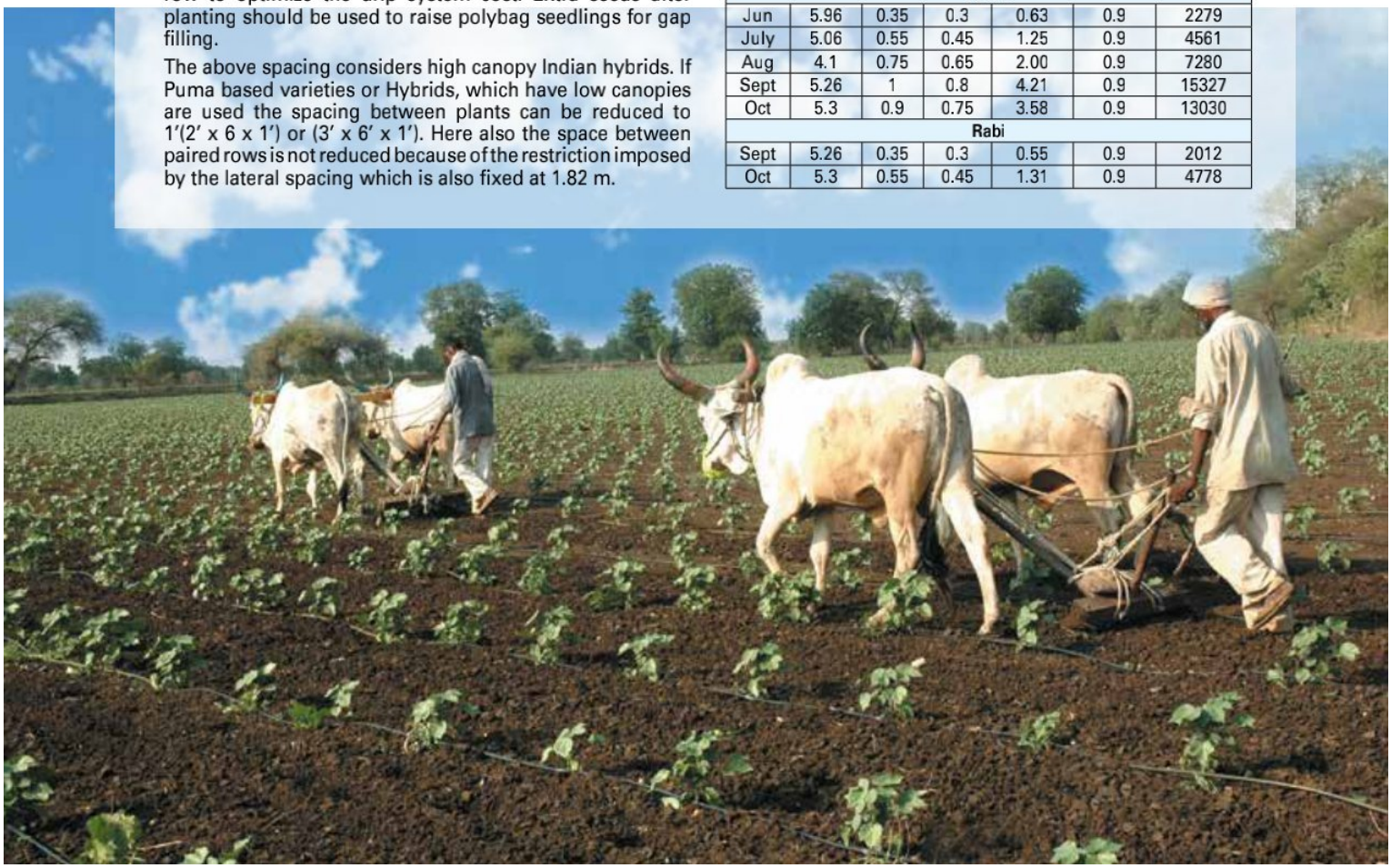
For seed germination the field should be kept just below field capacity by continuous operation of drip for 12-16 hours.

Irrigation Schedule:

As an example water requirement and irrigation requirement are worked out for one district using FAO data table for ETP and Crop factor.

Water requirement and irrigation schedule for drip irrigated Cotton:

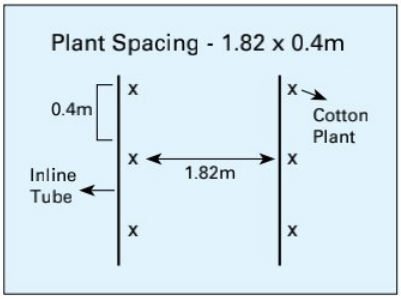
Season	Avg ETP mm/day	Crop Factor	Canopy Factor	Water requirement mm/acre	Irrigation Efficiency of Drip	Irrigation requirement l/acre/day
Kharif						
Jun	5.96	0.35	0.3	0.63	0.9	2279
July	5.06	0.55	0.45	1.25	0.9	4561
Aug	4.1	0.75	0.65	2.00	0.9	7280
Sept	5.26	1	0.8	4.21	0.9	15327
Oct	5.3	0.9	0.75	3.58	0.9	13030
Rabi						
Sept	5.26	0.35	0.3	0.55	0.9	2012
Oct	5.3	0.55	0.45	1.31	0.9	4778



Season	Avg ETP mm/day	Crop Factor	Canopy Factor	Water require-ment mm/acre	Irrigation Efficiency of Drip	Irrigation require-ment l/acre/day
Nov	4.63	0.75	0.6	2.08	0.9	7589
Dec	3.96	1	0.8	3.17	0.9	11539
Jan	4.35	0.9	0.75	2.94	0.9	10695
Summer						
Jan	5.26	0.35	0.3	0.55	0.9	2012
Feb	5.53	0.55	0.5	1.52	0.9	5539
Mar	6.54	0.75	0.7	3.43	0.9	12506
Apr	7.6	1	0.85	6.46	0.9	23529
May	8.26	0.9	0.8	5.95	0.9	21661

The rainfall events are very erratic and therefore not adjusted on a daily basis. **The general recommendation is that if rain fall exceeds 10mm in any one day suspend drip irrigation for the next 3 to 4 days.**

Drip layout and dripping schedule:



1. Lateral to Lateral spacing 1.82m
   Dripper spacing 0.40 m
2. Total lateral /acre 2230m
   Total no. drippers/acre 5575

Weeding and Interculture:

Timely weeding is essential as cotton growth will be affected by weeds. In a well prepared soil, use of drip irrigation will decrease weed germination as the wetted area is restricted. In the paired row system, the interspace between two pairs can be easily intercultivated by small implements.

Pre sowing soil incorporation of Basalin (Fluchloralin) @ 1.25-1.5 a. i. /ha is effective.

Apply Lasso (Alachlor) @ 1.5- 2.0 Kg a. i. /ha or Benthiocarb (Saturn) 2 1.5 kg a.i/ha or Pendamethlin (Stomp) 2 1.5- 2.0 kg a.i./ ha as pre-emergence spray.

Fertigation:

High yielding varieties of cotton require abundant quantities of nutrients. NPK and Mg are the major nutrients and Fe, B, S, and Zn are the microelements required by cotton.

Though the NPK doses are determined after a soil analysis, in general Cotton requires 50 kg N, 30 kg P, and 35 Kg of K per acre. But in high-tech cultivation the NPK can be varied based on the target yield to be achieved. Thus in drip irrigated crop N upto 120 Kg per acre; P up to 60 kg/acre; and K up to 100kg/acre when applied will improve the yield many fold.

Fertigation schedule:

1. For normal fertilizer rates 50N: 30P: 35K per acre (Urea 116 kg; SSP 188 kg and 60 kg MOP)

Apply all SSP as soil basal dressing before planting . Use Urea ad MOP for fertigation.

5-30 days	20 kg Urea	7 kg /wk/acre for 3 weeks
	12 kg MOP	4 kg/wk/acre for 3 weeks
31-60 days	60 kg Urea	15 Kg/wk/acre for 4 weeks
	15 kg MOP	3.75 kg/wk/acre for 4 weeks
61-100 days	36 Kg Urea	12kg /wk/acre for 3 weeks
	33 Kg MOP	6.6 kg/wk/acre for 5 weeks

2. For High-tech production use 120N:60P:100K per acre (Urea 280 kg; SSP 188 kg plus 58 kg Phosphoric Acid; and 167 kg MOP)

Apply all SSP as basal soil dose. Use Urea, Phosphoric acid and MOP for fertigation.

5-30 days	50 kg Urea	2kg /day/acre for 25 days
	20 kg MOP	1kg/day/acre for 20 days (10-30 days)
31-60 days	150 kg Urea	5kg/day/acre for 30 days
	50 kg MOP	1.7 kg/day/acre for 30 days
	45 kg H3PO4	1.5 kg/day/acre for 30 days
61-100 days	79 Kg urea	2kg/day/acre for 40 days
	97 kg MOP	
5-30 days	50 kg Urea	2kg /day/acre for 25 days
	20 kg MOP	1kg/day/acre for 20 days (10-30 days)
31-60 days	150 kg Urea	5kg/day/acre for 30 days
	50 kg MOP	1.7 kg/day/acre for 30 days
	45 kg H3PO4	1.5 kg/day/acre for 30 days
61-100 days	79 Kg urea	2kg/day/acre for 40 days
	97 kg MOP	2.4 kg/day/acre for 40 days
	13 kg H3PO4	1.3 kg/day/acre for the first 10 days.

Secondary and Micronutrients for Cotton production:

Addition of Ca, Mg, Iron , Boron and Zinc are required in locations where the soil shows deficiency of these minerals.

Pest and disease management:

Cotton production is often hampered by pests. Insect pests are more detrimental to cotton. The different diseases and insect pests and their control measures are listed in the following tables for ready reference and action in the field.

IPM measures for Cotton:

- Clean cultivation and destruction of crop residues (leaves, twigs etc.) before the onset of season.
- Plough deeply to expose the hibernating larve/pupae for predation.
- Practice early sowing that will help to escape the pest onslaught.

- Sun dry or hot water treatment of seeds up to 60 oC to kill any seed- borne larvae or fungi.
- Use tolerant variety of cotton.
- Control irrigation to reduce pest pressure. If drip is adopted it will help.
- Removal of reproductive parts (flower buds) during late season. Apply Chloroflurenol @ 1ml/l water to suppress formation of late flowers.
- Release egg parasitoids *Trichogramma chilonis* or larval parasitoids *Bracon gelechidae, B. greeni*, or *Chelonus pectinophorae.*
- Conserve the predators *Chrysoperla carnea* or *Scymnus sp.* or *Triphles tantilus* or release them in the fields.
- Use pheromone traps baited with insecticides to kill the pest.
- Apply bacterial formulations B.t.k. 21 kg/ha
- Do not use synthetic pyrethroids repeatedly.
- While spraying for sucking pests ensure that the spray reaches the lower side of the leaves.
- Do not grow Okra, Cucurbits, and solanaceous crops (Brinjal, Chilly etc,) near the cotton field.

Benefits of Drip irrigation for Cotton :

- Increases yield upto 100%
- Reduces water used for irrigation up to 55%
- Allows uniform high % germination
- Drip is suitable for any type of seedbed- flat, ridges and furrows and bed and furrow.
- Helps in early planting which is a pre-requisite for IPM
- Allows for a Summer cotton crop (high quality lint)
- Early and uniform maturity
- Allows the user to control vegetative growth by precision irrigation and fertigation and increase flowering and boll formation.
- Controls weed growth as water is applied only to the root zone of cotton.
- Creates opportunity for high value rotation crops

Dos:

- Ensure good drainage in the field.
- Cotton field should not have any shading from trees or other structures.
- Adopt drip irrigation for irrigation.
- Compulsorily go for crop rotation.
- Prepare seedbed to fine tilth for good aeration and infiltration.
- Compulsorily apply organic manure (FYM or Compost)@ 5t/acre and neem cake @ 1t/acre.
- Select high yielding, disease and pest tolerant hybrids.
- Prefer Rabi and Summer season for high-tech cultivation of cotton.
- Sow early in the season.
- Follow a planting pattern suitable for drip laying – Paired row method.
- Treat the seeds with fungicides before sowing.
- Irrigate with drip strictly following the schedule given by the engineer.
- Follow the drip system maintenance schedule given by the engineer.
- Compulsorily weed/ intercultivate, timely operation helps in crop growth.
- Follow fertigation schedule as given by the engineer.
- Follow the precautions while operating the drip system as explained by the engineer.
- Apply micronutrient as and when needed.
- Follow disease and pest control measures timely and effectively.
- Apply sprays in the evening or early morning only.
- Harvest on dry days. Store in dry cool place.

Don'ts:

- Don't over irrigate the crop at anytime except for germination.
- Don't cultivate co-host (Pigeon pea) for insects of cotton in or near the cotton field.
- For fertigation don't mix solid fertilizers and dissolve them together. Prepare individual solutions and mix them for application.
- Don't spray the crop under hot sunlight.
- Don't make a fire near cotton field with Drip system.
- Don't use the fertigation unit for bulky organic manure and fertilizers that are not soluble in water
- Don't add solid fertilizer from the bag directly to the fertilizer tank. Prepare solution separately and pour the solution to the fertilizer tank. Prepare solution only in plastic buckets. Don't use metal container.
- Don't stir the solution with naked unprotected hand. Use wooden spoon or stick.
- Don't heat the fertilizer solution to increase solubility.
- Don't pick cotton when it is humid.

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