4. Seed Production Technology

Recall a little ?

- Seed Technology is a branch of science which deals with the study of methods of improving genetic and physical characteristics of seed.
- The scientific seed production consists of various activities such as selection of seed source, production of crop, harvesting, processing, storage and distribution.
- Maintaining genetic purity of the seed is of utmost importance. The seed production must be carried out under standardised and well organized conditions.

4.1 PRINCIPLES OF SEED PRODUCTION

Pure seed of good quality is produced only under utmost care and by applying general principles of seed production. The general principles of seed production are broadly classified into two groups as genetic and agronomic principles.

4.1.1 Genetic principles :

Genetic principles are as follows:

1. Deterioration of varieties : Genetic purity of a variety can deteriorate due to several factors during production cycles. The important factors which are responsible for deterioration of genetic purity or trueness are.

a. Developmental variations : These variations are due to change in the environment for seed crops. When seed crop is grown under different conditions of soil, climate, elevations, etc., for too many consecutive generations, this variation may appear as differential growth responses. Therefore, crop should be grown in areas of their adaptation and growing seasons

b. Mechanical mixtures : There are different reasons responsible for the mechanical mixture of seed. The reasons and remedies for them are as given in table 4.1 :

c. Mutations : Mutation means sudden heritable change in the progeny. Mutation is not a major factor and in certain cases, it is even difficult to detect minor mutations.

d. Natural Crossing : It can be an important source of varietal deterioration in sexually propagated crops. The deterioration may be due to natural crossing with diseased plants, off types and undesirable types.

Can you recall?

- What is meant by variation?
- What is the significance of variation in plants?
- What are the kinds of variation?

Table 4.1 : Reasons and remedies for the mechanical mixtures

Reasons causing mechanical mixture of seed	Remedies
• Use of the same seed drill for sowing more than one variety.	• Cleaning of seed drill before sowing new varieties.
• Presence of volunteer plants in the seed field.	• Irrigating the field 3 weeks prior to sowing and deep ploughing.
• Cultivation of different varieties in adjacent field.	• Space isolation should be provided to seed plot.
• Use of threshing floor at a time for different varieties.	• Only one variety should be threshed at a time and threshing yard should be cleaned before next use.
• Use of combining or threshing equipment and gunny bags contaminated with the seeds of different varieties.	• Combining or threshing equipments should be cleaned before use. Gunny bags should be new or old gunny bags should be cleaned and fumigated before use.

e. Minor genetic variations : The varieties appearing phenotypically uniform and homogeneous at the time of release may consists of some minor genetic variations. The yield trials of lines propagated from plants of breeders seed in the case of self pollinated crop and proper precautions during the maintenance of nucleus and breeders seed of cross pollinated varieties are suggested to control these variations.

Remember this

Woody plants tend to have more genetic diversity than the vascular plants like grasses.

f. Selective influence of pest and diseases New crop varieties often are susceptible to newer pest and diseases and thus, cause deterioration. Seed production under clean and disease free conditions is important to overcome the influence of pest and diseases.

Do you know ?

Which precautions are taken for avoiding deterioration of genetic purity or trueness to its type during the seed production ?

g. Techniques of plant breeder : The genetical variations in the variety may occur due to inadequate evaluation of cytogenetic irregularities during the release of variety.

2. Maintenance of genetic purity during seed production :

During seed production, the genetic purity can be maintained by following measures.

a. Control of seed source : The seed to be used for seed production should be from approved authorities and appropriate class of seed.

b. Preceding crop requirements : This should be studied prior to the selection of land for avoiding contamination from volunteer plants and soil borne diseases.

c. Isolation : The isolation of seed crop is essential for avoiding contamination due to natural crossing from neighbour crop, off types and disease infection by wind, insects, etc. from neighbouring fields. It is also required during harvesting and post harvesting process to avoid-mechanical mixtures. The distance should be as per seed certification standards.

d. Roguing : The off type plants i.e., plants of same crop species showing different characteristics from those of the seed crop varieties, should be removed out of the seed fields and isolation area at different growth stages of seed crop. This procedure of removing off type plants is called as roguing. Regular supervision of seed field is necessary for the same.

e. Seed certification : Seeds certification is a legally sanctioned system for quality control of seed multiplication and production. Inspection of seed plot from seed certification agency is necessary to verify that seed crop is of requisite genetic purity and quality. Inspection of seed lot after harvesting and in processing plant is also necessary to verify quality of seed.

Try this

- Point out the importance of roguing and isolation distance in seed production.
- Obtain the information regarding the isolation distance to be kept for seed production of different crops.

f. Grow-out test : These are also done periodically to test genetic purity of variety grown and to ensure that they are being maintained in their true form. This is conducted by seed certification agency.

4.1.2 Agronomic Principles :

- **Selection of suitable Agro-climatic region** The variety proposed to be grown for producing seed should have suitable climate in respect of temperature, photoperiod, rainfall, wind velocity etc. In general, regions of moderate rainfall, temperature and humidity are suitable for

seed production. Most crops require ample sunshine and moderate temperature for flowering and pollination. The seed plot should have suitable soil structure and fertility characteristics as required by a crop. It should be free from volunteer plants and seed of weed and other crop plants.

- **Isolation :** The isolation distance from neighboring field crop should be as per requirement of certification standards. In certain crops as in hybrid maize time isolation is useful. In nucleus and breeder seed production, the isolation is provided by enclosing plant or group of plants in cages or enclosing individual flowers by bags. Isolation is also required during harvesting, threshing and seed handling to avoid mechanical mixtures.
- **Land preparation :** Good land preparation is essential for proper crop growth and irrigation management.
- **Variety :** The variety should suit the prevailing agro-climatic conditions. It should be high yielder and possess characteristics such as disease resistance, grain quality, etc.

Try this

- Select and list the crops which will fit to your agro-climatic conditions.
- Select and list the varieties suitable for your agro-climatic conditions.

- **Seed :** While buying the seed it should be seen that tag and seals of bags are intact and its validity period or expiry date is not over. The seed should be of appropriate class.
- **Seed treatment :** The seed should be treated to prevent the attack of certain pest and diseases, improving germination, increasing nitrogen fixation by legumes, breaking seed dormancy etc.
- **Time of sowing :** The seed crop should be sown at its normal time. However, certain changes in time of sowing need to be done for synchronization of parents and for preventing the incidence of certain pest and diseases. There should be sufficient moisture in the soil at the time of sowing, which will be helpful for proper germination.
- **Seed rate :** For seed crop lower seed rate is desirable for having convenience in roguing and inspection of seed crop.
- **Method of sowing :** The seed crop is generally sown in rows by mechanical seed drill. Broadcasting is followed for thickly sown crops. The seed is sown to a proper depth by mechanical drilling. The seed drill should be cleaned before use. The spacing between two rows should be sufficient to allow proper aeration and penetration of sunlight. For hybrid seed production female and male parent lines are sown in the proportion of 4:2 to 6:2.
- **Depth of sowing :** It should be such that it would allow proper emergence of crop. It depends on size of seed and type of soil. Small seeded varieties are sown shallow, but bold seeded can be sown little deeper. The depth may be kept more in sandy soils than in to clay soils.
- **Roguing :** It is usually done at vegetative or pre flowering stage, flowering and maturity stage. In some crops roguing and sorting of ear heads is necessary to remove off coloured, diseased or malformed ear heads. Adequate and timely roguing is important to prevent all kinds of contamination and it is the responsibility of seed producer.
- **Supplementary pollination :** Artificial or supplementary pollination is necessary for the crops which are cross pollinated by insects. Honey bees are kept in hives in the vicinity of seed crop. In sunflower crop two adjacent flower heads are rubbed on each other or cotton cloth is tied on hand palm and moved in clock wise direction on flower surface. This results in increasing the pollination and thereby seed setting.
- **Weed control :** Production of high quality and quantity of seed depends on effective control of weeds. Weeds reduces yield and

also cause contamination by sheltering diseases and by their mixture in the crop seed. Hand weeding, hoeings and use of herbicides are the methods of weed control. Proper crop rotation and use of clean fallow land for seed production also helps in checking weed growth.

- **Irrigation :** Excessive moisture conditions and prolonged drought will adversely affect seed production. Soil type, season and water requirement of crop decides the total quantity of irrigation and time interval between two irrigation turns. A critical stage of growth is also a criterion for scheduling irrigation.
- **Nutrition :** Proper plant nutrition is essential for good yields and better quality of seed. Along with primary nutrients like nitrogen, phosphorous and potassium certain secondary and micronutrients should be applied in proper quantities and at right stage of crop growth.
- **Insects-pest and disease control :** Effective control of all pest and diseases is essential to produce healthy crop. They should be controlled by using suitable insecticides and fungicides for seed treatment and for spraying on crop. Roguing of diseased plants and ear heads is also necessary.
- **Time of harvesting :** The exact time of harvesting is important in getting maximum seed yield with better quality. The optimum time is when the seed is fully mature and when the seed is easily harvested and cleaned with minimum losses. The optimum moisture content is a good indication of the right time of harvesting. The period of time, for which the seed crop will remain proper for harvesting varies with climatic conditions and the nature of the crop.
- **Method of harvesting :** Harvesting and threshing of seed crop is done manually by hand or by using machines (combiners). Proper care should be taken to avoid mechanical injury to the seed and to avoid mechanical mixtures in seed at the time of harvesting and threshing.
- **Drying of seed :** Drying of seed to safe moisture limit is essential to keep the viability and vigour of seed intact. Care should be taken to avoid mechanical mixing and to keep the identity of seed lot intact.
- **Seed storage :** For short period storage, seed is kept in gunny bags or sacks in godowns. Each bag should be labelled with necessary particulars. Bags should stacked on wooden pallets. The storage structure should be cool, dry and clean. Proper preventive control measures should be taken in godowns against storage pest and diseases.

Try this

Visit nearby seed warehouse to know about :

- The methods of seed storage.
- The methods of insect and pest control in seed storage.
- The methods of moisture and temperature control in seed ware house.

- **Information of variety :** Detailed information regarding pedigree and quality of seed is given on the label attached to the seed bag.

4.2 HYBRID SEED PRODUCTION OF JOWAR

Botanical name – *Sorghum bicolor*
Family – Gramineae
Origin – North East Africa and India

Fig. 4.1 Jowar earhead

Fig. 4.2 Jowar crop

Can you recall?

Jowar is one of the important cereals. It ranks fourth in the world after wheat, rice and maize and third in India as far as area and production is concerned. In India highest area under *Jowar* is in Maharashtra. Its grains are the basic food in India.

4.2.1 Uses :

Jowar is cereal crop. Its grain is eaten in the form of unleavened bread that is roti or *Bhakri.* The grain is also consumed in the form of pop grain and hurda. Grain itself is used as cattle feed, poultry ration, etc. Grain is used in the industries for the extraction of starch, oil, glucose, ethyl alcohol and such other products. The grain is also boiled and consumed like rice. *Jowar* stem with leaves (green fodder, dry fodder i.e. *kadbi*) is used as animal feed. The sweet sorghum can also be used for preparing of jaggery and sugar. Grains have ritual value and used in various ceremonies.

Use your brain power

Why jawar plants are not fed to cattles before 50% flowers stage of crop ?

4.2.2 Climate :

Jowar is a tropical crop. It is cultivated throughout the year in tropics. *Jowar* is also cultivated in temperate region as a summer crop provided that the temperature is sufficiently high. About 7° to 10°C temperature is necessary for germination. The optimum range of temperature for growth is 27° to 32°C. It does not tolerate frost. *Jowar* is well adapted to semi arid region with annual rainfall of 350 to 400 mm. In India it is grown in the regions receiving an annual rainfall of about. 400 to 1000 mm. *Jowar* is drought resistant crop.

4.2.3 Method (principle) :

Hybrid seed of *Jowar* is produced by using cytoplasmic genetic male sterility. This involves crossing of male sterile line i.e. Line 'A' (seed parent) with the restorer line (pollinator) i.e. line 'R'.

The steps involved in hybrid seed production of *jowar* are :-

- Maintenance of parental lines namely male sterile line (line A) carrying cytoplasmic-genetic male sterility; maintainer line (line B) male fertile, non pollen restoring and restorer line (line R).
- Production of hybrid seed i.e., crossing of male sterile line (line A) with restorer line (line R).

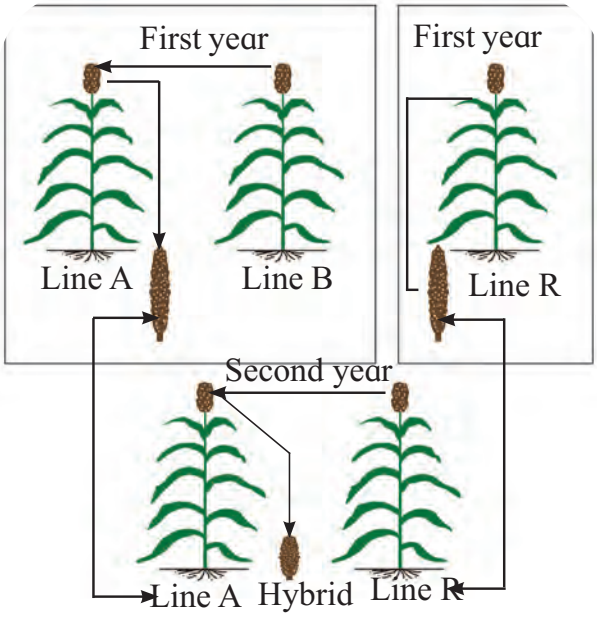


Fig 4.3 Steps in hybrid seed production of *jowar*

4.2.4 Maintenance of Male sterile lines (Line 'A') :

a. Principle : The male sterile line (Line A) carries male sterility due to cytoplasmic genetic factors. It is maintained by crossing with male fertile, non-pollen restoring strain (Line B) which is sister strain of Line A is an isolated plot.

Remember this

Line B is similar to Line A in all respects except that Line B is pollen fertile, whereas, Line A is pollen sterile. Maintenance of parental lines is called as foundation seed production and production of hybrid seed is known as certified seed production.

b. Land requirements : Land to be used for seed production should be free from volunteer plants. There should not be Johnson grass in the seed field as well as within the isolation distance. Medium to deep black soil should be selected for sowing of this lines. The land should be well drained and fertile.

c. Isolation requirements : *Jowar* is self pollinated crop, but cross pollination up to 8 to 10 percent may also occur. The distance of isolation is as shown in the following table.

Table 4.2 Isolation distance of *Jowar*

Sr. No.	Contaminant	Minimum distance (meters) foundation seed
1	Fields of other varieties of grain and dual purpose sorghum and the same variety not confirming to varietal purity	300
2	Johnson grass (*sorghum halepense)*	400
3	Forage sorghum	400

d. Land preparation : The land is prepared to fine tilth by one deep ploughing, three to four harrowing and levelling. The land should be free from weeds.

e. Sowing season and time : In Maharashtra generally crop is sown in *Kharif* season and time of sowing is from fourth week of June to first week of July. If crop is taken in *Rabi* season the time of sowing may be mid September (mostly in South India)

f. Source of Seed : Obtain nucleus / breeders seed from a source approved by the seed certification agency.

g. Sowing Method : Maintenance of Line A consists of sowing of two parents. The female parent (Male sterile line – Line A) and male parent (pollinator parent – Line B) are sown in the proportion of 4:2 row. Four to six border rows of male parent are sown all around the field. The Border rows should be distinctly separated from crossing block by at least one meter.

h. Spacing : Row to Row spacing should be 75 cm and plant to plant is 7.5 cm

i. Seed rate :

Female parent (Line A) – 8 kg / ha.

Male parent (Line B) – 4 kg / ha.

j. Roguing : Following precautions should be taken while roguing.

1. Start roguing before off types, volunteers and pollen shedders in female rows start shedding pollen.
2. All rogues invariably be pulled out, to prevent regrowth.
3. All out crosses (identified by height) should be removed as they soon as appear.
4. The plants which are out of place i.e., plants in between the rows, male plant in female rows and also female plant in male rows should be removed.
5. Proper attention should be given at flowering time. The roguing should be done every day to remove pollen shedding types in the seed rows.
6. Plants of other *Jowar* variety and Johnson-grass, sudan grass should be removed within isolation distance.
7. The diseased heads affected by smut should removed.
8. Roguing should also be done thoroughly before harvesting and after the seed has matured to the stage when true plant and seed characters appear.

k. Fertilizer :

i. Rainfed area

First dose Nitrogen and phosphorus are added each at 40 kg/ha. and potash if recommended at the rate of 35 kg/ha. at the time of sowing.

Second dose Nitrogen is added at the rate of 40 to 60 kg/ha. about 30 days after sowing.

Try this

Collect the information of *jowar* hybrids cultivated in your region. Visit such farm and observe the cultivation practices

ii. Irrigated area

First dose Nitrogen @ 60kg, phosphorus 50kg/ha. and if recommended potash 40kg/ha. is added at the time of sowing.

Second dose Nitrogen is added @ of 60 to 70 kg/ ha. about 30 days after sowing.

l. Irrigation : In *kharif* season first irrigation is given as pre-sowing irrigation and in the case of long dry spell one or two protective irrigations are given as required. If grown in *rabi* season four to five irrigations are given at an interval of 10 to 15 days. The critical stages of *Jowar* growth for irrigation are

1. Seedling
2. Grand growth stage
3. Flag leaf stage
4. Flowering
5. Grain development

m. Inter-cultivation : The weed infestation is more during the period of 15 to 35 days after sowing. About 2 to 3 hoeing and one hand weeding in between them are given to control weed. These operations are also helpful in loosening the soil and improving soil aeration. The inter-culture operations should not be more than 4 to 5 cm deep. Pre-emergence spraying of atrazine (atrataf) at 0.5 kg active ingredient per hectare or propazine at 1 kg chemical (50 per cent wettable powder) in 1000 liters of water can also be applied for controlling weeds.

n. Plant protection : It is the same as given in certified (hybrid) seed production.

o. Harvesting : Male rows are usually harvested first and its produce is kept separate to avoid mixture at later stages. The female rows are harvested, when fully ripe. The harvested heads should be sorted out to remove diseased or undesirable heads. The heads are dried for a week before threshing. Threshing can be done by threshers. Seed should be dried to 10 percent moisture content before storage.

4.2.5 Maintenance of Restorer Line (Line R)

The seed of restorer line (Line R) is produced in an isolated field. The cultural practices are as follows :

Preparation of land, sowing season and time fertilizer, irrigation and intercultural operations are same as in the case of maintenance of line 'A'

a. Method of sowing : The crop is sown in rows. The depth of sowing should be 3 to 4 cm.

b. Spacing : 1. Row to Row - 45 cm

2. Plant to plant - 15 cm

c. Seed rate : 12 to 15 kg / ha.

d. Plant protection : The information is same as given in hybrid (certified) seed production.

e. Roguing : Rogue out off types and volunteer plants before they begin to shed pollen. The plants usually should be pulled out to prevent regrowth. Rogue out all other plants such as Johnnson grass, forage plants and Sudan grass. The diseased plants are also removed from time to time as required.

f. Harvesting : The crop must be fully matured. The harvested heads should be sorted out to remove diseased and undesirable heads from heap. The heads are dried and threshed by threshers. Seed is dried to 10 per cent moisture content before storage.

4.2.6 Production of Hybrid Jowar Seed (Line A x Line R)

Hybrid seed is produced by crossing male sterile line (Line A) with restorer line (line R) in an isolated field.

a. Land requirement : Sorghum prefers medium deep to deep black soils. Land to be used for seed production should be fertile and well drained. It should be free from off types and volunteer plants. The previous crop should not be the other variety of same crop. Land should be free from Johnson grass and other contaminants.

b. Isolation requirements : The isolation distance for fields of other varieties of grain, dual purpose sorghum and same hybrid not confirming varietal purity requirements of certification is 200 meters. Isolation distance for fields of other hybrids having same male parent should be 5 metres. The seed field should be isolated by 400 metres from fields of forage sorghum and Johnson grass.

c. Cultural practices :

i. Preparatory tillage

The land is prepared by deep ploughing,

3 to 4 harrowings and levelling.

ii. Sowing season and time The *Jowar* seed crop is preferably sown in *kharif* season during the month of June to July.

iii. Synchronization of male and female parent

For achieving perfect synchronization in flowering of parental lines, staggered sowing based on difference in blooming time and hardening treatment for late parent to promote germination, etc., are recommended. Generally, male parent is sown 4-6 days earlier than female parent.

iv. Sowing method (ratio) :

Usually four rows of female parent and two rows of male parent are sown alternately. About 4 to 6 rows of male parent are sown all around the field as border rows to prevent out crossing and to supply ample pollen grains to seed plant. At both the ends of male rows 3-4 seed of dhaincha or sannhemp are dibbled for identifying male parent.

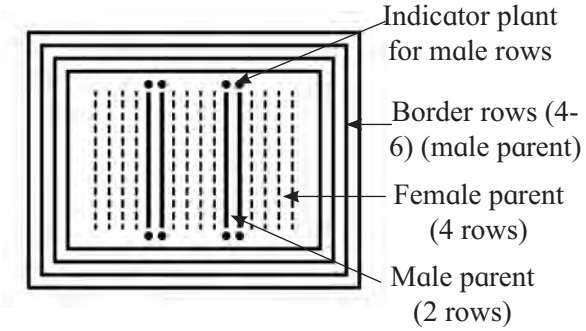


Fig. 4.4 Sowing ratio (Sowing plan) for hybrid seed production of *Jowar* (Line A x Line R)

v. Spacing

The recommended spacing between rows is 75 to 90 cm. The crop may be thinned to retain 7.5 cm distance between two plants in a row.

vi. Seed source

Foundation seed of line 'A' and Line 'R' should be obtained from the source recommended by the seed certification agency.

vii. Seed rate

It may be 8 kg/ha. for female parent and 4 kg/ ha. for male parent.

viii. Hybrids and their parents

	A (Female)		R (Male)
1) CSH-1	CK 60 A	X	IS-84
2) CSH-2	CK 60 A	X	IS-3691
3) CSH-3	MS2219 A	X	IS-3691
4) CSH-4	MS1036 A	X	IS-3924
5) CSH-5	MS2077 A	X	CS-3541
6) CSH-7R	MS-36A	X	CS-168
7) CSH-8R	MS-36A	X	PD-3-1-11
8) CSH-9	MS-296 A	X	CS-3541
9) CSH-16	MS-27A	X	CS - 43

ix. Roguing

It is similar to that for maintenance of male sterile line (Line A).

d. Pest Control

i. Stem borer

Larva initially feed on leaf whorls and later on bore into the stem and feed on inner material. Infected plant dries up.

Control measures

Removal and destruction of dead hearts (infected plants). Collection and destruction of stubbles of previous crop are the effective control measures against stem borer. Spraying the crop with chloropyriphos is also recommended.

ii. Ear head midge or midge fly

The maggot feed on the ovary making it dry. Grain formation may not take place in such dry ovaries.

Control measures

Dusting the crop with melathion 5% D.P. @ 20 kg/ha. and zonal sowing of crop, that is sowing of crop at a time by forming the group of villages has also been proved effective. Spraying the crop with Quinalphos or chloropyriphos may also be followed.

iii. Shoot fly The maggots feed on the growing tip of the plant. As a result of which main shoot stops growing and too many lateral tillers (shoots) arise from the base of infected plants. THese tillers are non-productive.

Can you tell ?

Whether the practice of Integrated Pest Management is possible in hybrid seed production of *Jowar*.

Control measures Drilling in soil 10% phorate or thimet granules @ 15-16kg ha. is useful preventive measure. Spraying of 25% Quinophos 25% EC is also done against this pest.

iv. Aphids Aphids suck up the sap from the leaves and other tender plant parts and interfere with the process of photosynthesis .

Control measures Drilling in soil 10% phorate @ 15 - 16 kg/ha. or spraying the crop with dimethoate 30% EC Imidacloprid 17.8 % SL is recommended.

v. Army worm It feeds on the leaves starting from margin towards the midrib.

Control measures Spraying the crop with Quinalphos, or chloropyriphos are the control measures.

e. Disease Control

i. Grain smut It is a fungal disease. Grains are replaced by elongated cylindrical structures, which are covered by black powdery mass of fungal spores.

Control measures Seed treatment with 300 mesh fine sulphar @ 4 to 6 g/kg seed has been proved effective.

Fig. 4.5 Grain smut

ii. Loose smut It is also a fungal disease. Grains are covered by loose-black powdery mass of fungal spores.

Control measures Seed treatment with 300 mesh fine sulphur @ 4 to 6 g/kg seed is the effective control measure.

iii. Downy mildew It is a fungal disease. Infected plants turn pale yellow. Lower side of the leaves show whitish fungal growth. The plants remain stunted and bear no ear - heads.

Control measures Proper crop cultivation, removal and destruction of infected plants and spraying the crop with mancozeb are the suggested control measures.

Fig. 4.6 Downy mildew

iv. Striga or witch weed (parasite) It is a root parasite and locally known as *Agya* or *talap*. With the help of special penetrating organ known as 'haustoria', it makes connection with *Jowar* xylem and gets water, minerals and manufactures its own food.

Control measures Spraying the crop with dicotox @ 720 g to 1 kg in 500 Lit water 2-3 times at an interval of 15 days has been recommended.

f. Harvesting : Initially male rows are harvested any time after flowering to avoid admixture and later on after maturity the female rows are harvested to collect hybrid seed. The ear-heads are then sorted out to remove diseased, unwanted ear-heads from the heap. The normal ear- heads are then dried for a week and threshed by using threshing machine. The seed is dried up to 10 per cent moisture content and stored.

Seed yield The average seed yield is 4 to 6 q/ha. However, it may be much higher under favourable conditions.

4.3 HYBRID SEED PRODUCTION OF COTTON

Botanical name *Gossypium species.*

Fig. 4.7 Cotton bolls

Fig. 4.8 Cotton green bolls

There are four cultivated species in cotton as stated below.

1. *Gossypium arboreum* - Known as *deshi* or old world cotton.
2. *Gossypium herbaceum* - It is also known as deshi or old world cotton.
3. *Gossypium hirsutum* - Referred as American or New world cotton.
4. *Gossypium barbadense* - Called as Egyptian or New world cotton.

Family : Malvaceae

Origin :

There are two different centers of origin

1. Old world - India, Indochina, Tropical Africa
2. New world - Maxico or Central America

4.3.1 Economic importance / uses :

Cotton is the most important fibre as well as cash crop in the world. Cotton is mainly grown for manufacturing cloth. Cotton seed contains considerable amount of oil, protein, carbohydrates and certain vitamins as well as minerals. Cotton seed cake is used as concentrates for cattle. Cotton oil is used for preparing vegetable ghee, soaps, explosives, cosmetics, etc. Cotton linters have many uses such as dressing or absorbent cotton, automobile and furniture padding, etc.

4.3.2 Method (principle) : Hybrid seed production in cotton is done by individual bud emasculation of female parent and pollination of same by dusting pollen from desired male parent manually. The technique and cultural practices are described below.

4.3.3 Climate : Cotton is a tropical region crop, but can be grown in subtropical region. Cotton favours warm climate. Optimum temperature for germination is 32°C to 34°C. Vegetative growth is well at temperature range 21-27°C temperature. For fruiting and boll development slightly higher temperature ranging from 27°C to 31°C is required. Deshi cotton can tolerate higher temperature. It does not tolerate continuous rain or long dry spell. Rainfed cotton can be grown in regions receiving

500-1200 mm rainfall. Well distributed rain fall of 900-1000 mm particularly during vegetative growth is beneficial. Cloudy and frosty weather conditions are harmful.

Remember this

- Cotton is known as king of fibres.
- The word cotton is derived from Arabic word *qutun* or *kutun*.
- India is the third largest cotton producer in the world

4.3.4 Land requirement : The land to be used for hybrid seed production should be medium deep to deep black, fertile and well drained. It should be free from volunteer plants. The sub-surface should not be hard, free from layer of carbonates.

4.3.5 Isolation : Cotton is often cross pollinated crop. Average cross pollination is 5 to 25%. However in some species it may be upto 50%. In hybrid cotton seed production under controlled emasculation and pollination the isolation distance of 5 m is provided all around the seed plot to avoid mechanical mixture.

4.3.6 Time of sowing : The cotton crop is sown about one week or more earlier than the usual date of on set of monsoon. Irrigated crop can be sown in the month of April.

4.3.7 Land preparation : Land is prepared by giving one deep ploughing, 2 to 3 harrowings and levelling.

4.3.8 Planting ratio : The area under female and male parent should be 4:1 or 5:1. Approximately first 4/5th of the total rows are used for sowing female parent and remaining 1/5th rows for male parent. The sowing of male parent is done in 2 to 3 installments so that pollens are available for staggered period of time.

4.3.9 Spacing : Row to Row distance for both male and female should be 150 cm. The plant to plant distance may be 100 cm in female rows and 50 cm in male rows. This may vary with the growth habit of parents used for crossing.

4.3.10 Seed source : Foundation seed of male and female parents should be obtained from the source approved by seed certification agency.

4.3.11 Seed rate : The seed rate may be 3.75 kg / ha. for female parent and 2.5 kg / ha. for male parent.

4.3.12 Seed treatment :

i. Delinting is the procedure of removing fuzz portion from the seed. It is done by rubbing the seed with mud or paste of soil with fresh cow-dung or by using concentrated sulphuric acid.

ii. Seed of deshi and American varieties are soaked in water for 2-3 hours and 4 to 6 hours, respectively, for enhancing the germination.

iii. Cotton seed is treated with 1% organo-mercurial compounds for preventing attack of fungal diseases.

iv. Seed treatment with *Trichoderma viride* @ 4 g along with thirum @ 3g/kg seed can be given to reduce the attack of wilt.

4.3.13 Crossing programme : It includes emasculation and pollination as stated - below.

1. Emasculation : It is the process of artificial removal of male reproductive organ (Androecium) from bisexual flower without disturbing female reproductive organ (Gynoecium). Initially with the thumbnail whole corolla and androecium are removed. This procedure is started one week after flower bud initiation. It is done each day from 2.00 to 6.00 P.M. or early in the morning before 7.30 AM. on the same day of pollination. The emasculated bud is then covered by butter paper bag or straw tube.

Fig. 4.9a. Emasculation in cotton

2. Pollination : It is the procedure of artificial transfer of pollen grains from desired protected flower of male parent to the stigma of emasculated female flower. It is done in the morning between 9.00 A.M.to 1.00 P.M. After pollination the female flower bud is covered by different coloured butter paper bag or straw tube. For easy identification a thread is tied to the pedicel of pollinated bud. The crossing programme is closed after eleventh week.

Emasculation and pollination of all the buds appearing in the first seven weeks of reproductive phase is essential for better development of bolls and good seed setting.

Fig. 4.9b. Pollination in cotton

4.3.14 Fertilization : At the time of land preparation 15-25 tones/ha. of FYM should added before last harrowing. Apply 50 kg nitrogen, 50 kg phosphorus and 50 kg potash per hectare as a basal dose. Top dress twice at the rate of 25 kg nitrogen per hectare after sixty days and again at ninety days from planting. Foliar sprays at the rate of 20 g of urea or 15 g of DAP per litre of spray may be given during the boll development period, at an interval of 10 days.

4.3.15 Irrigation : As per soil condition and climate, irrigate the crop once in 15-20 days. Heavy irrigation during flowering period should be avoided. For irrigation system of furrow irrigation should be adopted. Square initiation to peak flowering stage is considered most critical for irrigation. In rainy season crop should be irrigated during the periods of long dry spell.

4.3.16 Roguing :

All off-types, diseased plants from seed field area should be removed at seedling stage, square initiation stage and flowering stage

Remember this

- Topping of plant is done to prevent abnormal plant growth and to enhance fruiting branches.
- Light irrigation is given during crossing programme as per requirement.

4.3.17 Harvesting (picking) :

Mature bolls are picked after their full opening and collected in the baskets. Middle pickings are good quality for seed production In second sorting they are again verified and dried for one to two days, and supplied to the authorized ginning unit. Precautions need to be taken to avoid mechanical mixtures during picking and further handling till it is handed over to processing plant.

[Seed yield: Average yield of hybrid seed cotton crop is 1000-1500 kg/ha.]

Hybrids and their parents

Hybrids	A (Female parent)	X	R (Male parent)
1. H4	G-67	X	Americal nectariless
2. Varlaxmi	Laxmi	X	SB 289-E
3. Savitri	Koparaon-203	X	SB 1085-6
4. Godavari	Buri nectariless	X	MCU-5
5. NHH-44	BN-1	X	AC-738
6. DCS-32	DS-28	X	SB -425
7. PKV DH.1	GAK-423	X	HD-110-151
8. PKV Hy.2	AK-32	X	DHY-286-1
9. PKV HY.4	CAK – 23 A	X	AKH-7 R
10. PKV Hy.5	CAK – 53 A	X	AKH-2 R

4.3.18 Plant protection

I. Insects-pests

Insects-pest affecting cotton crop are classified as follows:

1. Insects-pest affecting crop before flowering

Aphids, jassids, thrips and white flies are common in this group. All these are sucking pest which suck the sap from leaves causing yellowing, curling or crinkling resulting in to stunted plant growth.

Control measures

Sl. No.	Name of pest	Control measures
1.	Aphids/ Jassids	Spray Immidacloprid 2 ml /litre of water, acephate 2 g/litre of water
2.	Thrips	Spray Fipronil 3 ml/ litre of water or thiomethoxon 0.5 g/litre of water
3.	White fly	Spraying of Acetamiprid 1 g/litre of water. Spray 5% Neem Seed kernel extract (NSKE)

2. Insects-pest affecting crop after it has commenced producing buds, flowers and bolls.

The important examples of this group are pink bollworm, spotted boll worm and American boll worm.

i. The nature of damage caused by **spotted boll worm** includes shedding of squares and bolls, holes on bolls and rotting of bolls.

ii. The **pink-boll worm** cause shedding of fruiting sqneres, discolouration of lint, holes on bolls etc.

iii. **American boll worm** (*Heliothis*) cause damage to squares, flowers and bolls. Holes appear on bolls.

iv. **Red cotton bug-** Nymphs and adults suck the sap from the buds, flowers and bolls and tinge the lint.

v. **Dusky cotton bug-** Nymphs and adults feed on the sap of premature and tinge the lint.

Control measures

i. All the bollworms can be controlled by using insecticides like acephate 75 SP, thiodecarb 75 WP, chloropyriphos 20 EC, spray spinocide @ 3.5 m*l*/10 lit of water etc

ii. Both the bugs can be controlled by spraying the crop with monochrotophos or quinolphos.

Try this

Collect important insects-pest and specimens of disesase affecting cotton crop, label them along with their control measures.

II. Diseases

1.Wilt

Symptoms :

i. It is soil and seed borne fungal disease.

ii. It consists of yellowing of leaves and gradual drooping and withering of a particular branch or entire plant.

iii. Vascular tissues turn brown.

Control measures :

i. Use of resistant varieties and proper crop rotation practices are the preventive measures.

ii. Seed treatment with organo mercurial fungicides like thirum along with *trichoderma viride* formulation is also effective.

2. Root rot :

Symptoms :

characteristic symptoms are sudden wilting of plant, rotting of roots and shredding of bark.

Control measures :

i. Seed treatment with benomyl or carbendazim @ 2.5 g/kg seed.

ii. Intercropping with moth bean (*matki*) is also effective against root rot.

3. Anthracnose :

Symptoms :

i. It is a fungal disease.

ii. Symptoms are characterized by rotting of bolls and seedling blight.

Fig. 4.10 Anthracnose

Control measures :

Seed treatment with 1% organo mercurial compounds and spraying the crop with copper compound are the recommended control measures.

4. Dahiya :

Symptoms :

i. This is common on deshi varieties.

ii. The older leaves show whitish fungal growth on their lower side.

iii. There is premature shedding of affected leaves.

Control measures :

The recommended control measures are growing of resistant varieties and dusting the crop with sulphur.

Fig. 4.11 Dahiya

5. Black arm :

Symptoms :

i. This is soil, seed and air borne serious bacterial disease of American types.

ii. Bacteria attack all aerial plant parts.

iii. Angular water soaked spots which are later on turn brown appear on leaves.

iv. It also causes rotting of bolls and seedling blight.

Fig. 4.12 Black arm

Control measures :

Treat the seed with streptomycin or vitavax, keep the campaign clean and practice proper crop rotation.

6. Leaf spots :

Symptoms :

i. *Helminthosporium* spots are light brown, circular with holes at the centre at later stage.

ii. *Alternaria* spots are papery, rusty brown of irregualr shape and size.

iii. *Cercospora* leaf spots are small, irregular with purple border and white centre.

Control measures :

Spray the crop with zineb, Copper oxychloride, etc.

Fig. 4.13 Leaf spots

Exercise

Q. 1 Answer the following questions.

A. Select appropriate alternative and complete the following statements.

1. General principles of seed production are broadly classified as genetic and ---------- principles.
   a. agronomic b. physical
   c. chemical d. biological
2. The parents of H4 are --------
   a. G-67 and American nectariless
   b. BN-1 and AC-738
   c. AK-32 and CS-2
   d. laxmi and BN-1
3. Hybrid Jowar seed is produced by using -------- male sterility.
   a. genetic b. cytoplasmic
   c. cytoplasmic-genetic
   d. none of these
4. *Sorghum bicolor* is the botanical name of -------- crop.
   a. Jowar b. bajra
   c. wheat d. cotton
5. Zonal sowing of crop is recommended to control -------- pest of jowar.
   a. midge fly b. shoot fly
   c. aphid d. jassid

B. Make the pairs.

Group 'A'	Group 'B'
1. CSH-7R	a. CK-60A×IS-84
2. CSH-8R	b. CAK-23A×AKH-7R
3. PKVHy.4	c. laxmi× SB-289-E
4. Varlaxni	d. MS-36A×CS-168
	e. MS-36A×PD-3-1-11

C. Find the odd one out.

1. Vishal, Varlaxmi, Savitri, Godavari.
2. Stemborer, Shoot Fly, Midge Fly, Downey mildew.
3. Shoot fly, Aphid, Army worm, Striga.
4. Processing, Gapfilling, Weeding, Hoeing.

D. Write true and false.

1. Cleaning of seed drill before sowing is the remedy for avoiding mechanical mixture of seed.
2. While buying the seed it should be seen that tag and seals of bag are intact.
3. Hybrid *jowar* seed is produced by crossing male sterile line (Line A) with restorer line (Line R).
4. Shoot fly is the major pest of cotton.
5. The seed to be used for seed production should be of appropriate class.

Q.2 Answer in brief.

1. Give two reasons causing mechanical mixture of seed.
2. Why isolation of seed crop is necessary?
3. What is supplimentary pollination?
4. What are the uses of cotton?
5. Write the parents of godavari.
6. What is the nature of damage of stem borer affecting *jowar*?
7. What are the control measures of cotton wilt?

Q.3 Answer the following questions.

1. Draw and label the sowing plan for hybrid seed production of jowar.
2. Complete the following chart.

Sr. No.	Hybrid	Female parent	Male parent
1	CSH-5	---------	---------
2	---------	Buri nectariless	MCU-5
3	PKVHY.5	---------	---------
4	CSH-16	MS-27A	---------

3. Describe the isolation requirements for maintenance of male sterile line (line A)
4. List the pest affecting *jowar* crop.
5. Explain the symptoms and give control measures of cotton wilt and anthracnose.
6. Describe the economic importance of *jowar* crop.
7. List out the cotton species.

Q. 4 Answer the following questions.

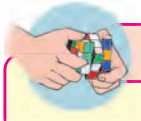
1. Write in brief about minor genetic variations.
2. What is the procedure of emasculation in cotton?
3. Write the parents of savitri and NHH-44.
4. What is the principle of hybrid seed production of jowar?
5. What are the critical stages of jowar growth for irrigation?
6. Which treatments are given to cotton seed before sowing hybrid crop?

Q. 5 Answer the following questions in detail.

1. What are the reasons for mechanical mixture of seed ?
2. What are the measures for maintenance of genetic purity during seed production ?

Q. 6 Answer the following questions in detail

1. Describe maintenance of male-sterile line in *jowar* seed production (Line 'A') on following points
   a. land requirement
   b. land preparation
   c. spacing
   d. seed rate
2. Elucidate hybrid seed production of cotton on following points.
   a. Time of sowing
   b. Land preparation
   c. Planting ratio
   d. Spacing



Activity

Collect the seed of different hybrids of *Jowar* and Cotton; label them and mention their parents.