TAMIL NADU AGRICULTURAL UNIVERSITY

LECTURE NOTES

SST 401 SEED PRODUCTION AND QUALITY CONTROL IN AGRICULTURAL CROPS (2+1)

DR. P. SELVARAJU
DR. V. PALANISAMY

ANBIL DHARMALINGAM AGRICULTURAL COLLEGE & RESEARCH INSTITUTE
TIRUCHIRAPALLI – 620 009

STUDY OF STRUCTURE AND MORPHOLOGY OF SEEDS IN

MONOCOT AND DICOT CROPS

Two principal groups of seed producing plants are Angiosperms and Gymnosperms.

Gymnosperms

These are characterized by producing their seeds exposed i.e. not enclosed in a fruit. The term 'gymnosperms' means naked seed. These are represented in the north temperate regions by the pines, spruces, hemlocks, cedars and other evergreens. Many of them bear their seeds in cones and none of them has conspicuous flowers.

Angiosperms

These have developed flowers and produce their seeds in an enclosed structure, which is called the fruit. The term 'angiosperm' means enclosed or hidden seed. The members of this group are very numerous and embrace all the well-known flowering plants.

The angiosperms are further subdivided into monocotyledons and dicotyledons.

1. Monocot seeds / Monocotyledons

The seeds of monocots are single seeded embedded in a fruit called caryopsis, utricle etc. The seed coat and fruit coats are fused as pericarp. The embryo is minute and confined to one end of the seed and is viable with 2n number of chromosomes. The storage tissue is known as endosperm and is nonviable with 3n number of chromosomes and occupies the major portion of the seed. The embryo consists of radicle and plumule which are enclosed in coleorizha and coleoptile respectively. The single cotyledon is known as scutellum. Aleurone layer is a protein body, which remains at the periphery of the endosperm. It helps in absorption of water and releasing enzymes, which helps in germination. Monocot seeds are known as albuminous / endospermous seeds.

2. Dicot seeds / Dicotyledons

The dicot seeds consist of primary axis and a living storage tissue, the cotyledons which combine the embryo of the seed. This embryo is enclosed in the seed coat. Mostly dicots do not have endosperm which is fully utilized for the development of embryo. Sometimes they have well developed endosperm (castor, fenugreek) and mostly they are exendospermous or exalbuminous in natutre (legumes). In some cases perisperm which is the remaining , unutilized portion of nucellus is also seen in dicot seed (eg) pepper.

COMPONENTS OF SEED

Seed coat

It is the outer covering of seed. It develops from the two integuments of ovule. Outer layer of the seed coat is known as the testa and is formed from the outer

integument. The inner layer of the seed coat is called the tegmen and is formed from inner integument.

Embryo

It is the mature ovule consisting of an embryonic plant together with a store of food, all surrounded by a protective coat, which gives rise to a plant similar to that of its mother. It is a miniature plant consisting of plumule, radicle and cotyledon. The plumule and radicle without the cotyledon is known as primary axis.

Radicle

Rudimentary root of a plant compressed in the embryo is the radicle which forms the primary root of the young seedlings. It is enclosed in a protective cover known as coleorhiza.

Plumule

It is the first terminal bud of the plant compressed in the embryo and it gives rise to the first vegetative shoot of the plant. It is enclosed in a protective cover known as coleoptile.

Cotyledon

Cotyledons are the compressed seed leaves. A single cotyledon (Scutellum) is present in monocots while two cotyledons are present in dicots, hence they are named as monocots and dicots, respectively. In dicots they serve as storage tissue and are well developed, while scutellum is a very tiny structure in monocots.

Endosperm

Endosperm develops from endosperm nucleus, which is formed by the fusion of two polar nuclei and one sperm nucleus. It stores food for the developing embryo.

APPENDAGES OF SEEDS

Some seeds will have appendages that are attached to the seed coat. They vary with kind of seed. The appendages sometimes help in dispersal of seeds or in identification of genotypes. Some of the appendages are awn, hilum, caruncle, aril, hair and wings.

Awn

The thorns like projection at tip of the seeds. (e.g) paddy- the bract tip is elongated into the awn.

Hilum

It is the scar mostly white in colour present on the lateral side of the seed. It represents attachment of the seed stalk to placenta of the fruit to mother plant e.g pulses.

Micropyle

The point where the integuments meet at the nucellar apex is referred as micropyle.

Chalaza

A region of integumentary origin and attachment opposite to micropyle is called chalaza.

Raphe

The area between the micropyle and chalaza is the raphe. The raphe may be visible on the seed coat of some species.

Caruncle

It is the white spongy out growth of the outer integument in the region of the micropyle seen in some species e.g. castor, tapioca.

Aril

It is the coloured flesh mass present on the outside of the seed e.g. nutmeg.

Hairs

They are the minute thread like appendages present on the surface of the seed e.g. cotton.

Wings

It is the papery structure attached to the side of the seed coat either to a specific side of the seed coat or to all sides e.g. moringa.

PARTS OF NORMAL SEEDLING

A seedling is categorized as normal only if it has the following essential parts:

Root (Primary)

The part of the plant growing underground is known as root. The radicle of embryo develops into root. It grows straight and must be free from damages and decays.

Shoot

The part of the plant growing above the ground is known as shoot. It develops from the plumule of the embryo.

Epicotyl

The portion of the shoot above the cotyledons

Hypocotyl

The region of shoot below the cotyledon and above the root.

Coleoptile

It is the cover that protects the plumule and helps in its emergence. It also helps in elongation of the cotyledons in monocot.

Coleorhiza

It is the sheath which covers the radicle portion and it is the elongation of hypocotyl region.

IMPORTANCE OF SEED STRUCTURES

1. For identification of cultivars, which can be done based on the morphological characters
2. To decide the shelf life potential of seeds by determining how many storage organs the seed has.
3. To decide about the various post harvest operations namely drying, threshing, processing,, cleaning and grading to prevent or minimize the mechanical damage.

SEED STRUCTURES OF CEREALS

Paddy (*Oryza sativa*)

The fruit is a caryopsis. The seed is having lemma and palea, which may be hairy or slightly hairy. Below the lemma and palea, the lower and upper glumes are present. The colour of the lemma and palea may be orange, yellow, golden yellow, brownish black, grey. In case of the hulled grain at the top of the grain the silk integmunts are present, which may be orange, black, yellow, brown, reddish brown, red violet. The colour of the grain also varies as that of the silk integument colour. The endosperm may be translucent, or opague and has pearl spot which may be in the centre or side.

Maize (*Zea mays*)

Maize seed consists of seed coat, storage organ (endosperm) and embryonic axis. Outer layer of the seed is called pericarp. Fruit coat and seed coat combine together and form the outer layer of pericarp. Aleurone layer is the thin layer present below the pericarp. Inside the portion consists of endosperm and embryonic axis and scutellum. The embryonic axis consists of shoot and root region. The shoot region consists of first leaf and tip of plumule which is covered by coleoptile and root region consists of root tip of radicle and coleorhiza.

Sorghum (*Sorghum bicolor) and* Cumbu (*Pennisetum glaucum)*

The outer layer is called pericarp. Below which a thin layer, endosperm is present. Embryo is placed in side of the seed. There are two types of endosperms namely corneous and vitreous. The variation in endosperm is due to genetic factors and place of production.

Ragi (*Eluesine coracana*)

It is a naked seed, botanically the seed is called utricle. The seed has thin papery pericarp. Some times it may or may not be attached with the seed. The shape is round at the top and flattened at the end. The embryo has embryonic axis (root and shoot tip).

SEED STRUCTURES OF PULSES

Structures of pulse seeds are one and the same. But they may differ in colour, shape and texture of seed coat and size. Raphe, hilum and micropyle are present. The embryo consists of two cotyledons, radicle and plumule. The other differences are as follows:

Cowpea

The shape varies from globular to kidney shape. The colour varies from white, green, puff, red, brown and variously mottled and blotched. The surface of seed coat may be smooth (or) wrinkled. The hilum is surrounded by a dark black ring.

Soybean

It has concave hilum, below the hilum a small hole micropyle is present. The outer layer is called coat. The two cotyledons are attached by a part called hypocotyl. One end of hypocotyl is called plumule and the other end is known as radicle. Formation of hilum is the indication of physiological maturity of seed.

Blackgram (*Vigna mungo*)

The shape is oblong with square ends. The colour of the seed is black. The surface of seed coat is smooth. The hilum is white and concave.

Green gram (*Vigna radiata*)

The shape may be kidney shape (or) oblong (or) globular. The variable colours are green, white, yellow and purple brown. The surface of seed coat is rough (or) wrinkled. The hilum is coloured and round.

Redgram (*Cajanus cajan*)

The shape is round or oval. The colour is white, greenish red, brown (or) purplish. The surface of the seed coat is smooth and the hilum is white.

SEED STRUCTURE OF SOLANACEOUS VEGETABLES

External characteristics

Small sized seeds, compressed, thin nearly equi-dimensional to slightly elongate. Seed coat has minute aligned depressions, in ***lycopersicon spurious*** hairs are present which are remnants of lateral epidermal walls. Yellowish to brown. Hilum compressed, seeds are marginal.

Internal characteristics

Seed coat 1. Embryo linear and curved or coiled. Has anatropous to hemianatropous ovule. Cotyledons 2 their tips either terminating near base of radicle or spirally curved. Endosperm abundant or nearly so, rarely scant; fleshy and semitransparent. The seeds are compressed with strongly curved embryo is the characteristics of *Solanaceae*.

SEED STRUCTURE MALVACEOUS VEGETABLES

External characteristics

Seed is plumby, laterally compressed in a sectorial fashion, margin notched, seed coat smooth, hilum with a characteristics grill-like structure extending up to the radicle of the seed.

Internal characteristics

Seed coats 2, outer one is thick, commonly impervious to water, inner thin, embryo peripheral and large folded in camphylotropous ovule dominated by large cotyledons, radicle inferior, cotyledons 2; well developed, folded. Endosperm scanty or absent, mucilagenous, perisperm is present as thin layer.

SEED STRUCTURE OF LEGUMINOUS VEGETABLES

Peas seed

The seed is somewhat roundish in shape and is covered by two distinct seed coats, of the two coats the outer whitish is called the testa; it comes off easily when the seed is soaked in water. The testa encloses another coat, which is loose, thin, hyaline and membranous; this inner coat is called the tegmen. Point of attachment of the seed to its stalk is called the hilum. Minute hole close to hilum is called as micropyle. Continuous with the hilum there is short ridge in the testa called raphae. Whitish fleshy body is called embryo consisting of two cotyledons.

Country bean

The country bean seed is more or less oval, and is covered by a blackish or reddish, hard seed coat. The seed coat consists of two layers fused together, the outer one is known as the testa and the inner one the tegmen. Whitish elongated ridge is called raphe. At the base of raphe, distinct broad scar is seen called the hilum. Other end of the raphe a minute hole called micropyle. Two fleshy cotyledons and an axis to which the cotyledons remain attached. It consists or radicle and plumule.

SEED STRCUTURE OF CUCURBITACEOUS VEGETABLES

External characteristics

Seed compressed oblanceolate, pointed at the hilum end rounded at the opposite end. Rarely linear, seed coat smooth, with or without a distinct thickened margin; black or brown or yellowish or whitish hilum in conspicuous seldom noted.

Internal characteristics

Seed coat two outer crustaceous or horny, inner thin. Embryo straight, spatulate. Anatropous ovule. Cotyledons dominant; radicle short inferior. Cotyledons 2; fallacious, veined, fleshy, embracing two distinct leaves. Endosperms absent i.e. non endospermic. Seed coat characteristics are quite strong for most members of this family and may be used for distinguishing species, genus etc.,

SEED STRCUTURE OF OIL SEEDS

Castor (*Ricinus communis*)

It is a dicot seed. It consists of hard, stony, brown coloured seed coat. Below the seed coat, a thin layer of endosperm is present. Below the endosperm two leafy cotyledons are present.

Sesame (*Sesamum indicum*) and Sunflower (*Helianthus annus*)

It consists of hard, brown / black coloured seed coat. Two cotyledons and embryo are present.

SEED STRCUTURE OF FIBRE CROPS

Cotton (*Gossypium* sp.,)

It has two cotyledons. They have hard seed coat (black coloured). Below the seed coat a thin layer or light brown colour portion is present this is called endosperm. Below the endosperm the folded cotyledon is present. Embryo is present inside the folded cotyledons.

SEED PRODUCTION IN PADDY

Paddy is a self-pollinated crop with cross-pollination upto 0-4%. The flower opening starts from the tip of the primary and secondary branches and proceeds downwards. Normally 6-8 days are required to complete flowering in a panicle. Under normal condition flower opening is between 7 to 10 a.m. The flower remains open for 10 minutes and afterwards it closes. The dehiscence of anthers is independent of spikelet opening. The dehiscence may take place before opening up of flowers or after flower opening. The stigma is receptive for 3 days and pollen grains viable for 10 minutes.

Methods of seed production

a. Varieties

The crop is raised in isolation and seeds are allowed to set by self pollination.

Nucleus seeds are raised in ear to row method under isolation. The rows containing off types are removed. Very true to type earheads are marked and harvested separately and issued for further multiplication.

b. Hybrids

The tool involved in hybrid seed production is known as cytoplasmic genic male sterility. It is a 3 line breeding system, where three lines A,B and R lines are involved.

In hybrid seed production programme, particularly in breeder seed and foundation seed stages, A line is multiplied with the use of B line and is produced in isolation from R line, which is multiplied as that of a variety. In certified seed production, A line and R line are crossed to produce actual hybrid.

Hybrid rice in China

The average yield of China is 6.7 t /ha against 2.9 t / ha in India. Hybrid rice was introduced commercially in China in 1976 and now 50% of the total area (15.7 million ha) is under hybrid cultivation. The father of hybrid rice "Yuan Long Ping" has developed one hybrid that yielded 17 t/ha. China's hybrid rice yield is 15-20% more than high yielding inbred varieties.

The hybrid (F1) yield is 2.4 t/ha with maximum of 7.4 t/ha.

Hybrid rice in India

Out of 143 million ha cultivable area in India,42.3 million ha is used for rice cultivation.

In India work on hybrid rice started in 1989 by ICAR. This work was further strengthened with the assistance from UNDP / FAO since 1991. Now the project is being operated as a National Research Network with 12 centres across the country with Directorate of Rice Research as a Co-ordinating centre.

Two lead centres - Kapurthala in Punjab - North India

Mandya in Karnataka - South India.
3 - Strategic Centres - DRR- Hyderabad
CRRI - Cuttack
ICAR - New Delhi.
Associate centres (Region specific research)

Coimbatore	- Tamil Nadu
Maruteru	- Andhra Pradesh
Karnal	- Haryana
Patnagar	- Uttar Pradesh
Faizabad	- Uttar Pradesh
Chinchura	- West Bengal
Karjat	- Maharastra.

In India, the first hybrid was released in 1994 at TNAU, Coimbatore CORH 1 (MGR) and so far 16 hybrids have been released including 3 from private sector. In Tamil Nadu,3 hybrids were released (CORH 1, CORH 2 and ADTRH 1). In India 2 million hactares are targeted to be covered with hybrid rice during 2000 AD.

Season

Kharif (May- June sowing)
Rabi (December- January sowing)

Rabi is more suitable than kharif.

Favourable climatic conditions during flowering for higher seed set.

1. Daily mean temperature 24 - 30^{o}C
2. Relative Humidity 70 - 80 %
3. The difference between day and night temperature should be 8-10^{o}C.
4. Sufficient sunshine and moderate wind velocity of 2-3 m / second.
5. Free from continuous rain for above 10 days during peak flowering season.

Seed set and seed yield will be affected if temperature is below 20^{o}C and above 35^{o}C during the time of flowering. In Tamil Nadu ideal time for sowing during kharif is 2nd fortnight of May and during rabi 2nd fortnight of December.

CORH 1	-.	110-115 days (May-June, Dec - Jan)
CORH 2	-	120-125 days (Rabi)
ADTRH 1	-	110-115 days (kharif)

Land requirement

Land should be fertile with good irrigation and drainage facilities. It should have good sunlight and aeration. It should be free from volunteer plants. The seed crop should be isolated from other varieties of the same crop. The field should not have been grown with the same crop in the previous season. If grown, it should be the same class of seed for the same variety and approved by seed certification agency.

Isolation (Space)

	Foundation seed (m)	Certified seed (m)
Varieties	3	3
Hybrids	200	100

Time isolation

Generally a time isolation of over 25 days is practiced. In other words, the heading stage of varieties grown within 100 m around the seed production field should be over by 25 days earlier or later than that of the CMS line.

Barrier isolation

Topographic features like hills, wood lot, vegetative barrier like maize, sesbania, sugarcane, etc., to a distance over 30 m and artificial obstacles (plastic sheets above 2 m in height) will provide better isolation.

Season and sowing (Rice seasons of Tamil Nadu)

Season	Month of sowing	Duration of the varieties
Navarai	December - January	Below 120 days
Sornavari	April - May	Below 120 days
Early kar	April - May	Below 120 days
Kar	May - June	Below 120 days
Kuruvai	June - July	Below 120 days
Early samba	July- August	130 - 135 days
Samba	August	130-135 and above 150 days
Late samba / Thaladi / Pishanam	September - October	130-135 days
Late thaladi	October-November	115 - 120 days

Seed rate

Varieties	-	Short duration	: 60 kg /ha
		Medium duration	: 40 kg /ha
		Long duration	: 30 kg /ha
Hybrids	-	A line	: 20 kg /ha
		B and R lines	: 10 kg /ha

Upgrading of seeds

Upgrade the seeds before sowing by density grading using common salt solution having a specific gravity of 1.13 (1.5 kg of salt in 10 liters of water) and collect only the heavy seeds that sink at the bottom.

Presowing seed hardening treatment

The paddy seeds are soaked in 1% KCl solution for 10 hours in 1:1 ratio. Then they are dried back to original moisture content (11-12%). Then the seeds are treated with Captan/Thiram @ 4g Kg^{-1} and also with Azospirillum/ Azatobacter @ 3 pockets/acre seeds.

To raise wet nursery, the rice seeds should be pregerminated as the seeds will not germinate in the waterlogged anaerobic condition since oxygen is very essential for germination, which is not available in the submerged condition. For pregerminating, the seeds are soaked overnight in loosely tied moist gunny bags. Then the gunny bags are tied tightly with thread. These bags are incubated in dark for 24 hours. The emerged plumule can be seen as white dots on the gunny bags after 24 hours.

Dormancy breaking treatment

Seeds may be soaked in 0.18 con. HNO_3 (240 ml in 45 liters of water) at 1:1 equal volume for 12 - 16 hours. The seeds may then be air dried to original moisture.

Nursery management

For hybrid seed production female and male nurseries should be raised separately. Sparse sowing in nursery beds @ 1 kg $cent^{-1}$ should be practiced to get robust seedlings.

Application of DAP @ 2 kg $cent^{-1}$ as basal in the nursery will ensure robust seedlings with 2-3 tillers at the time of planting.

Seedlings of 20 - 25 days old have to be planted (hybird). Varieties: short duration 18-22 days medium duration 25-30 days and long duration 35-40 days.

Staggered sowing of parents for synchronization

As the seed set on CMS line depends on cross pollination it is most important to synchronize the heading date of the male and female parents, especially for the hybrid combinations having parents with quite different growth duration. In addition, in order to extend the pollen supply time, the male parent is usually seeded twice or thrice at an interval of 4-5 days.

The following 3 methods can be used to determine the differences in seedlings date for synchronization between male and female parents.

1. Growth Duration Difference (GDD) method
2. Leaf Number Difference (LND) method
3. Effective Accumulated Temperature (EAT) method

Among these 3 methods though the LND method is more reliable one, the GDD method is mostly followed since it is rather simple and easy to adopt. In GDD method by checking the previous data on the difference in duration from seedling to heading between male and female parents, the proper seeding date of both parents in current season can be determined. This method is suitable in seasons or regions where the temperature fluctuation is small.

Staggered seeding of R line for synchronization.

1. Single seeding of R line

a) ♀ Flowering duration (10 days)
b) ♂ Flowering duration (8-10 days)

2. Two seeding of R line

a) ♀ Flowering duration (10 days)
b) ♂ Flowering duration I seeding
c) ♂ Flowering duration II seeding

3. 3 seeding of R line.

a) ♀ Flowering duration (10 days)
b) ♂ Flowering duration I seeding
c) ♂ Flowering duration II seeding
d) ♂ Flowering duration III seeding

Main field management

Spacing	varieties:	Short duration	20 x 10 cm
		Medium duration	20 x 15 cm
		Long duration	20 x 20 cm

Row ratio, row direction and planting pattern

8:2 or 10:2

Factors influencing row ratio

1. Plant height of the pollinator
2. Growth and vigour of the pollinator
3. Size of the panicle and amount of residual pollen
4. Duration and angle of floret opening in CMS lines
5. Stigma exertion of CMS line.

Layout for transplanting

To facilitate outcrossing , the rows of male and female in the seed production plot should be perpendicular to the prevailing wind direction expected at flowering time of the parents.

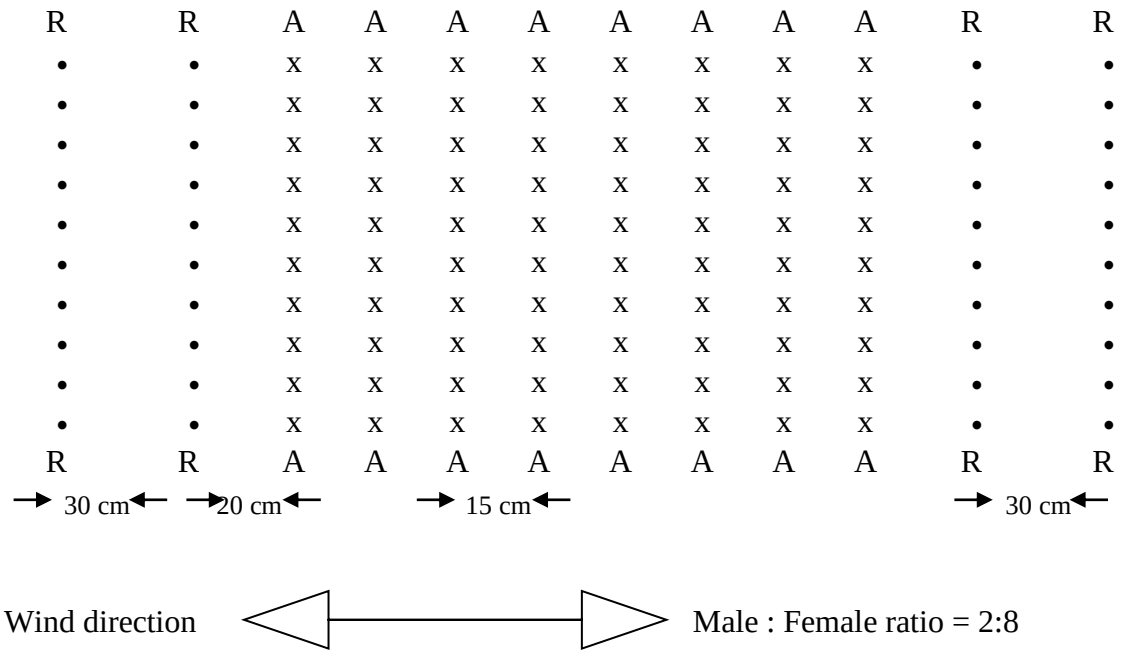
Practically a row ratio of 8:2 (A x R) is currently adopted for hybrid seed production and the transplanting sequence for 8:2 row ratio is as follows:

Transplanting of the 'R' line

Transplant the seedlings of ' R' line in paired rows of 30 cm apart.

In case of 2 staggered seedlings of R line, the first and second sown R line seedlings may be planted in two separate rows at 15 cm spacing or the 1^{st} sown seedlings may be planted in both the rows with 30 cm spacing and 2^{nd} sown seedlings may be planted in the middle of two seedlings in both rows. Whereas in three staggered seedlings of R line all the seedlings may be pulled out separately, mixed together thoroughly by spreading one over the other and planted in the two paired rows @ 2-3 seedlings per hill with 15 cm spacing within the rows. It is more convenient , easy and labour saving method incase of large scale seed production.By proper synchronization, higher seed set and yield have been recorded in 3 staggered seedlings of R line. Leave a 145 cm or 110 cm wide block between paired rows of R line seedlings for transplanting 8 rows blocks of A line seedlings.

Row ratio, row direction, spacing and planting pattern for hybrid rice seed production.



Transplanting of the 'A' line

Transplant the ' A' line seedlings in blocks of 8 rows in between the paired rows of ' R' line seedlings. Transplant with one or two seedlings per hill with inter and intra row spacing of 15 x 15 cm in 145 cm wide block or 10 x 15 cm in 110 cm wide block according to the fertility of field. Leave a 20 cm spacing between the ' A' line rows and the nearest ' R' line rows.

Prediction of heading date

The method, which is widely used and found to be effective, is by examining the development of young panicles. Based on the morphological features, the young panicles are classified into 8 development stages. The synchronization in flowering can be predicted by using such criteria. In practice, about 30 days before heading, the male and female parents in the seed production field are sampled and their young panicles within the main clumps and tillers are carefully observed with a magnifying lens every three days. Usually female and male parent will take 27 and 32 days respectively from panicle initiation to heading in 8 stages.

Method of observing panicle initiation

- Select the main tiller (the longest one) and cut at the base where stem and root join.
- Make a longitudinal slit from the base upto the top of the tiller
- Open the slit just above the nodal portion
- Observe the developing panicle with the help of a magnifying lens.

Adjustment of flowering date

If it is found during the first3 stages of panicle differentiation that synchronization of flowering will not be attained, the earlier developing parent should be applied with quick releasing nitrogen fertilizer (2% urea spray) or apply 35 kg /ha of urea with knapsack sprayer at 500 lit /ha and the later developing parent should be sprayed with 2% solution of DAP. By this measure a difference of 4 to 5 days ma be adjusted.

If it is found during the later stages of panicle differentiation that synchronization of flowering will not be attained a difference of 3-4 days may be adjusted by drainage or irrigation because the R lines are more sensitive to water than CMS lines. For instance, if R line is found to be earlier, draining water from the field will delay the panicle development. On the other hand if R line is found to be late, higher standing water would facilitate rapid panicle development.

If the difference in flowering period between the two parents reaches 10 days or more it is necessary to remove the panicles from early developing parent and apply nitrogen fertilizer subsequently, thus making it late emerging tillers or unproductive tillers bear panicles and subsequently achieve synchronization of flowering.

Further during the flowering stage if the blooming time is found not to be synchronized (usually the R line flowers earlier than CMS line) adjustments can be made in blooming time by improving the microclimate in the field through drainage, removing dew drops from the CMS plants and spraying cold water to the R lines.

Application of Gibberellin (GA_3)

GA_3 plays an important role in rice hybrid seed production. It can adjust physiological and biochemical metabolism of rice plant especially stimulating the elongation of young cells. About 25-30%. spikelets of a panicle are inside the flag leaf sheath in most of the indica CMS lines than that of the Japonica CMS lines. GA_3 has a definite role in exertion of panicle. In general, it is recommended that 50 g /ha with knapsack sprayer in two split doses, i.e. spray on 15-20% earhead emergence and 2nd spray in the next day for enhanced seed set.

GA_3 will not dissolve in water and hence it should be dissolved in 75-90% alcohol (1g in 20-25 ml of alcohol) and make the required solution. Spraying should be done at 8 to 10 a.m. and 4-6 p.m.

Advantages of GA_3 application

- Enhances panicle and stigma exertion
- Adjust plant height of seed and pollen parents
- Speed up the growth of later tillers and increases the effective tillers
- Sets uniform panicle ear.
- Flag leaf angle is increased
- Increases 1000 grain weight
- Reduces unfilled grains
- Remarkably enhances seed setting and seed yield

Supplementary pollination

Natural outcrossing was recorded less than 10% by Ramlingam et al. (1994). However, this depends upon the wind direction and its velocity.

Shaking the R line panicles by rope pulling at panicle level or rod driving during anthesis can make their anthers dehisce and spread the pollen widely and evenly thus the outcrossing rate could be increased. It is more effective especially on calm or breezy days.

Generally, supplementary pollination is carried out at 30 minutes interval for 5 times daily both morning and evening during peak anthesis (10-12 am and 2-4 p.m.) until no pollen remains on the R line. It is not needed when the wind is greater than moderate breeze.

Fertilizers

Short duration varieties : 120:38:38 NPK kg/ha. N is applied in 3 split doses.

Medium & long duration varieties :150:50:50 "

Hybrids :150:60:60 "(during (1) basal (2) active tillering (3) Panicle initiation. N & K applied in 3 splits)

Roguing

Remove the undesirable plants either in A or R line rows that differ from plants that are true to type. The pollen shedders and off types are removed.

The undesirable plants come from many sources. They may be volunteer plants from the previous cropping.

The most important stages for roguing are at maximum tillering, at flowering and just before harvesting.

Roguing in hybrids

In A line remove pollen shedders. In A line only 40-50% of seed set is possible. If > 60-70% seed is noticed and the panicle is drooping it would be R line (or) other varieties.

Harvesting, threshing & drying

Turning of 90% green seeds to straw yellow colour is the stage of physiological maturity i.e 28 days after 50% flowering in short and 31 days in medium and 35 in long duration. Moisture content will be 17-20%.

- Male parent should be harvested first .
- Care should be taken to avoid admixture of male line with female line while harvesting.
- The female parent should be threshed at 16-17% moisture content separately in a well cleaned threshing floor.
- The threshed seed should be winnowed and dried to reduce the seed moisture content to 12%
- The seed should not be dried under direct sun between 12 to 3.00 p.m. during hot sunny days.

Grading	Size of seed	Sieve size
Long slender (Ponni, whitePonni)		= 1/16 x 3/4 " (1.3mm x 19 mm)
Slender - IR 50		= 1/15 x 3/4" "
Medium slender (IR 20, CO 43)		= 1/14 x 3/4" (1.5 mm x 19 mm)
Short bold (ADT 36, 37,38,39, TKM 9,Ponmani)		= 1/13 x 3/4" (1.8 mm x 19 mm)

Seed treatment

Seeds are treated with thiram / captan @ 4 g/kg. Or with 5 gm halogen mixture. The halogen mixture is prepared by mixing $CaOCl_2$ + $CaCO_3$ for 1 week in air tight container.

Foliar spray

Foliar spray of 2% DAP increases yield and qualities of seed

Short duration	- Ist Spray on	60 DAS
	II nd "	80 "
Medium duration	Ist Spray on	80 DAS
	II nd "	100 "

Storage

Fort short term storage use gunny bag or cloth bag.For long term storage use polythene bag of > 700 gauge and dry the seeds to 8% moisture content. When compared with varieties, the hybrids and parental lines A & B lines are poor in storability. The order of the storage potential is R > F1 > B > A.

Types of hybrids

1. 3 line breeding : A,B & R lines are used.

2. 2 line breeding

a. EGMS- the thermo sensitive or photosensitive lines are used. The TGMS lines are multiplied in winter and then hybrid seeds are produced in summer.
b. Using chemical hybridizing agents
   Chemicals like sodium arsenate, zinc methyl arsenate, etherel or maleic hydrazide may be used to induce sterility.

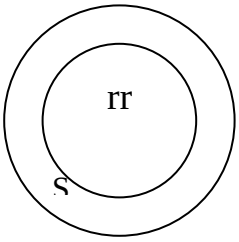
c. Emasculation and dusting.

3. Single line breeding or apomixis.

Stages of multiplication

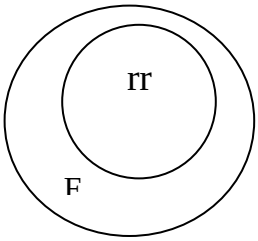
Breeder seed	A x B	B	R
Foundation seed	Ax B	B	R
Certified seed	-	-	A x R

A line



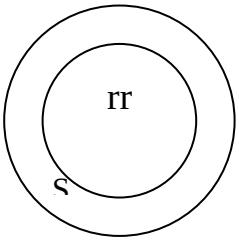
Male sterile
Cytoplasm sterile

B line

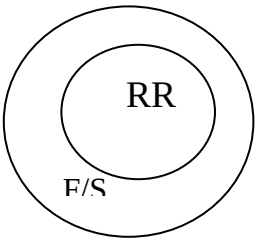


Male fertile
Cytoplasm fertile

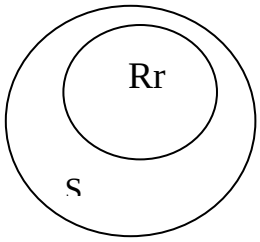
A line



R line



Male fertile
Effect of sterile cytoplasm
engaged by restorer gene.



Male fertile F1 hybrid

Parents of hybrids

CORH 1 (MGR)(1994) - IR 62829 A x 1098-662 R (110-115 days)

CORH 2 (1998) - IR 58025 A x C 20 R (120-125 days)

ADTRH 1 (1998) - IR 58025 A x IR 66 R (110-115 days)

SEED PRODUCTION TECHNOLOGIES OF SORGHUM VARIETIES AND HYBRIDS

Floral biology

Sorghum is an often cross-pollinated crop. The extent of out crossing is 6-45% and depends on nature of earhead. In loose panicles the cross-pollination is more and less in compact panicle. Spikelets occur in pairs on the lateral branches of the panicle. One is sessile while the other spikelet is pedicelled. Sessile is bisexual and pedicelled spikelet is male or sterile. Sessile spikelet is comparatively larger than staminate spikelet and each spikelet has two florets.

Flower opening starts after 2 to 4 days of emergence of panicle from the boot leaf. Flowering starts from the tip of the panicle and proceeds downwards (basipetal). Flowering completes in 7 days. The pollen is viable for 10 to 20 minutes under field conditions. Fertile pollen will be lemon yellow in colour. Older pollen grains will normally turn to orange. Receptivity of stigma starts two days before opening and remains for several days (5 days). Flower opening and anthesis will be from 2.00 am to 8.00 am.

Methods of Seed Production

1. Varieties.

By open pollination under isolation.

2.Hybrids

Hybrids are produced using cytoplasm genic male sterility.

Stages of Seed Production

Breeder seed ---> A x B - B - R

Foundation seed ---> A x B - B - R

Certified seed ---> A x R

Varieties

K5, K7, CO 19, CO 20 (Fodder), CO 21, K9, BSR 1, CO 26, K4, K8, CO 25, APK 1, K 10, Paiyur 1,2.

Hybrids

CSH1 : CK 60 A x IS 84
CSH 5 : MS 20 77 A x CS 35 41
CSH 9 : MS 296 A x CS 3541
COH3 : MS 2077 A x 699 Tall
COH 4: MS 296 A x TNS 30
CSH 13 R (Rabi) - 296 A x RS 29
CSH 15 (R) - 104 A x R 585

The first hybrid (CSH 1) was released in 1964. In 1969, the Coordinated Sorghum Improvement Project was established. Now there are more than 30 hybrids.

Season

a. Varieties - June - July and October - November

b. Hybrids - October - December.

Land requirement

The field offered for seed production should not have been grown with the same crop in the previous season. If it was grown it should be of the same variety. In this case the field is to be irrigated 3 weeks before ploughing to destroy the germinated seeds. Land should be fertile and should not be problematic soil viz., calcareous or acidic soils.

Isolation

	Foundation stage (M)	**Certified seed stage (M)**	
Varieties	200	100	(from other variety fields)
	400	400	(from Johnson grass *S healepense*)
	400	400	(from forage sorghum with high tillering)
Hybrids	300	200	

Differential blooming dates are not allowed.

Seed rate

Varieties: Irrigated - Direct sown 10.0 kg / ha and transplanted 7.5 kg/ha
Rainfed - Direct sown 15.0 kg.

Hybrids A line (female parent) 7.5 kg /ha
B& R line (male) 5.0 kg /ha.

Panting ratio

F.S.	4:2
C.S	5:2

Border rows : 4 rows

Sowing

Seeds are sown in ridges and furrows.

Pre-sowing treatment

1. Soak the seeds in 2% KH_2PO_4 for 10 hrs. Seeds are soaked in equal volume and the seeds are dried back to original moisture content (or)
2. Soak the seeds in 1% prosopis and pungam leaf extract in1:0.6% volume for 16 hours and dry back to original moisture. Then pellet the seeds with pungam leaf powder at 500 mg/kg of seeds using 10% maida as the adhesive material, which is pollution free and eco friendly treatment.
3. Seeds can also be treated with 5% carbofuran 3G along with rice gruel as adhesive to protect the seed from shootfly infestation in the field.

Spacing

Varieties : 45 x 10 cm

Hybrids A line 45 x 10 cm R line 45 x 10 cm

Fertilizers (varieties)

NPK :100:50:50 kg ha^{-1}
Basal :50:50:50 kg ha^{-1}
Top dressing : 25 kg N (25 DAS)
:25 kg N (45 DAS)

Synchronization

1. Staggered sowing: Sowing of male parent and female parents are adjusted in such a way that both parents come to flowering at the same time. In CSH-5, MS 2077 A must be sown 10-15 days earlier to the male CS 3541, and in CSH 6, the female parent MS 2219 A can be sown simultaneously with CS 3541 and in CSH 9, the female parent MS 296 A must be sown 7-10 days earlier than male CS 3541 in November- December season.

2. Spraying growth retardent MH 500 ppm at 45 DAS, delays flowering in advancing parent. MH wont dissolve in water and hence dissolveit in NaOH and then mix with water.

3. Urea spraying 1% to the lagging parent.

4. Withhold one irrigation to the advancing parents.

5. Spraying CCC 300 ppm will delay flowering.

Gapfilling

It should be done within a week after sowing.

Markers

For easy identification of male line live markers are used. It is other crops like sunflower are grown at both ends of the male line. The markers should not be pollinator and their duration should be more than the crop age.

Micronutrient deficiency

- If Zn deficiency is found apply 25 kg of zinc sulphate / ha.
- If Fe deficiency is found apply 50 kg $FeSO_4$ along with 5 t of compost. During growth if Fe deficiency is noted spray 0.5% $FeSO_4$

Roguing

Roguing should be done periodically to remove off types, pollen shedders, volunteer plants based on leaf orientation , leaf margin, size of leaf blade,type of earhead and seed colour.

Field Standards

	Foundation seed %	Certified seed %
Offtypes (max) Varieties	0.05	0.10
Hybrids	0.05	0.10
Pollen shedders (max)	0.05	0.10
Designated diseased plants (max)	0.05	0.10 (Ergot and smut)

Pollen shedders

Presence of B line plants in A line are called pollen shedders.

Partials

In certain A line plants, a part of the earhead-shed pollen due to the removal of sterility due to parental impurity (or) developmental variation or temperature.

Irrigation

Critical stages for irrigation are primordial initiation, vegetative, milky and maturity stages.

Pest and diseases control

Shootfly

In nursery, spray any one of the following for an area of 120 sq.m., endosulfan 35 EC 18 ml, demeton 25 EC 12 ml; dimethoate 30 EC 12 ml. In main fields for direct sown crop, spray one of the followings per ha $^{-1}$, endosulfan 35 EC 500 ml, demeton 25 EC 500 ml; dimethoate 30 EC 500 ml (250 1 of spray fluid ha $^{-1}$). Keeping 12 nos. of fish meal traps/ha effectively reduces the damage.

Stem borer

Mix any of the following insecticides with sand to make up a total quantity of 50 kg ha^{-1} and apply in leaf whorls. quinolphos 5 G 15 kg; endosulfan 4 G 15 kg; phorate 10

G 8 kg; carbofuran 3 G 17 kg; carbaryl 4 G 20 kg, carbaryl + lindane (sevidol) 4 G 20 Kg; endosulfan 4 D 10 kg; phosalone 4 D 10 kg; fenthoate 2 D 5 kg or endosulfan 35 EC 750 ml or carbaryl 50 WP 1kg (500 l spray fluid ha $^{-1}$).

Mites

Spray 3.75 kg wettable sulphur or 1500 ml dicofol per ha. Direct the spray fluid towards the under surface of the leaves. ETL for sorghum mite = 5 mites/ cm^2 of leaf area.

Designated diseases

1. Kernal smut 2. Head smut

Sugary disease of sorghum

It is specific for hybrids. If A line is not pollinated and fertilized, the ovule which is rich in sugar will burst and oozes out sugar in drops. These drops will be attracted by pathogens, and ultimately the earhead and its yield will be reduced. This can be controlled by spraying thiram 0.2% two times at boot leaf stages. Plants showing the symptoms of honey dew will also to be removed and destroyed from the plots at earhead emergence and at 50% flowering.

Downy mildew

Seed treatment with metalaxyl at 4 g kg^{-1} of seed. Rogue the infected plants upto 45 days after sowing and spray metalaxyl 500 g or mancozeb 1 kg or ziram 1 kg or zineb 1 kg ha^{-1}. Spray mancozeb 1250 g ha^{-1} after noticing the symptoms of foliar diseases, for both transplanted and direct sown crops.

Charcoal rot

Treat the seeds of sorghum with ***Trichoderma viride*** @ 4g kg^{-1} of seed.

Pre-harvest sanitation spray

Normally sorghum earheads are infected with black mold if rain comes at the time harvest. To prevent this, bavistin @ 200 g /ha is recommended.

HARVESTING

Should be done at physiological maturity i.e.40-45 days after 50% flowering where the seed moisture is around 30%. The formation of dunken layer (black layer) on the seed serves as a external symptom of physiological maturation.

Method of harvesting

Male and female lines should be harvested separately. The male rows are harvested first and transported to separate threshing floor. Like that female rows are harvested and threshed separately.

Threshing

At the time of threshing the seed moisture content should be reduced around 15-18%. Threshing can be done by beating the earheads with bamboo sticks. While using the mechanical threshers, care should be taken to avoid mechanical damage.

Drying

Seed should be dried to 12% for short term storage and 8% for long term storage.

Processing

The sorghum seeds can be processed in OSAW cleaner cum grader using 9/64" round perforated metal sieve.

Seed treatment and storage

The seeds are treated with captan or thiram @ 2 g/kg of seed and pack it in cloth bag at 12% moisture content for short term storage and 8% moisture content in 700 gauge poly ethylene bag for long term storage (or)

The seeds can also be treated with halogen mixture @ 3 g/kg of seeds. The halogen mixture is prepared by mixing $CaOCl_2$ and $CaCO_3$ +*Albizzia amara* at the rate of 5:4:1 and this mixture is kept in an air tight plastic container for 1 week. After one week the mixture is used for seed treatment.

The treated seeds can be stored upto 12 months under open storage and upto 18 months in moisture vapour proof containers, provided it is not infested by the storage insects.

Seed standards

Standards	Foundation seed	Certified seed
1. Physical purity % (max)	98.0	98.0
2. Inert matter % (max)	2	2
3. Other crop seed (max)	5/kg	$10kg^{-1}$
4. Weed seeds (max)	$5kg^{-1}$	$20\ kg^{-1}$
5. Other distinguishable varieties (max)	$10\ kg^{-1}$	$20\ kg^{-1}$
6. Ergot disease (max) (by number)	0.020%	0.040%
7.Germination (mini) %	75	75
8. Moisture content (max)		
a. moisture pervious container	12.0	12.0
b. moisture vapour proof container	8.0	8.0

Mid -storage correction

Old seeds with declining viability may be upgraded and soaked for 6 hours in double the volume of Na_2 HPo_4 (3.59 g/100 l water) and dried back to 8% moisture content.

TYPES OF CONTAMINATION

Inside	A line	B line	R line
Presence of	B	A	A
	R	R	B
Called as	Pollen shedder	Off type	Rogue
	Rogue	Rogue	Rogue
Causes	Physical	Physical	Physical & genetical
	Physical & genetical	Physical & genetical	Physical & genetical

Anthesis

The process of dehiscence of anthers and period of pollen distribution.

SEED PRODUCTION TECHNOLOGIES OF VARIETIES AND HYBRIDS IN CUMBU

Floral biology

It is a highly cross-pollinated crop. The pollinating agent is wind. The flowers are protogynous. The spike emerges about 10 weeks after sowing, The styles begin to protrude 2-3 days later first at the top of the inflorescence and proceeds. They take two days to complete the entire spike. Exerted stigma remains receptive for 12-24 hours. Anthers usually emerge after the styles are dry. The anther emergence starts from middle of the spike and proceeds upwards and downwards. Anthesis occurs throughout the day and night with the peak between 8.00 p.m. to 2.00 a.m.

Land requirement

Seed field offered for certification should not have been grown with cumbu in the previous season. However if it was grown, the field should be irrigated 3 weeks before sowing to destroy the germinating seeds.

Method of seed production

Varieties : By open pollination

Hybrids : CGMS. The first hybrid HB 1 was released in 1965 and now more than 60 hybrids are available.

Isolation distance

	Foundation seed	**Certified seed**
Varieties	400 m	200 m
Hybrids	1000 m	200 m

Stages of Seed Production

Varieties	Breeder seed --->	Foundation seed --->	Certified seed
Hybrids	Ax B	Ax B	Ax R
	B	B (under isolation)	
	R	R "	

Season

The best season is October -December.

Seed rate

Varieties : 3.75 kg /ha

Hybrids : A line 3.125 kg/ha
R line 0.750 kg /ha

Spacing

Varieties 45 x 20 cm

Hybrids

A line 45 x 20 cm and R line 45 x solid row.

Removal of ergot affected seeds and sclerotia to prevent primary infection.

Dissolve 1 kg of common salt in 10 liters of water. Drop the seeds into the salt solution. Remove the ergot and sclerotia affected seeds, which will float. Wash seeds in fresh water 2 to 3 times to remove the salt on the seeds. Dry the seeds in shade

Pre-sowing Seed Management

Use graded seeds for sowing.Treat the seeds with three packets (600 g) of Azospirillum or pellet the seed with arappu leaf powder.

Nursery Preparation

Nursery area required is 7.5 cents / ha. Apply 750 kg FYM and incorporate by ploughing. Sow the seeds in raised bed. Form beds at 3 m x 1.5-m breadth. Open rills at 15 cm gap to 1 cm deep. Sow the seeds and cover them with 500 kg FYM.

Apply phorate 10 G 180 g or carbofuran 3 G 600g mixed with 2 kg of moist sand, spread on the beds and work into the top 2 cm of the soil to protect the seedlings from shootfly infestation.

Age of seedlings

Transplant the seedlings at the age of 15-18 days old.

Main field preparation

Form ridges and furrows at 45 cm gap. Plant the seedlings at 15 cm gap within the ridge.

Planting ratio

F.S : 4:2
C.S : 6:2

Border rows

F.S : B line 4 rows
C.S : R line 8 rows

Manures and Fertilizers

Compost	:	12.5ton/ha
NPK	:	100 : 50 : 50 kg/ha
Basal	:	50 : 50 : 50 N P K kg/ha
Top	:	50 kg N/ha (30-35 days-tillering phase)
Foliar spray	:	DAP 1% solution is sprayed at peak flowering stage to enhance uniform flowering and increased seed set.

Jerking

Flowering and maturity (i.e flowering in the early parent) can be delayed by a week or so by jerking the earheads in the first stage. This may be continued till the other parent starts reaching the boot stage.

Tip sterility

Due to the action of desiccating wind , the stigma in the flowers of the top of the earheads dries up and looses its receptivity leading to no seed set.

Roguing

Should be done based on plant height, leaf colour, length of earhead etc.,

In hybrid, roguing is done at 4 times in and varieties 3 times.

Hybrids	Varieties
Before flowering 1	Before flowering 1
During flowering 2	During flowering 1
Before harvest 1	Before harvest 1

Field standard

	FS	CS
Off types	0.05	0.10
Pollen shedders	0.05	0.10
Smut diseases heads	0.05	0.10
Downy mildew diseased plants	0.05	0.10
Ergotted ear heads	0.02	0.04

Harvesting and threshing

The earheads of male and female parents are harvested separately when plants show drying symptoms or yellow colour and the moisture content of seed at this stage will be 20-25%. The earheads are threshed after reducing the moisture content to 15-20%. Seeds can be threshed manually with bamboo stick or by mechanical thresher and the speed will be around 1400 rpm.

Drying

Dry the seeds to 10% moisture content.

Grading

Grade the seeds using 4/64" (1.64 mm) round perforated metal sieve as middle sieve for obtaining uniformity in the sample. For WCC 75 alone, 5/64" round perforated metal sieve should be used as middle sieve.

Seed treatment

Seeds are slurry treated with thiram or captan @ 2 g/kg of seed along with 5 ml of water.

Storage

Treated seeds packed in cloth bag or polyethylene bags (700 gauge) will maintain viability upto 15 months under ambient conditions.

Mid-storage hydration - Dehydration for prolonging shelf life of seeds

Seeds that show a decline in vigour and germination during the early period of storage should be soaked for 3 hours in double the volume of Na_2HPO_4 (36 mg/lit of H_2O). The seeds after soaking should be dried back to 8% moisture content and dry dressed with thiram (or) captan @ 2g/kg of seeds to maintain shelf life upto 10 months with minimum loss in vigour and viability.

Seed standard

Parameters	**Foundation seed**	**Certified seed**
1. Physical purity (%) (min)	98	98
2. Inert matter (%) (max)	2	2
3. Other crop seeds (max)	10 kg^{-1}	20 kg^{-1}
4. Weed seeds (max)	10 kg^{-1}	20 kg^{-1}
5 Germination % (min)	75	75
6. Moisture content (%) (max)		
a. Moisture pervious	12	12
b. Moisture vapour proof	8	8

Important Varieties: CO 7, WCC 75, and K3.

Important hybrids in cumbu

KM 1	-	MS 5141 A x J 104
KM 2	-	MS 5141 A x K 560 -D-230
X4	-	MS 5141 A x PT 1921
X5	-	PB 111A x PT 1921
X6	-	732 A x PT 3095
X7	-	111A x PT 1890
H B1	-	Tift 23A x BIL -3B
HB 3	-	" x J 104
HB 5	-	" x K 559
UCH 11	-	732 A x PT 3075
COH(cu) 8	-	732A xPT 4450

Synthetics : If more than 5 parental lines are combined ,which are having general combining ability e.g. CO 7, ICMS 7703

Composite: 3-5 inbreds with no general combining ability are mixed and multiplied. WCC 75.

SEED PRODUCTION TECHNOLOGIES OF VARIETIES AND HYBRIDS IN MAIZE

Floral biology

The inflorescence is unisexual and monoecious. Staminate inflorescence is terminal and known as tassel and pistillate is axillary and called as cob. The cob is covered by the leaf like structures called husk (bracts). The husks are enlarged leaf sheaths from each node, forming a protective covering around the inflorescence. The ovary in the cob has a thread like style called silk and it is receptive throughout the length.

Anthesis and Pollination

Maize is an example for protandry. Pollen shedding begins 1-3 days before the silks emerge from the cob. It is estimated that a normal plant produces 2,50,00,000 pollen grains. Pollen is viable for 12-18 hours. Silk remains receptive for 8-10 days.

Methods of seed production

In maize, open pollinated varieties, synthetics, composites and hybrids are available.

a. Open pollinated varieties
   Raise the varieties under isolation of 400 m in foundation seed stage and 200 m in certified seed stage and allow the plants to openly pollinate among themselves and set seed.
b. Synthetics
   In cross pollinated species, a variety obtained by inmating in all possible combinations, a number of lines (>5) that combine well with each other. COBC 1 (Baby corn).
c. Composite varieties
   These are produced by open pollination among a number of outstanding strains usually not selected for combining ability with each other e.g. K1, Jawahar, Vikram, Sona, Amber, CO 1 and Kisan.

Inbreds

It is relatively true breeding strain resulting from repeated selfing (5 times.)

Hyrbids

a. Single cross hybrid
   It is a cross between 2 inbreds.
   e.g. COH 1- UMI 29 x UMI 51
   COH 2- UMI 810 x UMI 90

b. **Double cross** - It is a cross between two single crosses. e.g.
   Deccan (CM 104 x CM 105) x (CM 202 x CM 201)
   COH 3 (UMI 101 x UMI 130) x (UMI 90 x UMI 285)

c. Three way cross.
   It is a cross between a single cross and an inbred.
   e.g. Ganga -5 (CM 202 x CM 111) x CM 500.

d. Double top cross

It is a cross between a single cross and an open pollinated variety.
e.g. Ganga safed, Histarch, Ganga 4.

Seed production technology

Season - November- December

Isolation distance

	Foundation seed (m)	Certified seed (m)
1. Inbreds	400	-
2. Composite, Synthetics and OPV	400	200
3. Single cross hybrid	400	-
4. Other hybrids	-	300

Spacing

Seeds are sown in ridges and furrows

Varieties	45 x 10 cm
Hybrids	60x 25 cm

Seed rate

Varieties	: 10 kg /ha
Hybrids	Female 12 kg/ha and Male 4 kg/ha

Planting ratio

Single cross	4:2	
Double cross	6:2	
3 way cross	6:2	
Border rows	a. Inbreds	& single cross 4 rows
	b. Others	3 rows

Seed treatment

1.Treat the seeds with carbendazim or thiram @ 2g/kg seeds
2. After 24 hours treat the seeds with azospirillum 600 gm.

Fertilizers(varieties) 150:75:75

Basal 40:75:40 NPK kg/ha
1st top 20 DAS 50:0 :0 kg/ha
2nd top 40 DAS 60:0:35 kg/ha.

Hybrids

200:100:100 kg NPK /ha.

Micronutrients

- If Zn deficiency is found apply 20 kg of zinc sulphate / ha.
- If Fe deficiency is found apply 12.5 kg /ha micronutrient mixture

Detasselling

Detaselling is the removal of tassel from female parent. Detasselling is done when the tassel emerged out of the boot leaf, but before the anthesis have shed pollen. Anthers take 2-4 days to dehisce after complete emergence. Only in few cases, the anthers start dehisc before its complete emergence. In such case detasseling should be done earlier. Detasseling is done every day from the emergence of tassel upto 14 days.

Procedure

Hold the stem with left hand and remove the tassel with right hand by a steady upward pull.

Precautions to be adopted during detasselling

- Grasp entire tassel so that all the pollen parts are fully removed.
- Do not break or remove leaves as removal will reduce yields and will result in lower quality of seed.

Roguing

Should be done periodically based on position of cob, colour of silk, arrangments of seeds in cob, leaves etc.

Shedding tassel

Refers to the tassels in female parents rows, shedding pollen or that has shed pollen in hybrid maize plots. During field inspection a tassel whose main spike or any side branch or both have shed pollen or shedding pollen in more than 5 cm of branch length is counted as a shedding tassel.

Field standard

	FS	CS
Off types	0.2	0.5
Shedding tassel	0.5	1.0 (when receptive silk is 5% or more)

Irrigation

Once in a week. Critical period (40-65 DAS)

Pest and disease

Shoot fly and cob borer are the important insects to be controlled.

Harvesting

Harvest when the husk completely turns into straw colour.

Methods of harvesting

Male lines are harvested first followed by female lines.

Threshing

a. **Dehusking** - The husks are removed manually.

b. Cob sorting - Remove ill filled, diseased cobs and cobs having kernel colour variation.

Xenia

The direct, visible effects of the pollen on endosperm and related tissues in the formation of a seed colour.

Mataxenia

Is the effect a pollen on the maternal tissues of fruit.

Shelling

The cobs are shelled either mechanically or manually at 15-18% moisture content.

Drying: Seeds are dried to 12% moisture content.

Grading: Grade the seeds using 18/64" (7.28 mm) sieve.

Seed treatment

Slurry treat the seeds with 8% moisture content either with captan or thiram 75% W.P. @ 70 g/100 kg with 0.5 litre of water. Treated seeds can be stored for 1 year in cloth bag.

Seed standard inbreds

		Hybrids	
Parameters	**Inbreds**	**Foundation seed**	**Certified seed**
1. Physical purity (%) (min)	98	98	98
2. Inert matter (%) (max)	2	2	2
3. Other crop seed (max)	5 /kg	5 kg^{-1}	10 kg^{-1}
4. ODV seeds (max)	5/kg	5 kg^{-1}	10 kg^{-1}
5 Germination % (min)	80	80	90
6. Moisture content (%) (max)			
a. Moisture pervious	12	12	12
b. Moisture vapour proof	8	8	8

Seed standard in varieties

Parameters	**Foundation seed**	**Certified seed**
1. Physical purity (%) (min)	98	98
2. Inert matter (%) (max)	2	2
3. Other crop seed (max)	5 kg^{-1}	10 kg^{-1}
4. ODV seeds (max)	10 kg^{-1}	20 kg^{-1}
5 Germination % (min)	90	90
6. Moisture content (%) (max)		
a. Moisture pervious	12	12
b. Moisture vapour proof	8	8

Modification of isolation distance

Differential blooming dates are permitted for modifying isolation distance provided 5.0% or more of the plants in the seed parent do not have receptive silks when more than 0.20% of plants in the adjacent field (s) within the isolation distance are shedding pollen.

Distances less than 200 meters may be modified by planting border rows of male parent, if the kernel colour and the texture of the contaminant are the same as that of seed parent. The number of border rows shall be determined by the size of the field and isolation distance from the contaminant.

SEED PRODUCTION IN COTTON

`

Floral biology

Simple, solitary, terminal, extra axillary, petals yellow to cream in colour, hermaphrodite, bracteoles called as epicalyx, three in number, free and deeply serrated and persistent at the base of the flower. Nectary gland is present on each bracteole. Calyx five, united, cup shaped corolla five, polypetalous, a purple spot is present on the inner side of the claw of the petal (petal spot) in some species. Androecium forming a staminal column (monadelphous) bearing numerous anthers. Ovary superior penta carpellary, style slender, passes through staminal column with three to five lobed stigma, ovules many in axile placentation.

There is much variation in case of flower opening. Asiatic cotton opens between 8 and 10. a.m. American cotton opens much earlier. Temperature affects the flower opening. After flower opening the cream yellow colour of corolla turns pink within a day and later changes to red. The receptivity of the stigma is 8 to 10 a.m.

Cotton is an often cross-pollinated crop where the extend of cross-pollination is > 60%. In cotton 4 different species are in popular usage, viz. ***G. arborieum*** (eg.K10) ***G. herbaceum*** (e.g. Uppam) ***G. hirsutum*** (e.g. MCU varieties) and ***G. barbadense*** (e.g. Suvin and Suguna).

Method of Seed Production

Varieties: Under isolation, by open pollination, the varieties are multiplied. For nucleus seed production, selfing of flowers is done with cotton (lint) or red earth.

Hybrids: In cotton both inter and intraspecific hybrids are available.

Interspecific Hybrid : Varalakshmi :Lakshmi x SB298 E (*G. hirsutum x G. barbadense*)
DCH 32 / Jayalakshmi : DS 28 x SB 425 (*G. hirsutum x G. barbadense*)

Intraspecific hybrid : Suguna

Tool employed for hybrid

The hybrid seed production in cotton is achieved through emasculation and dusting technique, which is the physical removal of male organ (staminal column) from the female parent.

1. Emasculation and dusting

At the time of flower initiation in female line, the flowers that are going to open next day are selected and the petals are removed between 3-6 pm. With the help of nail or needle, the total staminal (pollen + anther + anther tube) column are removed. Then the flowers are covered with a definite colour cover for easy identification of the emasculated flowers. In the morning between 9 am -12 noon, which is the anthesis time, the flowers of

selected male parent are plugged and dusted on the stigma of the emasculated flower on opening the cover. It is again covered with different coloured cover to avoid pollination with other pollen and to identify the emasculated and dusted flower from the rest. The pollen from a single flower is enough to dust 4-5 female flowers. The pollen receptivity of the stigma is for 46 hours.

For easy identification of selfed boll from emasculated and dusted boll the bract can be removed while emasculating owing to the little contribution of bract to seed set and seed yield.

Particulars of varieties/hybrids

Varieties	Parentage	Season	Irrigated / Rainfed	Seed yield (kg/ha)
MCU 5	Multiple cross	Aug- January	Irrigated	1850
MCU7	X ray irradiation of x L 1143 EE	Jan- Feb. to May - June(summer)	Irrigated (Rice fallows)	1330
MCU 11	MCU 5 x Egyptian hirsutum hybrid derivative	Aug - September	Irrigated	2200
LRA 5166	Laxmi x Reba B.50 x AC 122	Sep-October to Jan - February	Rainfed	725
K10	K9 x 11876 hybrid derivative	Sep-October to Jan - February	Rainfed	726
K11	(0794-1-DX 11876) x (0794-D x 11450) Multiple Hybrid derivative	Oct- March	Rainfed	1100
Suvin	Hyrbid derivative from the cross Sujatha x St.Vincent	Aug - February	Irrigated	1020
Jalyalaxmi	Interspecific hybird of DS 28 *G. hirsutum* x SB 425 (VF) *G. barbadense*	Aug-February	Irrigated	2880
TCHB 213	Interspecific hybird of TCH 1218 *G. hirsutum* x TCB 209 *G. barbadense*	Aug-February	Irrigated	2215
SVPR 1	MCU 7 x AC 129/2	February - July	Summer - Irrigated	15-16 Qtl. Of kapas /ha
Savitha	T7 x M 12 (Intra hirsutum hybrid)	Aug-February	Irrigated	1800
HB 224	It is an interspecific hybrid involving *G. hirsutum x G. barbadense*	Aug-February	Irrigated	2000

Steps necessary for efficiency in seed production

1. Emasculate and dust as far as possible buds appearing during the first six weeks of reproduction phase to ensure good setting and development of bolls.
2. Restrict your emasculation each day evening from 3 pm to 6.pm and pollination in morning between 9-12 noon to ensure highest purity of hybrid seeds. Emasculation should be complete and perfect.
3. Choose optimum size of bud and avoid young or too old buds for emasculation.
4. Cover the male buds with paper bags, previous evening for their use next day.
5. Emasculated buds may be covered preferably with butter packets.
6. Do not forget to tie a thread to the pedicel of the bud immediately after pollination.
7. Close your crossing programme after 9^{th} week (from commencement of crossing) and remove all buds and flowers appearing subsequently to facilitate the development of crossed bolls.
8. Nip the top and side shoots to stop further vertical and horizontal growth.
9. Light irritations should be given as and when required. Excessive or scanty or inadequate irritations should be avoided especially during crossing and boll development period.
10. Continue irrigation till last picking of the crossed bolls. Frequency of irrigation depends on weather factors like rainfall, temperature and wind velocity.
11. Pick up the ripe and completely opened bolls along with threads and collect in baskets for second sorting. Bolls without threads may be bulk harvested as female seed cotton.
12. Crossed bolls collected in baskets may be sorted out for second time to verify that they are crossed bolls. Then collect the crossed seed cotton and store in gunny bags carefully marked as crossed bolls.
13. Rain touch cotton or hard locks be picked and kept separately to avoid poor germination of hybrid seeds.
14. Store the crossed seed cotton in a cool dry place till it is handed over to processing unit.

Use of Genetic male sterility

Hybrids are also produced by employing genetic male sterility system in cotton, where the female parent will segregate into 50:50 ratio of male sterile and male fertile plants. The male fertile plants are removed and the male sterile plants are crossed with concerned male line.

E.g. Suguna: Gregg x K 3400

Land requirement

The field should be fertile and formed into ridges and furrows. Black cotton soils are highly preferable than other soils. Land should be free from volunteer plants and designated diseases especially the wilt disease.

Season

Winter crop : Aug - Sep
summer crop : Feb - March

Seeds and Sowing

Seeds should be obtained from an authenticated source with tag and bill.

Pre-sowing management

The seeds can be hardened with 1% prosopis and pungam leaf extract for rainfed/summer sowing to resist water stress problem.Use of delinted seed is better than fuzzy seed to avoid diseased and injured seed.

Seed rate

Varieties :15 kg/ha (fuzzy seed) 7.5 kg/ha (delinted seed)
Hybrids : 3.75 kg/ha (Jayalakshmi), 1 kg TCHB 213)
Male : 2 kg /ha and Female 4 kg /ha.

Seed treatment

Treat the seeds with azospirillum at 3 packets (600 g/ha) and 2 kg of azospirillum / ha mixed with 25 kg of FYM and 25 kg of soil and applied on the seed line. This saves 25 % nitrogen besides increasing yield.

Spacing - Varieties

1. Long duration : 90 x 30 cm
2. Short duration : 60 x 30 cm

Hybrids - Planting ratio

8:2 but here it is block system where flowers of 2 parts of male is sufficient to dust 8 parts of female parent. The male and female parents are raised at an isolation of 5 m to avoid genetic and physical contamination.

Isolation (m)

	Foundation seed	**Certified seed**
Varieties	50	30
Hybrids	50	30

Manures and fertilizers

Compost : 12.5 tons/ha
Total : 100:50:25 NPK kg/ha
Basal : 50:50:25 NPK kg/ha
Top dressing : 25:0:0 NPK kg/ha
(40-45 days after sowing)
25:0:0 NPK kg/ha (70-75 days after sowing)

Foliar spray:

Spray DAP 2% (for A lines, spray on 60,70,80 and 90th days after sowing. (Soak 5 kg of DAP in 25 liters of water over night and supernatant liquid should be taken and mixed with 475 liters of water for spraying 1 hectare).

Micronutrient application

Mix 12.5 kg of micronutrient mixture formulated by the Department of Agriculture Tamil Nadu with enough sand to make a total quantity of 50 kg for one hectare.

NAA application

Spray 40 ppm of NAA (40 mg of NAA dissolved in 1 liter of water) at 40 / 45th day using high volume spray liquid in 1125 liter /ha. Repeat the same dose after 15 days of first spray.

Topping

Arrest terminal growth by nipping the terminal 10-12th node for controlling excessive vegetative growth.

Rouging

The crop should be rouged for off types, selfed plants, from vegetative phase to harvest phase depending on plant stature, leaf size, leaf colour, hairiness, stem colour, flower colour, petal spot, pollen colour, number of sympodia, boll size, boll shape, pittedness etc. to maintain genetic purity.

Field standards

	Maximum permitted (%)			
	Foundation seed		**Certified seed**	
	Varieties	**Hybrids**	**Varieties**	**Hybrids**
Off types	0.1	0.1	0.2	0.5

Weed management

Pre-emergence application of fluchloralin 2 l/ha or pendimethalin 3.3-l/ha or thiobencarb 3.0 l/ha followed by one hand weeding on 40 days after crop emergence. At the time of herbicide application sufficient soil moisture must be there. Fluchloralin needs soil incorporation or irrigation immediately after application. If sufficient soil moisture is not available for applying herbicides hand weeding may be given at 10-20 days after crop emergence.

Irrigation management

Once in 10 days. Critical periods are boll formation to boll maturation stages.

Specific problems

Boll shedding will occur either due to extreme dry climate or lesser frequency of irrigation or physiological disorder. By spraying 40 ppm of NAA and cycocel at 20ppm, this can be minimised.

Harvesting

The seed attains physiological maturation 45 days after anthesis. The initiation of hair line cracks on the dried bolls are the physical symptoms of physiological maturation. At that time, the moisture content will be 30-35%. The bolls are harvested as pickings in cotton. Due to continuous flowering habit once over harvest is not practiced. As and when the bolls burst with hairline cracks the bolls are collected and dried. Normally five to seven pickings can be practiced in a crop. But early 4-5 pickings are recommended for seed purpose.

Harvest in the morning hours upto 10 to 11 a.m. only when there is moisture so that dry leaves and bracts do not stick to the kapas and lower the market value. Pick kapas from well burst bolls only. Remove only the kapas from the bolls and leave the bracts on the plants. As kapas is picked, sort out good puffy ones and keep separately. Keep stained, discoloured and insect attacked kapas separately.

Kapas sorting

Kapas is sorted manually to pick good quality seeds. Hard locks are to be removed (Kapas without proper bursting and lint is light yellow in colour), since these kapas mostly result in poor quality seeds, due to boll worm or other insect attack.

Ginning and certification

1. Gin the crossed kapas in separate gins erected in authorised seed processing units or farm gins under the close supervision of the authorities concerned to ensure purity and avoid seed damage.
2. Sieve the seed in two types of mesh to remove small, shrivelled seeds, broken seeds and clean perfectly from any dirt or dust.
3. After ginning, the seeds should be dried well and cleaned by hand picking. After cleaning, certification agency will take sample for testing germination and genetic purity test. Minimum germination 65% and genetic purity 90% should be maintained.
4. Certified seeds would be bagged in one kg bag, sealed and details regarding its origin, germination, physical purity per cent and genetical purity percent, besides season of production are passed on to sale agencies or respective producers for commercial sale.
5. Uncertified seeds would be procured by the concerned Department or Agency at the market rate for the ordinary cotton seeds for further multiplication. This step is essential to avoid unauthorised sale of substandard uncertified seed.

Processing

The ginned seeds (or) the fuzzy seeds are graded by hand picking and by pressing on wire-mesh sieves to remove the under sized seeds and dust.

Acid delinting

Fuzzy seeds will clog with one another. So for easy handling the seeds are delinted using H_2SO_4 @ 100 ml/kg of seed for 2-3 minutes. After acid treatment, the seed should be washed thoroughly for 3 to 4 times with fresh water. From the floaters, mature seeds without any visible damage can be picked and added to the sinkers.

Procedure

Weighed quantity of fuzzy seeds are taken in a plastic container and required quantity of the acid is added. Stir well with wooden rod till a shiny black colour appears (Tar like) wash with more of water (5-6 times) and shade dry the seed to reduce the moisture content to 12% before further handling.

Processing of delinted seed

The free flowing delinted seeds can be graded using 10/64" round perforated metal sieve, which is recommended as standard sieve in OSAW cleaner cum grader for cotton.

The seed can also be graded by specific gravity method by using floatation technique using water. The seeds will separate into floaters and sinkers. The sinkers are good seeds. From floaters, reddish (immature) and damaged (seed with insect hole) are removed. The brownish seeds which are good seeds are hand picked and used for sowing.

Seed standards

Characters	**Foundation seed**	**Certified seed**
Physical purity % (min)	98	98
Inert Matter % (max)	2.0	2.0
Other crop seeds (max)	5.0 kg	10
Weed seeds (max)	5	10 kg
Genetic purity (%)	100	100
Germination (min)	65	65
Moisture content (max)		
a. Moisture pervious	10	10
b. Moisture vapour proof	6	6

Seed storage

The seeds can be stored upto 8-9 months in moisture pervious container and upto 12-15 months in moisture vapour proof containers. The seed treatment with thiram @ 2.5 kg^{-1} or chlorine based halogen mixture @ 3g kg^{-1} will protect the seed from storage fungi ***Aspergillus*** spp and preserve the storability.

Mid storage correction

The fuzzy and delinted seeds can be soaked in double the volume of 10^{-4} molar solution of Na_2HPO_4 for 2 and 1 hr respectively (3.59 g / 100 l of water.) Then the seeds are shade and sun dried to bring back to the moisture content of 10-12%. The mid storage correction improves the planting value of old seeds.

Dead seeds may be removed by soaking acid delinted cotton seeds in monolayer for 3 h and drying back to original moisture content. The seeds when put into potable water will separate into sinkers and floaters. Dead seeds become buoyant and float.

SEED PRODUCTION IN PULSES

RED GRAM

Botany

Axillary or terminal raceme borne on long peduncle. The flowers are yellow or purple. Based on the back of the standard petal colour, the variety is identified. Flowers are papilonaceous, bracteate, barcteolate, clayx five, gamosepalous and corolla with keel petals free stamens (9+1) diadelphous and didynamous, ovary superior with a few ovules. Fruit is a pod.

Anthesis usually occurs, between 8 a.m to 5. 00 pm. Fertilization occurs five hours after pollination. Red gram is an example for often cross-pollinated crop. The cross-pollination occurs mainly due to bees and thrips. Pigeon pea is an often cross-pollinated crop where natural out crossing is recorded upto 40-70%.

Varieties: Under isolation the crop is raised and by open pollination seeds are allowed to set.

Season	**Varieties**
Adipattam (June - August)	SA 1, CO4 and CO 5
Puratassipattam (Sep. November)	CO 5, COH 1 and COH 2
Summer (February-March)	CO5, COH 1, COH 2, SA1, CO3 and BSR1

Hybrids

The tool employed for production of hybrid seed is genetic male sterility system (GMS) where male sterility is maintained in heterozygous stage following the test cross principle, there would be male fertile and sterile plants in the ratio of 1:1.

Common hybrid	Female	Male
ICPH 8	MS Prabhat DT	ICPL 161 by ICRISAT in 1990
COPH 1 (Non-DT)	MST 21	ICPL 87109
COPH 2(Non-DT)	MS CO 5	ICPL 83027

Particulars of redgram varieties / hybrids

Particulars	SA1	CO 3	BSR 1	COH 1	COH 2
Parentage	Pureline selection from Tirupattur	Mutant CO 1	Pureline selection from Mayiladumparai, Madurai	MS T 21 x ICPL 87109	MS CO5 x ICPL 83027
Duration days	180	130	180	115-120	120-130
Yield kg/ha Rainfed Irrigated	 1250 -	 1180 1400	 0.75 to 1 kg of green pods/plant	 936 1500	 - 1050
100 seed wt (gm)	8.5	7.2	12.0	10.3	9.0-9.4
Seed colour	Pale reddish brown	Reddish brown	Reddish brown	Light brown	Tan brown

Land requirement

The land selected should not have been grown with pigeonpea crop in the previous season. It should be fertile with good irrigation facilities.

Isolation (m)

	Foundation seed	Certified seed
Varieties	250	100
Hybrids	250	100

Seeds and Sowing

The parental lines either for foundation or certified seed production should be bought from an authenticated source with tag and purchase bill.

Seed rate		**Spacing**
Varieties	25 kg ha^{-1} (short duration)	45 x 30 cm
	10 kg ha^{-1} (long duration)	90 x 30 cm
Hybrids	Male: 5 kg and female 40 kg /ha.	45 x 15 cm

Seed treatment

Treat the seeds with carbendazim or thiram @ 2g/kg of seed 24 hours before sowing (or) with talc formulation of Trichorderma virdie @ 4 g/kg of seed (or) Pseudomonos fluorescens @ 10 g/kg of seed. Bio control agents are compatible with biofertilizers. First treat the seeds with bio control agents and then with rhizobium. Fungicides and biocontrol agents are incompatible.

Fungicide treated seeds should be again treated with a bacterial culture. Treat with Rhizobial culture CC 1. There should be an interval of atleast 24 hours after fungicidal treatment for giving the bacterial culture treatment. For red lateritic soil rhizobial culture VPR 1 is effective.

Three packets of Rhizobial culture are sufficient for treating seeds required for one ha. The bacterial culture slurry may be prepared with rice kanji. Dry the bacterial culture treated seeds in shade for 15 minutes before sowing.

Planting ratio

The male and female seeds are sown in 1:4 ratio or 2:8 (COPH 1) and 1:6 (COH 2) for maximization of yield. Sow 2 rows of male line all around the field as border row.

Synchronization treatment

1. The pollen parent ICPL 87109 should be sown one week after sowing the female parent (MST 21) in COPH 1
2. The field should be bordered with sunflower to increase the seed yield by attracting honey bees

Season

The optimum time for taking up the hybrid seed production is first fortnight of June or first fortnight of December.

Seed production in different stage

Varieties : Breeder seed - Foundation seed - Certified seed

Hybrids : BS- multiplication of A(female) and R (male) under isolation
FS - Multiplication of A(female) and R (male) under isolation
CS - A and R crossed to produce hybrid seed.

Manures and fertilizers

Compost : 12.5tons ha^{-1}

25:50: NPK kg ha-1

Basal 25:50: NPK kg ha-1

Supplementary foliar application

Spray 250 litres of aqueous solution containing urea, DAP, muriate of potash and potassium sulphate at 10.0, 2.6, 1.75 and 1.4 kg respectively with addition of succinic acid at 40 g and teepol at 120 ml per hectare on the 55th and 70th day after sowing. The spray application should be made only in the afternoon.

NAA application

Apply 40 ppm of NAA (40 mg / lit) which may be advantageously mixed with urea and spray.

Irrigation

1st irrigation immediately after sowing and 2nd 2-3 days after sowing. Subsequent irrigations at 8-10 days interval.

Roguing

In male sterile line or female parent

- Remove the off types and volunteer plants.
- Remove the male fertile plant by examining plumby and yellow colour of anthers at the time of 1st flower formation, one day before flowering.
- Rogue at 7-10 days interval till completion of flowering.
- Remove the late flowering and early flowering plants.

In male fertile line or pollen parent

- Rogue the off types
- Remove immature pods set in the plants from time to time to induce continuous flowering and to ensure pollen availability for longer period.

Pollination

1. To supplement pollination 5-8 beehives may be arranged per ha.
2. To have the availability of pollen from the male parent for a prolonged period, clip off pods from the male parent. This will induce more flowering.
3. The whole plot should be bordered with sunflower to increase the bee activity to effect cross-pollination.

Pre harvest sanitation spray:

The pod borer attack and bruchid infestation starts from the field. To avoid this 3 sprays at 10 days interval should be given before the harvest. The chemical recommended is endosulphan or malathian (0.07%)

Harvesting

The crop attains physiological maturity 32 and 38 days after anthesis in winter and summer respectively. To avoid field exposure, matured pods should be harvested in 2-3 pickings. In hybrids male line should be harvested first and female line should be harvested later on.

Processing

The seeds are to be graded using 3.5 mm (B.S.S. 5 x 5) round perforated metal sieve for large seeded varieties and B.S.S. 6 x 6 (2.8 mm) for small seeded varieties. The seeds deviate from original tan colour are also to be removed. Rain at the time of harvest may enhance the occurrence of off coloured seeds and result in dimpled seeds. These seeds are to be removed.

Seed standards

Characters	Foundation seed	Certified seed
Physical purity (max) %	98	98
Inert matter (max) %	2	2
Other crop seed (max)	5/kg	10/kg
Weed seed (max)	5/kg	10/kg
Other distinguishable varieties (max)	10/kg	20/kg
Germination (min)% (including hard seed)	75	75
Moisture content (max)		
(a) Open storage	9.0	9.0
(b) Moisture vapour proof storage	8.0	8.0

Seed storage

The seeds devoid of bruchid infestation can be stored upto one year under ambient straoge and upto 15 months under 700 gauge polyethyelene bags. Seed can be mixed with leaf powders of arappu, neem, nochi and fruit rind powder of *sepindus laurifolisu* (pootchi kottai) and *Accacia concinna* (soap nut powder) in 1:100 ratio for dual-purpose storage. Seeds can also be mixed with activated clay in 1:100 ratio to avoid bruchid infestation.

Characteristics of pigeon pea hybrid COH 1 and its parents

Characters	Female parent MS T 21	Pollen parent ICPL 87109	F1 hybrid COH 1
Habit	Indeterminate(NDT)	Determinate (DT)	Indeterminate (NDT)
Maturity duration	115-120	100-110	115-120
Plant height (cm)	126	78	106
Inflorescence	Axillary raceme	Terminal raceme	Axillary raceme
Flower 1. Corolla 2. Back of Standard petal	 Yellow Yellow with light red vein at the base	 Yellow Red to crimson red	Yellow Yellow with red to dark red veins throughout
Pod colour	Green with purple streaks when young and brown at maturity	Light green with light streaks when young and brown at maturity	Green with purple streaks when young and brown at maturity
Hundred seed weight (g)	9.0	12.0	10.0
Colour of seed	Reddish brown	Light brown	Light brown

Hybrid seed production of COPH 1 pigeon pea

For hybrid seed production, a ratio of 4:1 of male sterile and pollen parent is adopted. Sufficient isolation distance i.e more than 250 meters for the hybrid seed production plot is needed. There should not be any pigeon pea crop within a radius of 250 meters from the seed production plot. Since, the male sterility is maintained in heterozygous state following the test cross principle, there would be fertile and sterile plants in the ratio of 1:1 in the male sterile population. It is therefore imperative to remove the male fertile plants in the male sterile population before flower opening. The roguing should be done thoroughly to avoid contamination by the pollen from any left out fertile plant.

Production and maintenance of male sterile lines

Genetic male sterility is utilized in hybrid seed production. In case of pigeon pea the male sterile line will segregate in 1:1 ratio of fertile to sterile. For the maintenance of the male sterile population, the male sterile plants have to be identified and tagged and the fertile plants have to be retained without tagging. The male sterile lines will be pollinated naturally by the pollen from the male fertile plants in the population through insect pollinators. After maturity, the seeds from the tagged male sterile plants are collected and will be used for producing male sterile lines again or for producing hybrid seeds.

The main difference between the hybrid seed production and the male sterile line maintenance is during hybrid seed production the male fertile plants from the sterile population are to be rogued off, while they are retained during male sterile line maintenance.

BLALCKGRAM AND GREEN GRAM

Botany

Black gram and green gram belong to Fabaceae and are highly self-pollinated. The extent of cross-pollination is upto 5-10%. An axillary raceme that may be branched with clusters of 5-6 flowers on a short but later elongates peduncle. Flowers are small, yellow and clustered at the top of the peduncle. Flowers bracteate, bracteolate, bisexual, hypogynous, zygomorphic, complete, pentamerous, gamosepalous, imbricate, corolla papilionaceous. Keel petals spirally coiled 10 (9+1) diadelphous, didynamous, ovary superior, uniocular with few ovules.

Flowers start opening early in the morning and are completely open between 7-8 a.m. The anthers begin to shed pollen in the previous day evening before the flowers open and anthesis is complete before mid-night. Self pollination is the rule.

Methods of seed production

Varieties:

The crop is raised under isolation by self-pollination and the seeds are allowed to set.

Popular varieties

Green gram : CO 5, CO 4, KM 2, Paiyur 1 and VBN 1

Blackgram : CO 4, CO5, VBN 1, ADT 2 and ADT 3.

Stages of multiplication:

Breeder seed ⟶ Foundation seed ⟶ Certified seed

Blackgram

Season	Varieties
Adipattam (June - August)	CO4, KM2, VBN1,2, TMV1, CO 5
Purattasipattam (Sep. November)	CO 5, KM2, VBN1, K1, VBN 2
Summer (February-March)	KM2, TMV 1, ADT 5, CO5, T9, CO4

Green gram

Season	Varieties
Adipattam (June - August)	CO4, KM2, VBN1,2, CO 5, Paiyur 1.
Purattasipattam (Sep. November)	CO 4, KM2, VBN1, K1, Paiyur 1
Summer (February-March)	KM2, CO4, Paiyur 1.

Particulars of blackgram /greengram varieties

Black gram

Particulars	CO 4	KM 2	VBN 1
Parentage	Mutant of CO 1	Derivative of T 9 x L 64	KM 1 x H 76-1
Duration days	70	60-65	60-65
Yield kg/ha Rainfed Irrigated	 640 1040	 690 -	 700 850
100 seed wt (gm)	5.7	4.0	4.6
Seed colour	Black & dull	Black with green mottling	Black

Green gram

Particulars	Paiyur 1	ADT 3	VBN 1
Parentage	Pureline selection from DPT 703	Hybrid derivative of H 70-16 / Rajendran / G 65	Hybrid derivative of S 8 x PIMS 3
Duration days	85-90	66	65
Yield kg/ha Rainfed Irrigated	 742 -	 500 500	 770 -
100 seed wt (gm)	3.5	2.6	3.6
Seed colour	Dull green	Dark brown	green

Land requirement

The land should be fertile and it should be prepared to fine tilth. Land should be free from volunteer plants.

Isolation (m)

	Foundation seed	Certified seed
Field of other varieties	10	5
Field of same variety not confirming to varietal Purity requirements for certification	10	5

Seeds and Sowing

The seed should be selected from an authenticated source. The off colour seeds should be removed from normal coloured, since they record lower germination. Only graded seed should be used.

In green gram and black gram the hard seed percentage may exceed 10% at a time. At that time seeds should be scarified with commercial sulphuric acid for 2 minutes and should be washed thoroughly and used for sowing.

Seed treatment

The seeds are to be treated with *Trichoderma* sp. @ 4g/kg of seeds or *Pseudomonos fluorescence* @ 10 g/kg of seed.

The seeds have to be treated with fungicide (thiram @ 2.5 g/kg) and insecticide (carbaryl @ 200 mg/kg) before sowing for early protection against diseases and insects.

The seeds should be treated with 3 packets of multi stain Rhizobium culture /ha of seeds to facilitate natural nitrogen fixation by the plants.

In dry land sowing the seeds can be soaked in 1/3 volume of 100 ppm of zinc sulphate (black gram) or manganese sulphate (green gram) for 3 hours and should be dried back to original moisture content by shade drying.

Spacing

Black gram	20 x 15 cm
Green gram	30 x 15 cm

The seeds should be dibbled 3-4 cm depth at the side of the ridges.

It can be grown in all 3 seasons but June-July is the best season. But sowing should be taken up in such a way that maturation period does not coincide with rain, which will increase the off coloured seed per cent in the seed lot. In summer production, hard seed content will increase compared to other season.

Manures and fertilizers

Compost FYM	:	12.5tons ha^{-1}
		25:50: NPK kg ha-1
Basal		25:50: NPK kg ha-1

Foliar spray: With micronutrients on 25^{th} and 40^{th} day after sowing.

Composition of micronutrients mixture

Chemical	**Blackgram**	**Greengram**
Urea	7.5 kg	7.5 -10.0 kg
DAP	1.95 kg	1.95-2.6 kg
K_2O	1.313 kg	1.313-1.75kg
K_2SO_4	1.05 kg	50 g
Succinic acid	40 g	50 g
Teepol	125 ml	125 ml

The composition was diluted in 250 litre of water/ha and given as spray to the crop at 25 and 40 days after sowing.

Water management

First irrigation immediately after sowing and 2nd 2-3 days after sowing. Subsequent irrigation 10-15 days interval. Apply KCl at 0.5% as foliar spray during vegetative stage if there is moisture stress

Weed management

Spray fluchloraline 1.5 l/ha or pendimethalin 2 1 /ha 3 days after sowing mixed with 900 l of water using backpack / knap sack/ rocker sprayer using flat type of nozzle. After this one hand weeding on 30-35 days after sowng gives weed free environment throughout the crop period. If herbicide is not given two hand weedings on 15 and 30 days after sowing.

Pest management

Apply any of the following insecticides at 25 kg.ha. Endosulfan 4% D; quniolphos 1.5% D; phasalone 4 %D, and carbaryl 1.5% D or spray per ha endosulfan 35 EC 1.01 or monocrotophos 36 WSC 500 ml (spray fluid 500 1 /ha to protect the inflorescence and pods from insects.

Disease management

Apply any one of the following fungicides when the symptom of diseases reaches grade 3.

1. Powdery mildew : Carbendazim 250 g or wettable sulphur 1.5 kg/ha
2. Rust : Mancozeb 1 kg or wettable sulphur 2.5 kg /ha.
3. Leaf spot : Carbendazim 250 g /ha
4. Tip blight : Carbendazim 250 g /ha
5. Yellow mosaic, Leaf curl and leaf crinkle: pull out and destroy plants infected in the early stage of growth (upto 30 days) and spray any one of the following insecticides after appearance of the disease.

Monocrotophos 500 ml/ha, methyl demeton 500 ml/ha and repeat after 15 days if necessary. For seed crop the plants affected by the leaf crinkle should be periodically removed upto 45 days after sowing since the leaf crinkle virus is seed borne.

6. Root rot: Treat the seeds with talc formulation or *Trichoderma virdie* @ 4 g/kg ofg seed or *Pseudomonos fluoroscence* @ 10 g/kg of seeds.

Spot drench carbendazim 1 g /lit or soil application of *Pseudomonos fluorescens* @ 2.5 g/ha mixed with 50 kg of well-decomposed FYM /sand at 30 days after sowing.

Apply neem cake @ 150 kg /ha basally to reduce root rot and also to have nematostatic action against cyst nematode.

Roguing

- Remove the off types, pest affected and mosaic plants.
- It should be done from vegetative phase to reproduction phase, based on leaf colour, plant stature, leaf shape, pod colour, flower colour and seed colour.

Field standards (Maximum permitted %)

	FS	CS
1. Off types	0.10	0.20
2. Plants affected by seed borne diseases	0.10	0.20

Pre harvest sanitation spray

To avoid bruchid infestation in the storage, crop should be sprayed with endosulphan 0.07% for 3 times at 10 days interval before harvest. Seeds attain physiological maturation 30 days after 50% flowering when the colour of the pod is black and brown respectively in black gram and green gram and the pod moisture content at this stage will be 17-18%.

The pods are dried to 12-13% moisture content and thrashed and precleaned. The seeds should be size graded using BSS 7 x 7-wire mesh sieve for homogenizing the seed lot.

Seed treatment

The graded seeds can be further dried to 7-8% moisture content and treated with chemicals mentioned in the order of preference.

i. Thiram 75% WDP 200 g and carbaryl 20 g dissolved in 500 ml of water per quintal of seed.
ii. Activated clay in 1:100 ratio is dry dressed. The clay should be free of acid and completely dried one.
iii. Neem seed kernel powder 3%

Seed standards

Characters	Foundation seed	Certified seed
Physical purity (max) %	98	98
Inert matter (max) %	2	2
Other crop seed (max)	5/kg	10/kg
Weed seed (max)	5/kg	10/kg
Other distinguishable varieties (max)	10/kg	20/kg
Germination (min)% (including hard seed)	75	75
Moisture content (max)		
(a) Open storage	9.0	9.0
(b) Moisture vapour proof storage	8.0	8.0

SEED PRODUCTION TECHNOLOGIES OF SOYBEAN

Botany of crop

Flowers – small, born on short axillary condensed raceme bearing 3-25 flowers. Flower white or purple with a papilionaceous corolla. Stamens 10, monadelphous, ovary with many ovules, short style, incurved, apical stigma. The stamens develop a tube around the pistil and pollen from the anther is shed directly on the stigma. So soybean is self-pollinated crop.

Flower opens early in the morning. The pollen is shed normally shortly before or after the flower opens. But pollen shedding may occur sometimes within the bud itself. Normally cross-pollination does not exceed 1 per cent.

Method of Seed Production

The varieties are raised under isolation and by thorough roguing genetically pure seeds are produced.

Seeds Multiplication stages

Breeder seed --> Foundation seed --> Certified seed

Varieties: CO1, CO2, ADT 1.

Land requirement

The land should be fertile and should not have been grown with the same crop in the previous season. If grown, it should be the same variety which was certified for the said class of seed.

Isolation (m)

Foundation seed	Certified seed
3	3

Season

June-July and September - October. There should not be rain or high humidity at the time of harvest.

Seeds and Sowing

Seed should be obtained from authenticated source with tag and bill. The seeds are to be treated with fungicides (capton 2g kg^{-1}) for better germination and establishment. Before sowing seeds are to be treated with Rhizobium culture.

Seed rate

80 kg ha^{-1}

Spacing

30x10 cm

Manures and fertilizers

Compost : 12.5tons ha^{-1}
80:80:160 NPK kg ha-1 (basal)
40 Kg N as top dressing at flowering stage.
Foliar spray : 2% DAP at initiation of flowering and 15 days after the 1st spray. Spray planofix 40 ppm together.

Pest and Diseases

To control white fly spray methyl demeton 25 E.C. 500ml ha-1 or phosphomidon 86 EC @ 500ml ha-1 or dimethoate 30 EC 500ml ha-1

Roguing

The off types and volunteer plants are to be removed as and when they occur from vegetative to harvesting stage based on leaf colour, stem colour, growth status, flower colour, pod colour, seed colour etc.

Field standards

Characters	Foundation seed	Certified seed
Offtypes (%)	0.10	0.50

Irrigation

Irrigation is given immediately after sowing. Life irrigation is given on 3rd day after sowing. Subsequently the field is irrigated once in 7-10 days. Critical stages are flowering and pod filling stage.

Pre-harvest sanitation spray

Two weeks before harvest endosulfan 0.07% should be sprayed twice at weekly interval to control pod borer and primary infestation of bruchid.

Harvesting

Seed attains physiological maturity 23-25 days after anthesis. The crop is harvested as once over harvest with pods intact with plant. Yellowing of plant and browning of pods is the external symptoms of physiological maturation.

Threshing

Whole plants of soybean are dried in the threshing floor and beaten with pliable bamboo sticks for removal of seeds. The extracted seeds are winnowed to get the seeds. The seeds should be dried to 7-8% moisture content under sun for good seed storage.

Grading

The bulk seeds are graded using 10/64" round perforated metal sieve for soybean.

Seed standards

The graded seed should possess the following characters for certification and sale as certified/ truthfully labeled seeds

Parameter	Soybean	
	Foundation seed	Certified seed
Physical purity (min) %	98	98
Inert matter (max) %	2	2
Other crop seed (max)	None	10/kg
Weed Seed (max)	5/kg	10/kg
Other distinguishable variety seed (max)	5/kg	10/kg
Germination (min)% (including hard seed)	70	70
Moisture content (max)		
(a) Open storage	12	12
(b) Moisture vapour proof storage	7	7

Seed treatment and Storage

The seeds should be treated with captan+ sevin @ 2g+200mg kg^{-1} of seed for safe storage. The treated seed can be stored upto one year in open storage and upto 2years in moisture vapour proof containers, provided the seeds are devoid of bruchid infestation both primarily and secondarily.

SEED PRODUCTION TECHNOLOGIES OF COWPEA

Botany of crop

A high rate of flower occurs in this crop. Normally a cowpea plant produces 100-500 flowers of which 70 to 80 per cent shed before anthesis. In the remaining about half of them abort prematurely. Under Coimbatore conditions flowers open between 7.00 a.m to 9.00 a.m. The time of dehiscence of anthers is from 10.00 a.m. to 12.45 p.m.

Varieties

CO1, CO 2, CO 3, CO 4, CO 6, C 152, KM 1, Vamban 1, Vamban 2 and Paiyur 1.

Season

Winter - September to October

Sowing

Remove all discoloured seeds and use high germinable (more than 90%) seeds retained by 12/64" diameter (aperture width 4.6 mm) round perforated sieve for CO 2 and 10/64" diameter (aperture width 3.96 mm) round perforated sieve for small seeded varieties.

Slurry treat 24 hours before sowing with Captan at 2 gm mixed with 5 ml of water per kg of seed. Just before sowing, treat with the rhizobium culture.

Spacing

Adopt a spacing of 45 x 20 cm.

Isolation

	Foundation	Certified
	10 m	5m

Application of fertilizers

Apply 25 : 50 : 0 NPK kg/ha.

plant protection

Pull out and destroy plants exhibiting severe symptoms of mosaic in the early stages of growth. Protect the flower parts and pods from pod borer by applying any one of the following insecticides.

Carbaryl 5% D 25 kg /ha; Phasalone 4% D 25 kg /ha; Endosulfan 4% D 25 kg /ha; Quinolphos 1.5% D 25 kg /ha; Endosulfan (0.07% spray) 1250 ml/ha; Monocrotophos (0.04% spray) 625 /ha.

Pinching the tendrils and application of NAA 40 ppm (40 mg/l) may be followed at flower initiation and at peak flowering stage to promote fruit setting.

Pre harvest sanitation spray

Two weeks before harvest endosulfan 0.07% should be sprayed twice at weekly interval to control pod borer and primary infestation of Bruchids.

Harvesting

Harvest the pods as they turn light straw in colour and the seeds within turn brown or mottled in colour. At this stage the moisture content of seeds will be about 18 per cent.

Air dry the pods at first for 1-2 days and sun dry until they become brittle and easily break by genetic flailing with pliable bamboo stick or machine thresh by adjusting the cylinder to avoid splitting and cracking of seeds. At threshing the seed moisture content should be about 12%. Tamil Nadu Agricultural University Model Pulses thresher may be used.

Grading

Grade the seeds at 10% moisture content using 12/64" diameter (aperture width 4.6 mm) round perforated sieve for CO 2 and 10/64" diameter (aperture width 3.96 mm) round perforated sieve for small seeded varieties.

Seed standards

The graded seed should possess the following characters for certification and sale as certified/ truthfully labelled seeds

Parameter	Cowpea	
	Foundation seed	Certified seed
Physical purity (min) %	98	98
Inert matter (max) %	2	2
Other crop seed (max)	None	10/kg
Weed Seed (max)	None	10/kg
Other distinguishable variety seed (max)	5/kg	10/kg
Germination (min)% (including hard seed)	75	75
Moisture content (max)		
(a) Open storage	9	9
(b) Moisture vapour proof storage	8	8

Drying, treating and storage

The graded seeds after the removal of the broken and immature seeds should be dried to 7 to 8 per cent moisture content.

For short term storage use fresh gada cloth bag or gunny bag and for long term storage use 700 gauge thick. L.D. Polythene bags. Alternately activated clay @ 1 kg /100 kg of seeds may be dry dressed for grain cum seed storage use.

SEED PRODUCTION IN OIL SEED CROPS

1. SEED PRODUCTION IN GROUNDNUT

Principle

Seeds are produced by self-pollination and fertilization. Here cross-pollination does not occur because the stigma remains enclosed in the keel petal even in fully opened flower.

Method of seed production

The crop is raised under isolation and seeds are allowed to set by self-pollination.

Stages of seed production

Breeder seed ⟶ Foundation seed ⟶ Certified seed.

Since it is a highly self-pollinated 5 stages are allowed in Foundation seed.

Seed production technology

a. Pollination behaviour: Self-pollination and the extent of cross-pollination is upto 0.5%.

b. Season : June - July (rainfed) , December - January (irrigated)

C. Varieties:

1. Spreading : TMV 1, 3, 4.
2. Semi-spreading : TMV 6, 8,10.
3. Bunch : TMV 2,7,9,11,12, ALR 1, 2, VRI 1, 2, 3, 4, JL 24, CO 1, 2, BSR 1.

Dormancy

TMV 7 - 10 days
CO 1 - 10-15 days
VRI 2 - One week

Seed colour

Light rose : TMV 2, 7, JL 24, VRI 1, 2 and VRI 3.
Rose : CO 1, CO 2
Red : ALR 1
Red blotched with white : TMV 10.

Land requirement

The selected land should not have been grown with the same crop in the previous season if grown it should be undergone the certification standards.

Isolation distance

Foundation	Certified
3m	3m

Seeds and sowing

Seed rate	: Rain fed	140 kg /ha
	: Irrigated	125 kg /ha

Increase the seed rate by 10% for bold seeded varieties like JL 24, CO2 and TMV 10.

Seed treatment

1. Treat the seeds with Trichoderma virdie 4 g /kg. This can be done just before sowing. It is compatible with biofertilizers. But should not be treated with fungicides.
2. Treat the seeds with Thiram or mancozeb at 4 g/kg of seed or carboxin or carbendazim @ 2 g / kg of seeds.
3. Treat the seeds with 3 packets (600 g/ha) of Rhizobial culture TNAU 14 using rice kanji as binder.
4. If the seed treatment is not carried out apply 10 packets/ha (200 g) with 25 kg of FYM and 25 kg of soil before sowing.
5. Seed treatment will protect the young seedlings from root-rot and collar rot infection.

Pre sowing seed hardening

The seeds are soaked in 0.5% $CaCl_2$ solution (50% seed volume) for 6 hours. After 6 hours seeds are spread over moist gunny bag and covered with another moist gunny bag for 20-24 hours. After 24 hours, the seeds with sprouted radicle (just visible expression of radicle) should be separated and dried under shade. It should be repeated for 2-3 times, with 2 hours interval and all the viable seeds with expressed radicle emergence should be separated and dried under shade and used for immediate sowing. Thus the viable and dead seeds are separated.

The remaining seeds can be dried to original moisture content and stored for 7-10 days.

To break dormancy the seeds are treated with 200 ppm ethrel.

Spacing	:	Bunch	-	25 x 15 cm.
		Spreading	-	60 x 25 cm
		Semi spreading	-	45 x 15 cm.

Sowing and gap filling.

Dibbling of seeds should be done without damage to the radicle of the pre-germinated seeds. Gap filling should be done with the pre-germinated seeds with in 10 days.

Manures and fertilizers

Compost	:	12.5 t/ha
NPK	:	40:40:60 kg /ha
Borax	:	10 kg/ha
Micronutrient mix		12.5 kg /ha

- Apply micronutrient mixture on the surface after sowing.
- Gypsum application of 400 kg / ha on 45th day of sowing increases easy penetration of peg as well as the pod formation and filling up of the pods.
- Spraying D.A.P at 0.5% at flowering stage is also recommended for proper seed setting.

Roguing

Roguing should be done from vegetative phase upto harvest based on the colour of leaf, size and shape of the pod, seed number per pod, and testa colour of seed.

Intercultural operations

The soil should be stirred well at the time of flowering for easy penetration of peg and this should be coincide with gypsum application.

Irrigation

It should be given once in 15 days and it is must during flowering, pod formation stage and seed filling stage.

Pest and diseases

Insects like red hairy caterpillar and diseases like tikka leaf spot should be controlled.

Harvesting

Drying and falling of older leaves and yellowing of the top leaves indicate maturity. The colour of the inner side of the pod shall turn black. The seeds will move inside the pod.

Method of harvest

The whole plant should be uprooted.

Stripping

It is the process by which pods are removed from plants either mechanically or manually. The pod moisture content at the time of harvest will be 35-40%.

Drying

The pods are dried to 10-12% moisture content

Pod grading

Dried pods are graded with round perforated metal sieves of 22/64" to 24 /64" depending upon the variety.

Decortication

The seeds are separated using decorticator and the moisture content will be 16% at that time.

Seed grading

Seeds are graded using round perforated metal sieves of 18/64" to 20/64".

Seed drying

Graded seeds are dried to 7-8% moisture content

Seed treatment

Treat the seeds with 2 g thiram / kg of seed. Pods can also be stored by treating the pods with thiram @ 2 g/ kg of pod. Pods can also be stored in gunny bags along with calcium chloride at 250 gm for 30 /kg of pod placed in a plastic container.

In general, pods can be stored for 18 months and seeds for 8months.

Seed standard

The graded seed should possess the following characters for certification and sale as certified/ truthfully labelled seeds

Parameter	Foundation seed	Certified seed
Physical purity (min) %	96	96
Inert matter (max) %	4	4
Germination (min)%	70	70
Moisture content (max)		
(a) Open storage	9	9
(b) Moisture vapour proof storage	5	5

Deficiency of nutrients

1. Calcium: Deficiency of calcium results in ' Pops'. In this disorder, early seed abortion occurs and although an apparently normal pod matures it contains either no seed or minute shrivelled remains of seeds. Another disorder ' Dark plumule' results in the seeds when split open showing a plumule, which is black. The normal plumules are light cream in colour.
2. Boron: Boron deficiency increased single compartment nuts. The shells are often cracked. Hollow heart in the kernels is produced. When the cotyledons of the seed are separated a knurled hollow is observed between them, which is sometimes darkened, or off coloured. This hollow heart leads to the invasion of seed borne pathogens as the seed develop.

2. SEED PRODUCTION IN SUNFLOWER

Botany of flower

Inflorescence is a head, consisting of pistillate or sterile flowers at the periphery and central hermaphrodite, disc florets. The involucre is bract. The pappus is calyx.

Method of seed production

In sunflower both varieties and hybrids are available. Varieties are raised under isolation and allowed to set by cross-pollination.

Hybrids are produced by employing cytoplasmic genetic male sterility. The male sterile female and male parents are raised in BSH 3, 1:6, KBSH 1, 1:4 ratio under 400 m isolation. Seeds are produced by transferring the pollen of male parent to the female parent with the help of honeybees reared at 5 hives / ha.

Stages of **seed production**

Pushtovoit varietal renovation or seed renovation model

In open pollinated variety, selection of superior plants are made from regarding of quality characters (plant height, size of head) and lab analysis of selected plants for yield (100 seed weight, oil content) and seeds should be collected separately. The evaluation should be made in the selected progenies in rows. Seeds of promising plant will be collected and this will form elite seeds.

Seed production technology

a. Pollination behaviour: Sunflower is a cross-pollinated crop. Two types of flowers are available. They are ray and disc flowers. Ray flowers are unisexual while disc flowers are bisexual.
b. Pollinating agent : Honey bees

b. Season : June - July, October - November

Isolation distance

	Foundation seed	Certified seed
Varieties	400 m	200 m
Hybrids	600 m	400 m

Seeds and sowing

Seeds are sown in ridges and furrows

Seed rate : Varieties 15 kg /ha

: Hybrids Female 12 kg /ha and Male 4 kg/ha.

Spacing

60 x 30 cm (hybrids), Varieties 45 x 20 cm

Planting ratio : 8:1 or 4:1

Manures and fertilizers

Compost : 12.5 t/ha

NPK : 60:45:45 kg /ha

Foliar application

At head opening stage 2 % D.A.P and 20 ppm N.A.A. sprayed 2 times on 30th and 60th day after sowing for effective seed setting.

Supplementary pollination

Due to lack of honey bees, seed setting will be poor. Hence critical or additional pollination is given to the crop for effective seed setting by

1. Rubbing the heads of two neighbouring plants with each other. It is done during mid flowering stage (i.e 58-60 days of planting for long duration varieties and 45-48 days for short duration varieties) at alternate days between 7-11 a.m for 2 weeks.
2. Hand pollination: The heads are rubbed with palm or muslin cloth so that pollination can be affected.
   In hybrids, the palm is first gently rubbed on the male parent flowers and then on the female line to transfer the pollen.

Roguing

Plants are rogued based on plant height, head size and colour of seeds during pre-flowering stage upto harvest.

Field standards

	Foundation seeds	Certified seeds
Off types	0.1 %	0.2%

Harvesting

The change of head colour from green to lemon yellow is the indication of physiological maturity. The heads are harvested separately.

Drying

Heads are dried to moisture content of 15-18 % for threshing.

Processing

Seeds are first graded by specific gravity separator. Then size graded by round perforated sieve with a specification of 9/64" (3.5 mm).

Seed standards

The graded seed should possess the following characters for certification and sale as certified/ truthfully labelled seeds

Parameter	Foundation seed	Certified seed
Physical purity (min) %	98	98
Inert matter (max) %	2	2
Germination (min)%	60	60
Moisture content (max)		
(a) Open storage	8	8
(b) Moisture vapour proof storage	5	5

Dormancy

If the seeds are fresh (1 to 5 months old) germination will be low due to dormancy. Hence the seeds should be soaked in aqueous solution of ethrel @ 300 ppm for 8 hours or in 0.5% KNO_3 for 16 hours.

Hybrids

BSH -1 = CMS 234 A x RHA 274
KBSH 1 = " x 6 DI
MSFH 1 = MHS 71 x MHR 48
MSFH 8
MSFH -17
TCSH 1 = CMS 234 A x RHA 272

Varieties

CO 1, CO 2, Morden, K1, K 2, EC 68414, EC 68415.

3. SEED PRODUCTION IN GINGELLY

Pollination behaviour

Often cross-pollination and cross-pollination extends upto 60%

Pollinating agent : Insects

Season : April - May

Land requirement

Previous crop should not be the same crop, if it is the same crop, it should be of the same variety and have undergone certification.

Seed and sowing

a. Seed rate : 3-4 kg / ha

b. Spacing : 30 x 30 cm

c. Isolation distance :

Foundation seeds	Certified seeds
100 m	50 m

Manures and fertilizers

Compost	:	12.5 t/ha
NPK	:	50 : 25 : 25 kg /ha
$MnSO_4$	:	5 kg /ha

Foliar application

D.A.P 1 % at first flowering and again 10 days after 1st spray.

Roguing

Based on branching behaviour, size of the capsule, colour of capsule and colour of seeds, the rogues are to be removed periodically.

Field standards

	Foundation seeds	Certified seeds
Off types	0.1 %	0.2%

Intercultural operation

Earthing up should be done to prevent lodging before flowering stage.

Irrigation

Once in 15 days and it is must during flowering and capsule filling stage.

Pest and disease

Borer, wilt and phyllody are to be controlled.

Harvesting

Harvest when 75-80% of the capsules start yellowing and bottom 1 or 2 capsules have dehised. At this stage, the pod moisture content will be 50 to 60% and seed moisture content 25-30%.

Method of harvest

The whole plant is cut at ground level, bundled and stacked inversely to provide humidity.

Stacking and drying

Stacked plants are left in the threshing floor for 3 days to bring down the moisture content to 15 -18%.

Threshing: is done manually by beating with pliable bamboo sticks.

Processing: The seeds are size graded using round perforated metal sieve of 5/64" to 4/64" depending upon the variety.

Seed treatment

Captan / Thiram @ 2 g / kg of seeds.

Storage

Seeds can be stored well upto 2 years in polythene bags (700-gauge thickness) and 9 months in gada cloth bag under open storage conditions.

Seed standards

The graded seed should possess the following characters for certification and sale as certified/ truthfully labelled seeds

Parameter	Foundation seed	Certified seed
Physical purity (min) %	97	98
Inert matter (max) %	3	3
Other crop seed (max)%	1	1
Weed Seed (max)	1	1
Germination (min)%	80	80
Moisture content (max)		
(a) Open storage	9	9
(b) Moisture vapour proof storage	5	5

Seed colour

Varieties - Seed colour

TMV 3, 4, 5, 6 VRI 1 - Brown Paiyur1, Co 1, Black SVPR 1 -White.

4.SEED PRODUCTION IN CASTOR

Sex expression

Inflorescences are borne terminally on the main and lateral branches. The main stem ends in raceme, which is the first or primary raceme. After the first raceme appears, 2 or 3 branches arise at the nodes immediately below it. Each of these branches terminates in racemes after 4 or more nodes have formed which are known as secondary racemes. Branches arise from the nodes just beneath secondary racemes, ultimately terminating in tertiary racemes. This sequence of development (indeterminate growth habit) continues.

The racemes of castor are monoecious with the pistillate flowers on the upper 30-50% and staminate flowers on the lower part of the inflorescence. The proportion of pistillate and staminate flowers among the racemes varies a great deal both within and among genotypes. It is influenced by the environment of the plant, genotypes and nutrition.

Female tendency is the highest in winter, while male tendency predominates in summer and rainy seasons. Also, the femaleness in young plants with high levels of nutrition is stronger than in old plants with low levels of nutrition.

Pistillate mechanism

In addition to monoecism a sub form of dioecism exists in castor, which has led to the identification of 3 different pistillate mechanisms.

1. **N type or conventional mechanism**

   It is governed by a recessive sex switching gene. This can be maintained by sibmating The progeny from seed produced on pistillate plants segregates in 1: 1 ratio of pistillate and monoecious plants. In the production of F1 hybrid seed using the N pistillate line, the producer is required to rogue out normal monoecious plants before anthesis to obtain 100% production of pistillate plants in the female rows. This has proved difficult to do for 3 reasons.

a. Uneven emergence,
b. Variation in time of flowering and
c. Higher percentage of monoecious plants than expected 50 percent.

2. **S type or non conventional mechanism**

It is derived from reversals, which start out as female and then revert to normal monoecism any time after the first raceme. Use of this pistillate line is beset with the problems of lack of stability of the expression of pistillate character as large number of revertants as well as monoecious plants was observed in the population. Eg. VP 1. This problem was successfully overcome with the exploitation of the NES system.

NES system

This line is normally pistillate under moderate temperature but produces interspersed staminate flowers under high temperature. In crossing fields (hybrid seed production plot) usually one or two roguing of the female line are sufficient to ensure that all flowering plants are pistillate to remove off types that appear.

E.g. The original population of VP 1 was thoroughly screened under high temperature to eliminate the monoecious plants as well as early revertants.

The seed setting in the selected totally pistillated lines is facilitated by the production of interspersed male flowers under the influence of environment sensitive genes.

India is the largest producer of castor in the world. In India, Gujarat is the leading state followed by Andhra Pradesh.

It is a highly cross pollinated crop. The pollinating agent is wind.

Varieties

SA 1, SA 2, TMV 4, 5, 6, CO 1, Aruna, Bhagya and Sowbaghya.

Hybrids

The development of N type pistillate line, N 145-4 has led to the exploitation of hybrid vigour in USA in 1950. A 100% pistillate line TSP 10 R (Texas S- pistillate 10) was released in 1962 in USA. Another stable pistillate line (NES 1, based on environmentally sensitive staminate flower character in combination with recessive sex switching gene released at Davis, California in 1964, is now used.

In India, Gujarat first started hybrid seed production in mid sixties.

First hybrid in India was released in 1968 in Gujarat as GCH3 (Gujarat castor hybrid) using TSP 10 R x JI 15.

Indigenous pistillate line VP 1 was developed at Vijapur and using this GAUCH was released in 1973. But it is susceptible to wilt and root rot diseases. Hence another hybrid GCH 2 was released in 1985. Another hybrid GCH 4 was released in 1986 and is in cultivation.

Hybrids	**Male**		**Female**
GCH 3	TSP 10 R	x	JI 15
GAUCH 1	VP 1	x	V 19
GCH 2	VP 1	x	JI 35
GCH 4	VP 1	x	48-1
TMVCH 1	LRES 17	x	TMV 5

Land requirement

Well drained fertile soil should be selected. The crop cannot tolerate alkalinity and salinity. It performs well with medium to deep sandy loam and heavy loam soils are highly suited for seed production.

Isolation distance

	Foundation seed	Certified seed
Varieties and Hybrids	600 m	300 m

Season

Rabi / Winter - Hybrid seed production. Summer and kharif provide ideal male promoting environment for undertaking seed production of the variety, male and female parents of hybrids. Kharif and summer encourages good expression of less productive plant which could be easily eliminated through timely roguing.

Female parents when raised in male promoting environment produce environmentally sensitive staminate flowers, which are very essential for self-production of the female parents.

Seed and sowing

Seed rate : 10 kg / ha (varieties)
2 kg / ha male and 5 kg/ ha female for hybrids.

Spacing

Varieties : 90 x 20 to 90 x 60 cm
Hybrids : 90 x 40 to 90 x 60 cm

Planting ratio

3:1 or 4 - 6:1

Fertilizer : Basal 40:60: 40 NPK / ha
Top : 1st 20 kg N/ha (40-50 DAS) , 20 kg N/ha. (After 1st picking)

Bloom : Presence of white waxy coating which protects from chilling and jassid attack.

4 types of bloom :

1. No bloom
2. Signle bloom - Bloom only on stem
3. Double bloom- On stem, petioles, and lower sides of leaves
4. Triple bloom - On all parts.

Stages of inspection

1. 10 days prior to flowering -Stem colour, inter-node length.
2. During flowering - No. of nodes upto primary raceme
3. Before 1st picking (Spike and capsule character, reversion to monoecious in second order raceme)
4. After 1st picking - Reversion to monoecious or flower initiation in third order raceme.

Irrigation

Critical stages are primordial initiation and flowering stage in differential segmental order branches. Moisture stress in sensitive crop growth stages may lead to production of more male flowers in monoecious varieties.

Harvesting

Castor produces 4 or 5 sequential order spikes, which can be harvested in 3-4 pickings starting from 90-120 days at 25-30 days interval.

Premature harvesting lead to reduced seed weight, oil content and germination. If shattering is not a problem in a variety, harvesting can be delayed until all capsules are fully dried.

Grading

The seeds are size graded using round perforated metal sieve of 8/64".

Field standards

	Foundation seeds	Certified seeds
Off types (Varieties)	0.1	0.2%
Off types (Hybrids)	0.5	1.0%

Seed standards

The graded seed should possess the following characters for certification and sale as certified/ truthfully labelled seeds

Parameter	Foundation seed	Certified seed
Physical purity (min) %	98	98
Inert matter (max) %	2	2
Other crop seed (max)%	-	-
Weed Seed (max)	-	-
Other distinguishable variety seeds	5 / kg	10/kg.
Germination (min)%	70	70
Moisture content (max)%		
(a) Open storage	8	8
(b) Moisture vapour proof storage	5	5

Seed storage

Thiram @ 2 g / kg

Pervious container - 1 year

Moisture vapour proof container - 2 years

SEED PRODUCTION IN VEGETABLES

Vegetable seed production is completely different from vegetable production where the fully matured reproductive part is not the economic produce. The reproductive part in younger stages are consumed as vegetables in most cases.

Vegetables broadly can be classified as solanaceous vegetables (tomato, brinjal and chillies) malvaceous vegetables (bhendi), cucurbitaceous vegetables (snakegourd, ribbedgourd, bittergourd, ashgourd, pumpkin and bottlegourd) and cruciferous vegetables (carrot, cabbage, knolkhol, cauliflower) based on the family origin. The leafy vegetables are amaranthus, lettuce, spinach and fenugreek where vegetative part is used for consumption.

1. SOLANACEOUS VEGETABLES

The familiar three vegetable crops are raised on transplants. First the seeds are raised in nursery and the seedlings are used for transplanting..

Nursery bed preparation and management

Nursery bed should be in other field and should be under partial shade. Apply farm yard manure to the nursery area and incorporate well before formation of raised nursery beds. The bed size of 1m breadth, 2m length and 30cm height will be ideal for nursery. The soil should be porous and loose for easy penetration of roots. Lines are drawn at 10cm apart. Seeds are sown sparsely at 1cm depth and covered with river sand. Watering is done with rosecan initially and after germination flood irrigation is done. Seeds germinate within 8 days. Drench the beds with fytolan (copper oxy chloride) @ 5 g/lit of water once in 7 days to prevent damping off disease. Apply 2Kg of DAP 10 days prior to pulling out of seedlings. Spray rogar or metasystax @ 1ml/lit of water, if sucking pests are noticed.

TOMATO

Seed rate**:** 300 g / ha

Age of seedling 25-30 days.

Spacing

CO 1	: 60 x 60 cm
PKM 1	: 75 x 60 cm
CO 2	: 80 x 75 cm
Pusa Ruby	: 80 x 70 cm
CO 3	: 60 x 30 cm

Fertlizers

Total	: 150 : 100 : 100 NPK kg / ha
Basal	: 75 : 100 : 100
Top dressing	: At the time of flowering 75 kg N.

Foliar application

NAA @ 20 ppm 65 and 75 days after planting followed every time by spraying urea at 12 kg, Super phosphate 4kg, 2 kg potassium sulphate and 200 g of micronutrient mixture dissolved in 100 lit water / acre.

Harvest

Seeds attain maturity 30-45 days after flowering

Harvest fully matured, red, ripened and healthy fruits. First 8 - 10 pickings alone should be used for seed extraction.

Seed extraction

Well-matured fruits are crushed and made into a pulp. For every 1-kg of pulp add 20-30 ml of commercial HCL acid and keep for 30 minutes with constant stirring. At the end of 30-minutes wash the seeds 3-4 times with water and air-dry the seeds.

Grading

BSS: 12 x 12 wire mesh (2.1 mm) sieve are used.

Storage

Dry the seeds to 7-8 % moisture and treat with thiram or captan 75 % WP @ 2 g + 200 mg sevin 50% WP / kg of seeds or halogen formulatioan (bleaching powder + CaCO3 + arappu leaf powder @ 5:4:1 @ 3 g / kg. The treated seeds can be stored upto 12 months in paper bags and upto 24 months in moisture vapour proof containers.

HYBRID SEED PRODUCTION IN TOMATO

Tomato is predominantly a self-pollinated crop and only less than 5.0 per cent cross-pollination has been reported. The conventional method of hybrid seed production in tomato involves 2 basic steps viz., emasculation and hand pollination which makes hybrid seed production expensive.

Conventional method of hybrid seed production

In this method, there are two steps generally followed viz., emasculation and hand pollination. As tomato is a self-pollinated crop, the parental lines are maintained by continuous selfing. The male parental lines have to be raised atleast 15 days in advance of raising female parent so that there will not be any problem for availability of pollen for hybridization in the first truss of flowers produced by female parent. A female : male parental ratio of 5:1 is recommended. Flower buds of female parent are emasculated 12 - 14 hours before opening. Flowers of male parent are bagged at bud stage and are picked up in the early morning. The pollen is collected in dry petridishes, as stamens are hygroscopic. The receptivity of stigma is 21-36 hours before opening of flowers. Pollination is done generally in the morning hours between 7.00 a.m. and 10.00 a.m.

The steps followed in the production of hybrid seeds are

- Raise the female and male parents during optimum season in the ratio of 5:1
- Select one or two well-developed flower buds of female parent, which will open the next day.
- Emasculate the flower bud in the evening by removing the anther cone using clean and pointed forceps or head pin.
- Cover the emasculated flowers with butter paper cover of convenient size preferably, 10 x 5 cm to prevent foreign pollen contamination.
- Cover the flower buds of pollen parent. Use covers of different colours for male and female parents.
- Collect pollen from the male parent between 7.00 a.m to 10.00 a.m in a clean petridish.
- Dust the pollen on the receptive stigma of the emasculated flower using camel hair brush.
- After hand pollination, cover the crossed flowers with butter paper cover and label for identification.
- Remove all other flower buds leaving one or two crossed flowers in a truss to ensure good fruit set.
- Allow the flower with cover for seven days to set fruits and remove the cover after ensuring fruit set.

Male sterility

The cost of hybrid seed production can also be reduced by use of male sterile lines. Male sterility would eliminate an important operation viz., emasculation thus reducing the labour cost substantially. Four types of male sterility have been reported in tomato.

i. Sterile plants
ii. Stamenless flowers
iii. Positional sterility (protruding stigma)
iv. Functional male sterility (in which pollens are functional but anthers are indehiscent)

Potato leaf and green stem was identified as one of the markers for male sterile lines. Pollen sterility in the pollen sterile mutant is also influenced sometimes by environment. The original male sterile forms have not come in common usage because they have not shown superior combining ability. But it has been rightly pointed out that suitable male sterile lines could be developed by incorporating the male sterility character into standard varieties through a back cross programme. Recently the use of the female lines having exerted stigma has been employed for hybrid seed production in tomato. Though the exerted stigma character is genetic, it is influenced by environmental conditions.

SEED EXTRACTION TECHNIQUES IN TOMATO

Fruit Grading

Based on fruit size and shape, true to type fruits are selected for seed extraction and large to medium sized fruits alone to be used for extraction of higher seed recovery. In tomato seeds are extracted from fully ripened (reddish) fruits by different methods. They are:

(I) Fermentation method

The fruits are pulped by trampling under foot or using a pulper and collect the pulp in plastic container or cement tank. The pulp is allowed to ferment overnight. The next day seeds get separated from the pulp. The floating fraction is removed and discarded and the sinkers (due to bacterial degradation the seed is fermented and settle down in the bottom of the container) are collected, washed well and dried in the shade for 1-2 days and then in sun between 8 -12 noon and 2-5 pm.

(II) Hydrocholoric acid method

The fruits are pulped by trampling under foot or by using a pulper and collect the pulp in a plastic container or cement tank. Add commercial hydrocholric acid @ 20-30ml Kg^{-1} of pulp and keep it for 20-25min with occasional stirring. The seeds get separated from the pulp and sink to the bottom. The floaters can be removed by discarding. The seeds are collected, washed well with water 3-4 times and dried in shade. The advantages of this method are the seeds are attractive in colour, recovery is very high, remove the external seed borne pathogens and do not clog each other while drying. Seed quality is also very high.Seed recovery is 0.8-1.0 %.

(III) Alkali method

By using sodium bicarbonate solution (30-35g/I of water) at 1:1 ratio of the solution and pulp for 12 hours will separate the seeds from the pulp, which will be washed and dried under shade.

Disadvantage is seed colour will be dull.

(IV) Mechanical extraction

Tomato seeds are also extracted by using tomato seed extractor or pulper for large scale seed extraction. The seed extraction consists of two units operated by electric motor, one is fruit pulper or crusher and second one is seed and pulp separator. The whole unit is made up of stainless steel. Here extraction is immediate, seed recovery is high and pulp/juice can be further used for making byproduct like jam, jelly etc., The cost of seed extraction is Rs.7.5/kg.

Seed yield: 150 kg/ha

BRINJAL

Season: June - July.

Seed rate**:** 450 g / ha

Nursery preparation

15 days before sowing drench the nursery with methane sodium @ 28 ml / sq. m. for controlling the nematodes, after 7 days with copper oxychloride @ 5 g / lit to prevent damping off.

Age of seedling: 30-35 days.

Spacing: 75 x 60 cm

Fertlizers

Total	: 150 : 75 : 75 NPK kg / ha
Basal	: 50 : 75 : 75
Top dressing	: Just before flowering 50 kg N/ ha.

Supplemental foliar application

NAA @ 20 ppm 65 and 75 days after planting followed every time by spraying urea at 12 kg, super phosphate 4kg, 2 kg potassium sulphate and 200 g of micronutrient mixture dissolved in 100 lit water / acre.

Harvest

Seeds attain maturity 40-45 days after flowering The symptom of harvestable maturity is turning of the skin colour from green to bright yellow. Medium size fruits yield more quantity and quality seed than big or small fruits.

Seed extraction

Well-matured ripened fruits are cut into 4 - 6 pieces and softened by soaking in water overnight. On extraction the floaters are removed.

Grading

Sieve size : 5/ 64 round perforated metal (2.1 mm) sieve or BSS 12 x 12 wire mesh sieve (2.1 mm) are used.

Storage

Treat the seeds with either thiram or captan 75 % WP @ 2 g + 200 mg sevin 50% WP / kg of seeds or Halogen formulatioan (bleaching powder + $CaCO_3$ + arappu leaf powder @ 5:4:1 @ 3 g / kg. The treated seeds can be stored upto 2 years in moisture vapour proof containers.

HYBRID SEED PRODUCTION IN BRINJAL

Brinjal potentially a self-pollinated crop is classified as an often cross-pollinated crop, about 30 to 40 per cent natural cross-pollination occurs through insects.

Hybrid seed production in brinjal is done by emasculation and hand pollination. The flowers of the brinjal plant are quite conspicuous and emasculation is fairly easy. A ratio of 10:1 for female and male parental lines would be the most optimum for efficient production of hybrid seeds. The following steps are adopted for hybrid seed production.

- Raise the female and male parents at an isolation distance of 200 m from each other as well as from other varieties. The male parent has to be raised 15-20 days ahead of the female parent.
- In the plants of female parent, select well developed plumpy long styled flower buds which are going to open on the next day morning (which can be identified by the prominent ovary)
- Emasculate the flower buds on the previous day evening between 3.00 and 5.00 p.m. using a needle by removing the anthredial cone carefully. Cover the emasculated flower buds with butter paper.'
- Similarly on the previous day evening cover the flower of male parent from which pollen is going to be collected on the next day morning.
- Next day morning by 6.00 p.m. collect the flower buds before opening and separate the anthers and put in a petridish covered by glass.
- Keep the petridish against sunlight to facilitate dehiscence of anthers and release of pollen grains.
- Remove the butter paper cover on the emasculated flower and dust the pollen over the stigmatic surface with the help of camel hairbrush.
- Rebag the flower and label. Since the stigma is receptive for 4 days, remove the bags only after 8-10 days when fertilized ovary is prominently seen.
- After full maturity, extract the seeds.
- On an average of 400 kg of hybrid seeds can be obtained from one hectare.

In the department of vegetable crops, Horticultural College and Research Institute, Coimbatore the planting ratio of female and male parents for the developed hybrid COBH 1 was standardized as 10:1. Planting the female parent (EP 45) and male parent (CO 2) in the ratio of 10:1 gave the highest seed yield of 469.9 kg / ha.

CHILLI ES

Season: June - July

Seed rate: 1 kg / ha

Age of seedling : 30-35 days

Spacing: 60 x 30 cm

Fertlizers

Basal	:50: 70: 70 kg NPK / ha
Top dressing	:50 kg N 15 days after transplanting. 50 kg N 45 days after transplanting and 40 kg N 90 days after transplanting.

Foliar application

NAA @ 20 ppm 65 and 75 days after planting followed every time by spraying urea at 12 kg, super phosphate 4kg, 2 kg potassium sulphate and 200 g of micronutrient mixture dissolved in 100 lit water / acre.

Harvest

Seeds mature 40-45 days after planting. Harvest the fruits when they become capsicum red in colour. Fruits obtained from first 5 to 6 pickings alone can be used for seed extraction.

Seed extraction

Dried fruits are taken in a gunny or cloth bag and threshed with a pliable bamboo stick or TNAU model chill seed extractor. The seeds are separated and graded.

Grading

Sieve size: 8/ 64" round perforated metal sieve or BSS 8 x 8 wire mesh sieve (3.1 mm) are used.

Storage

Intact pods can also be stored upto 20 months. Seeds dried to 7 to 8 % moisture content and treated with halogen formulatioan (bleaching powder + $CaCO_3$ + arappu leaf powder @ 5:4:1 @ 3 g / kg or captan 75% WP 4g / kg. Seeds can be stored upto 10 months in cloth bag and 18 months in moisture vapour proof containers.

HYBRID SEED PRODUCTION IN CHILLIES

The hybrid seed production in chilli is by adopting the emasculation and pollination technique. Emasculation may be done early in the morning or in the previous evening before opening of flower. With the help of a pair of forceps, the petals are easily parted and anthers are removed and bagged. There is no intention of doing any emasculation on the following 1 or 2 days all unopened buds, which are likely to open on these days, must be removed and whole plant should be covered with a muslin cloth bag.

Late in the morning or early in the afternoon of the following day, fresh flowers should be plucked from intended male parents which have been previously bagged and pollen dusted in the stigma of the emasculated flowers. The pollen is dry and powdery and easily dislodged from the anthers with a camel hair brush.Te bag should be replaced and labels denoting of parents and date of pollination should be tied outside the bag.

Crossing is found to be successful when the plant is in full bloom. During cloudy weather, crossing should be avoided, as setting is very low in such conditions. The ratio of seed parent to pollen should be 5:1. Hand emasculation and hand pollination are the most expensive method of hybrid seed production because of high labour cost and low fruit set percentage. Therefore hand pollination without emasculation is done using male sterility. Hence genetic male sterility mechanism is more economical and can be exploited for hybrid seed production. The 50% heterozygous male fertile plants are removed in the female plant and 50% homozygous male sterile plants are kept for hybrid seed production. The expression of genic male sterility is affected by environment especially temperature. The male sterility less sensitive to environmental factors should be selected for hybrid seed production. Few hybrids developed in Chilli are Agni, HOE 808, HOE 888, CH 1, HOE 818, BSS 138, BSS 141, ARCH 228, CH 104, Capscicum are Bharat, Early Bonty, Indira, Lario and Green gold.

BHENDI

Season: March, April and May

Seed rate: 8 - 10 kg / ha

Spacing: 60 x 20 cm

Fertlizers

Basal	: 40 : 50 : 30 kg NPK / ha
Top dressing	: 20 : 0: 0 kg NPK / ha
	1. 10 kg N / ha at first flowering
	2. 10 kg N / ha 10 days after flowering.

Foliar application

DAP @ 0.5 % thrice at 10 days interval commencing with first flowering enhances the yield of good quality seeds.

Harvest

Seeds mature 28-30 days after anthesis. Harvest the pods when they dry and turn brown and develop hairline cracks along the ridges. In bhendi first formed two pickings can be used for vegetable purpose and the next 6 pickings can be used for seed purpose.

Seed extraction

Harvested pods can be dried in the sun for 2-3 days and seeds can be extracted in a machine thresher or by hand with pliable bamboo stick.

Grading

Sieve size: 10/ 64" round perforated metal sieve or BSS 6 x 6 wire mesh sieve (4.2 mm) are used.

Upgrading; To remove the empty seeds, water flotation technique is adopted. Air dry the seeds.

Storage

Seeds can be easily stored when they are dried to 8 % moisture content and treated with halogen formulatioan (bleaching powder + $CaCO_3$ + arappu leaf powder @ 5:4:1 @ 3 g / kg or captan 75% WP 4g / kg.Seeds can be stored upto 15 months in cloth bag and 24 months in moisture vapour proof containers.

SEED PRODUCTION TECHNOLOGY OF GOURDS

SNAKE GOURD

Snake gourd (*Trichosanthes cucumerina* L) is also called Chicinda.

Season

July - December and January - June.

Pre-sowing treatment

Pre germination of seeds by soaking in double the volume of water for 4 hours enhance the seed germination.

Seed rate

1.5 kg /ha.

Spacing

Dig pits of size 45 x 45 cm at 2.5 x 2.0 m spacing .

Manuring

100 g of the mixture (6:12:12) per pit as basal and 10 g N/pit 30 days after sowing.

Foliar application

Maleic hydrazide @ 400 ppm at 2 leaves stage and 5 leaves stage enhances the seed yield and quality or application of ethrel @ 100 to 200 ppm at weekly intervals from 4 **TH**LEAF stage. During the course of fruit development apply urea @ 12 kg / ha, super phosphate 4 kg /ha, potash 2 kg /ha and micronutrients 400 g/ha.

Harvest

Fruits can be harvested at visible yellow to orange skin initiation stage.

Seed extraction

Manually the immature seeds can be removed as water floaters during wet extraction. After drying the seeds the immature and small sized seeds should be removed as air blown rejects. 16/64" round hole sieve may be used or BSS 4 x 4 (6.2 mm).

Storage

Seeds dried to 7 to 8 % moisture content and dry dressed with thiram / captan 75% wettable powder or halogen mixture @ 3 g / kg of seeds, can be stored in cloth bag upto 10 months and over 18 months in moisture vapour proof containers.

Varieties: CO 1, CO 2, MDU 1, PKM 1 and APAU Swetha.

BITTER GOURD

Bitter gourd (*Momordica Charantia* L) is also called Balsam pear.

Season

June to July and January to February.

Sowing

Sowing pre-germinated seeds to maintain optimum field population, the seeds are soaked in water for 24 hours. Then place the seeds in moistened sand and cover the seeds with sand and left for 3 days. Maintain the sand in wet condition. After 3 days the seeds with protruding radicle are separated and used for sowing.

Seed rate

1.8 kg /ha

Spacing

45 x 45 cm at 2.5 x 2 m . dip 3 seeds per pit.

Manuring

Apply 10 kg FYM per pit.

Top dressing

i. Urea 22 g / pit during 1st flowering.
ii. Urea + potash 18 + 5 gm/pit during 20 days after flowering.
iii. Urea 18 gm + potash 5 gm/ pit during 40 days after flowering.

Foliar application

Spray ethrel 200 ppm from 4 leaves stage onwards at 1 week interval for 4 times.

Harvest

Change of fruit colour to orange.

Seed extraction

Cut the fruits longitudinally, then remove the seeds along with mucilaginous material. Then wash the seeds with water.

Drying

Dry the seeds under shade for one or 2 days. Then dry under sun to 7-8% for storing in cloth bag and 6% for moisture vapour proof containers.

Grading

Grade the seeds using BSS 4 x 4 size .

Storage

Captan or thiram 4 gm/kg of seeds or halogen mixture @ 5 g/kg of seeds.

Varieties

CO 1 and MDU 1.

ASH GOURD

Ash gourd (*Benincasa hispida cogn*) is otherwise called wax gourd.

Varieties

CO1, CO 2, APAU Shakthi and S 1.

Season

January - May and June - November.

Seed rate

2.5 kg / ha.

Manuring

100 g of the mixture (6:12:12) per pit as basal and 10 g N / pit 30 days after sowing.

Foliar application

Maleic hydrazide @ 400 ppm at 2 leaves and 5 leaves stages enhances the seed yield and quality or ethrel @ 100-200 ppm at weekly intervals from 4 leaves stage for 4 times.

During the course of fruit development apply urea 12 kg / ha, super phosphate 4 kg/ha, potash @ 2 kg /ha and micronutrients 400 g / ha.

Harvest

Fruits can be harvested 80-85 days after anthesis when stalk becomes dry and ashy coat prominent. Fruits weighing < 2.5 kg should be rejected.

Seed extraction

Fresh fruits can be used for extraction.On fresh extraction immature seeds can be removed as floaters. Cutting the fruits into longitudinal bits and soaking in 1:6 concentrated HCl acid for 30 minutes and wash the seeds with water 2 to 3 times to remove the acid.

Grading

Using 16 / 64" round perforated metal sieve or BSS 4 x 4 wire mesh sieve grade the seeds.

Storage

Fruit storage

i. Half matured fruits available at the last harvest can be removed and stored over sand bed at ambient conditions. On dry storage seed develops and can be used for seed extraction. Facilitate early field release.
ii. Fruits weighing not less than 2 kg without bruishes and proper protection from insect pathogen and rodents can be stored over sand for more than 6 months. The loss in fruit weighing amount to 35% with germination of 80-90%
iii. Seeds should be dried to 8% moisture and treated with thiram 4 kg of seeds or halogen mixture 5 g / kg and stored in moisture vapour proof container for longer storage.

HARVESTING AND PHYSIOLOGICAL MATURITY

1.Physiological maturity

It is a stage of accumulation of maximum dry matter within the seeds. It is expressed with maximum seed weight, germination and vigour potential. The moisture content of the seed will be in decreasing order (25-30%).

2.Harvestable maturation

The physiological maturation is represented to a seed and this maturation will not be the same for all the seeds of a single plant / population, due to continuous differential flowering habit. Hence the stage of attainment of physiological maturity by 80% of the population is considered as the harvestable maturation stage. The moisture content of the crop will be lesser than the physiological maturation stage (18.20%).

Normally the seed is harvested at field maturity or harvestable maturity.

3. Harvesting indices

Changes in ripening fruits and seeds have been viewed as indicators of maturity. These indices can be grouped under physical indices and biochemical and physiological indices.

Physical indices of maturity

a. Colour change
b. Increased firmness or brittleness
c. Decreased moisture content and specific gravity
d. Changes in physical dimension

Biochemical indices

Changes in concentration of fat, sugars, starch, soluble nitrogen and protein nitrogen.

Physiological indices

Germination percentage
Seedling vigour

Morphological maturity symptoms in different crops

Crop	Symptoms of maturity
Paddy	Change of green colour to straw yellow colour panicle
Sorghum	Formation of dunken layer (Black).Change of earhead colour to pale yellow (depending upon the variety)
Cumbu	Formation of dunken layer (Black), Earhead colour changes to ivory.
Maize	Husk dries and becomes straw yellow. Drying of silk
Cotton	Hairline crack in bolls
Sunflower	Backside of thallamus turning lemon yellow in colour

Groundnut	i. Black colouration in inner side of the shells ii. Rattling sound in kernal Yellowing of older leaves
Pulses	Turning of pod colour to brown / black
Soybean	Withering of leaves. Pod colour changes to brown
Gingelly	Browning / yellowing of pods. Seeds become chocolate brown in colour and 1or 2 capsules at bottom are dehiscing
Brinjal	Yellow colouration of fruits.
Tomato	Reddish colouration of fruits
Ashgourd	Ashycoating over the fruit
Pumpkin	Yellowish browning of fruit rind
Ribbed gourd	Rattling sound of seed in fruit , browning of dried fruits
Snake gourd & Bitter gourd	Change of fruit colour to yellow / red at distal end or any part of fruit.
Onion	Umbel colour change into yellow colour (10-20% black seeds visible.

Methods of harvest

The seeds can be harvested either manually or mechanically.

In mechanical harvesting, single harvest is possible but care should be taken to avoid mechanical injury.

In manual harvesting, crops can be harvested either as single harvest or as periodical harvest. The crops having continuous flowering habit are to be harvested in different harvest / pickings.

The optimum time of harvest is when the seed is fully mature, weather damage has just begun and the seed is easily harvested and cleaned resulting in minimized harvest losses. Harvesting at an early stage makes (17.20% moisture content) threshing / combining difficult and relative losses due to threshing and cleaning are greater. Similarly harvesting at a later stage may result in increased weather damage to seed, losses due to shattering of seeds (in pulses), bird damage, stalk breakage and lodging of plants in the field. Thus optimum harvest time is somewhere between these two extremes.

The moisture content is another good indicator of optimum time of harvest in most seed crops. Moisture content of seed crop is not a limitation if the crop is harvested manually. If harvesting is to be done mechanically, moisture content of the seed must be below 20 per cent. Combines do not operate well above 15 per cent seed moisture.

Types of harvests recommended for different crops

Crop	**Types of harvest**
Paddy	Once over harvest
Cumbu	Two harvests
Pulses	Two-three harvests or pickings

Cotton	5-6 pickings
Sunflower, groundnut	once over harvest
Bhendi	4-5 pickings
Tomato	6-8 pickings
Brinjal	6-8 pickings
Gingelly	Once over harvest
	4-5 pickings
Gourds	

Threshing

Threshing is practiced in almost all cereals, pulses, oil seeds and tree species. Threshing is done either manually using stick in the case of small quantity and mechanically using threshers in the case of bulk quantity. Trampling of animals and tractor treading are also practiced in some parts of our country. Irrespective of the threshing technique practiced, adequate care is needed for minimizing mechanical damage. Among the threshing techniques, tractor treading cause mechanical damage to a larger extent compared to others, particularly incase of pulses where the seed coat damage is more. Animal trampling is not good for seed crop as there are chances for mechanical and genetic mixture to the seed, which is foresighted for all types of purity. Better one will be mechanical threshing with proper care on damage caused to the seed which can be minimized by proper adjustment of blades, operture size etc., depending on the type of machine used for threshing.

In mechanical threshing for maintenance of genetic purity, cleaning of the instruments viz., thresher, sheller, combiner is a must. The machinaries should be cleaned prior to each harvesting or threshing and between fields of different parental inbreds or hybrid seed crops. A source of air pressure 700 g/cm2 and a vacuum source are necessary to clean the harvester thoroughly. The machines also should be calibrated properly for all its internal operations according to moisture content of the seed and that of the plant taken together.

Specific extraction techniques

The extraction of seed from the reproductive part (fruit / pod/cone/boll) vary with the crop depending on the crop and embeddence of seed in the reproductive part. Some of the special extraction techniques specific to crop are as follows:

Shelling

The production part of maize is known as cob and the extraction of seed from the cob is known as shelling. Cob shellers are used in mechanized way, while cob in gunny bag are threshed with bamboo stick and then the unwanted material are blown in air. In cob sheller the moisture content of cob should be 15-18 per cent, otherwise the drier cobs leads to splitting of kernels, while cobs of higher moisture content will lead to crushing of seeds. Both lead to reduction of seed quality.

Ginning

Cotton seeds are embedded in the lint and fuzz., Removal of lint from seed is known as ginning. It is normally done with ginneries.

Delinting

Ginned seeds are fuzzy and non-free flowing. Delinting is the process, which make them free flowing and also aid in removal of insect damaged and ill filled seeds. Delinting is done with commercial sulfuric acid which at large scale creates soil degradation on disposal of used acid. Gas delinting with hydrochloric acid fumes are practiced in cotton delinting.

Decortication

It is special operation specific to groundnut. Pods are considered as seed. But on sowing decorticators are used for shelling of kernel from pod.

In sunflower the mechanical threshers are used to separate the seeds.

Wet extraction

In vegetables, with fleshy fruits seeds are wet extracted. In tomato acid extraction took over the conventional fermentation method. Tomato seed extractors are also used by large scale seed producers for dual purpose extraction. In cucurabitaceous vegetables (ash gourd, pumpkin, watermelon, snake gourd and bitter gourd) the seeds are wet extracted and washed with lime solution (05%) or concentrated hydrochloric acid for 10 ml/lit of pulp for removal of the muscilagenous tissue.

SEED DRYING

Harvested seed must not have too high moisture content, which will affect storage period of the seed. Hence, the seeds have to be dried immediately after harvesting.

Drying is lowering the seed moisture content to safe moisture limits in order to maintain seed viability and vigour.

Methods of drying

1. **Natural drying - Sun drying**: Seeds are dried under sun to reduce the moisture content to the required level. The seeds are spread to a thin layer on a clean threshing floor or on a tarpaulin.High moisture seed with a moisture content >17% should not be dried under a heavy noon sun. It should be dried first under shaded sun to reduce the moisture content to less than 17% and then dried under heavy sun. Avoid noon drying (bet 11 a.m. to 2. p.m) to avoid the harmful effect of rays. Sun dried seeds should not be allowed to remain open in the floor during night since seed will absorb moisture from air.

2. Artificial drying

a. Natural air drying

Generally ordinary seed godowns are provided with window type of ventilations for movement of air circulation and the drying is achieved.

b. Forced natural air drying

In modern godowns provisions are given for forcible circulation of air with the help of an electric blower. The outside air which is comparatively dry is circulated into the seed bag in the godown and the seeds get dried up in the process.

The above two methods are possible only during dry months.

C. Heated air drying

In this method the outside air is heated with the help of a burner / heater and circulated inside the godown and into the seed for drying. This principle is employed in several types of the modern driers. In driers,we have batch driers and continuous flow driers.

Batch driers

Longer drying process. Drying by blowing warm air through the seed stored in containers. In the course of several hours, excess moisture is removed. After drying the seed has to be cooled to about outside temperature and thoroughly mixed.

Continuous flow driers

Shorter drying process. From the intake hopper, the moist seed is slowly moved through a hot air zone and finally through a cooling zone. At the end of the process it shows the required moisture content.

Some driers

a. Louisiana state University drier

In this, cotinuous column of heated air is used. The seeds are fed from the top with the help of bucket elevator and the heated air is blown from the bottom. The falling seeds get dried up by the heated air in the drier. The process is repeated till we get a reduction of the moisture to the expected level.

b. Metal bin drier (batch)

Here the seeds are spread into a thin layer over a perforated metal sheet inside a metal bin and the heated air is blown to pass through the seedbed. The heated air removes the moisture from the seed.

In warm air drying damage may occur if the temperature is too high which leads to reduced germination. The drying temperature should not exceed 45^{o}C.

Seed moisture content %	Drying temperature 0^{o}C
18-30%	32^{o}C
10-180%	37^{o}C
10%	43^{o}C

The drying process must not be too fast. The paddy seeds should be dried to eliminate only 1.5% seed moisture content at any one time. Then the seeds should be allowed tempering for 4 hours.

Tempering is also a process of drying in which the time is given for the exchange of internal moisture to the surface.

GRADING

The threshed produce are precleaned either manually or mechanically and are graded using different but optimum sieve of specified sizes. This grading bring homogeneity in the lot which aids in obtaining uniformity among the population in the subsequent sowing.

The sieve sizes recommended for different crops

S. No	Crop	Sieve size (Perforated round metal sieve)
1	Maize	18/64
2	Paddy	1/14 x ¾
3	Pearlmillet	4/64 (5/664 for WCC 5)
4	Sorghum	10/64
5	Bengalgram	10/64
6	Cowpea	10/64
7	Blackgram	10/64
8	Greengram	7/64
9	Redgram	10/64
10	Gingelly	4/64
11	Sunflower	9/64

12	Soybean	12/64
13	Cotton fuzzy	12/64
14	Cotton acid delinted	10/64
15	Tomato	5/64
16	Chillies	5/64
17	Brinjal	5/64
18	Bhendi	10/64
19	Gourds	16/64
20	Onion	5/64
21	Groundnut seed	18/64
22	Groundnut pod	24/64

In some crops weight grading is used for upgrading.

Examples

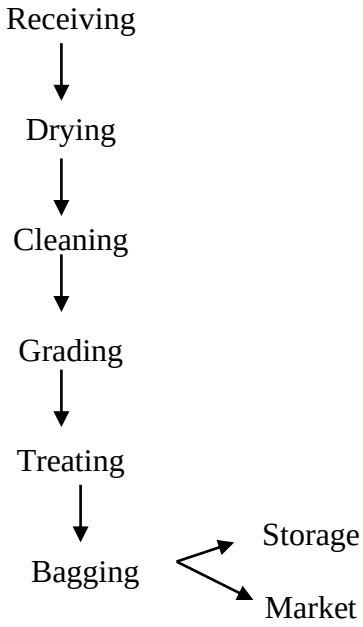
Crop	Weight grade technique
Paddy	Salt floatation using egg
Sunflower	Use of specific gravity separator
Cotton, Bhendi	Water floatation technique

SEED PROCESSING

Seed processing

The term seed processing includes a wide range of operations to improve or upgrade seed lots after threshing or extraction.

Sequence of processing



Objectives of processing (or) importance of processing

It is to remove a wide range of materials including plant debris, soil, stones, seeds of other crops and weeds, damaged and discoloured seeds.

Principles of seed processing

The separation of seeds from other material is based on physical differences such as relative size, shape, length, density, surface texture and colour. Based on these characters the processing equipments are designed.

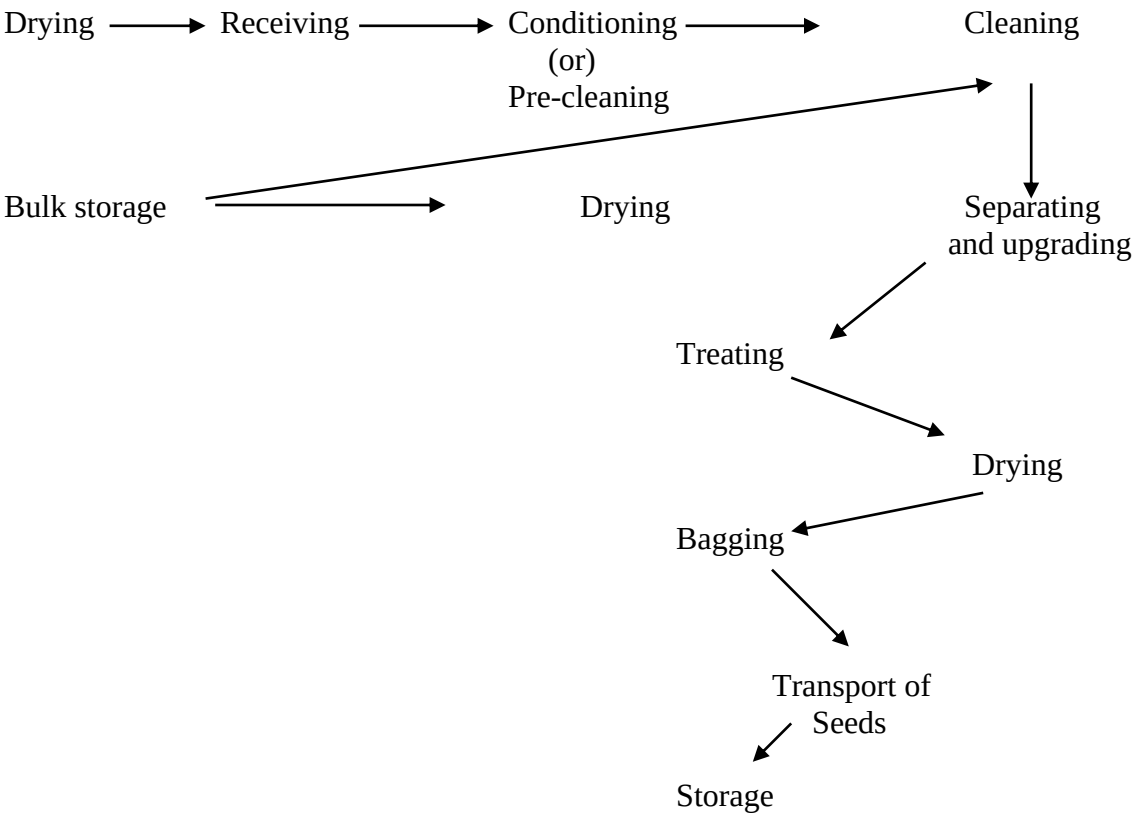
Requirements In Seed Processing

1. There should be complete separation
2. Minimum seed loss
3. Upgrading should be possible for any particular quality
4. Efficiency
5. It should have only minimum requirement

PHYSICAL CHARACTERISTICS USED TO SEPARTE SEEDS

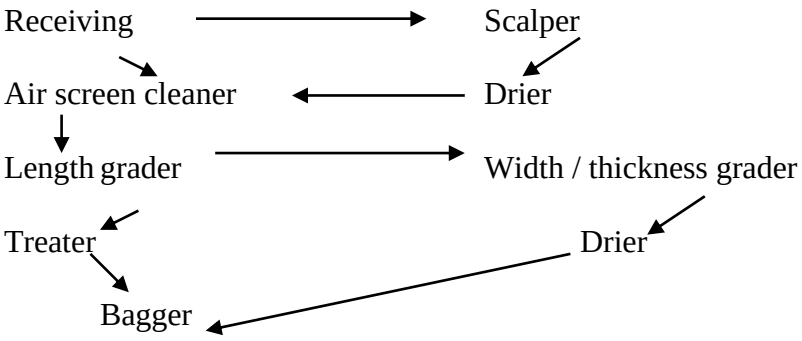
1.	Size	: Cleaner cum grader
2.	Length	: Disc or indented cylinder separator
3.	Weight	: Specific gravity separator
4.	Shape	: Spiral separator or draper separator
5.	Surface texture	: Dodder mill
6.	Colour	: Electronic colour separator
7.	Electrical conductivity	: Electrical charge
8.	Table separator	: Affinity to liquid.

SEED MOVEMENT / BASIC STEPS IN SEED PROCESSING PLANT

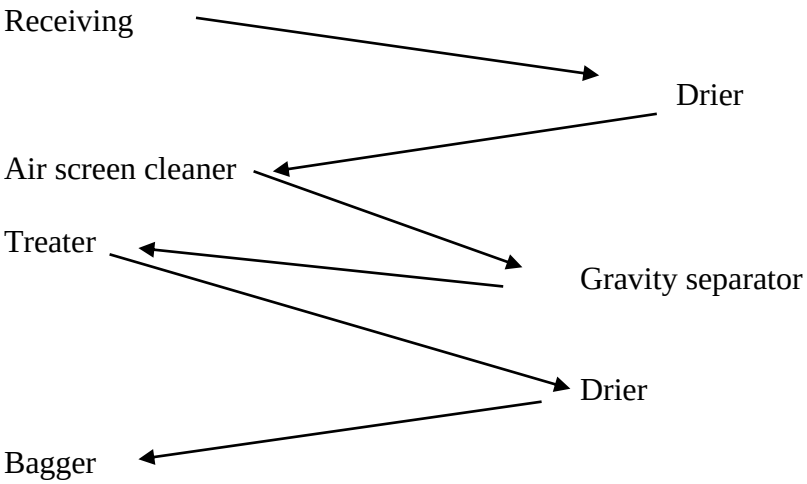


PROCESSING SEQUENCES OF DIFFERENT CROPS

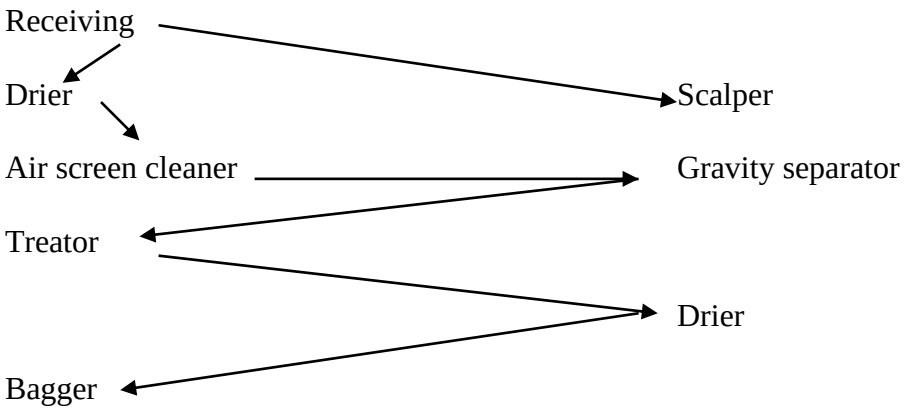
PADDY



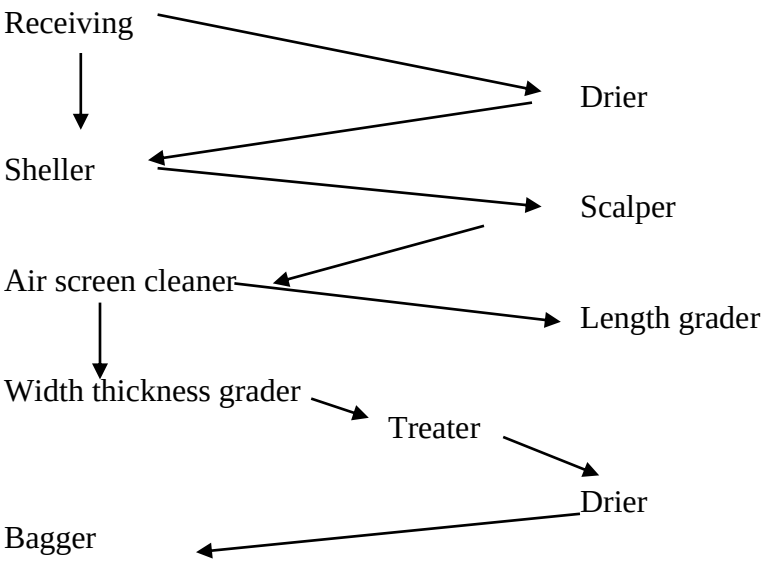
SORGHUM



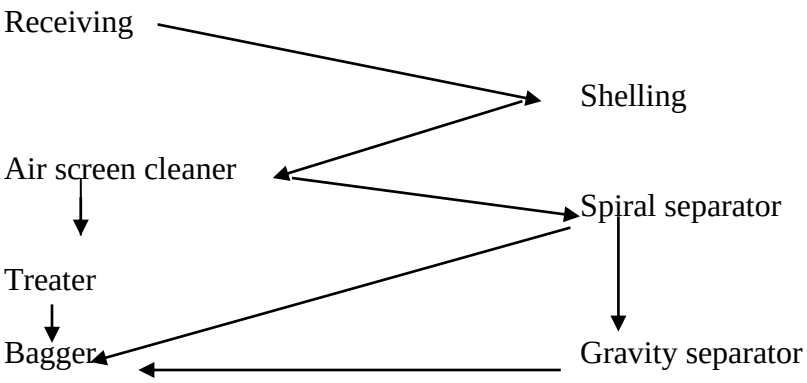
BAJRA



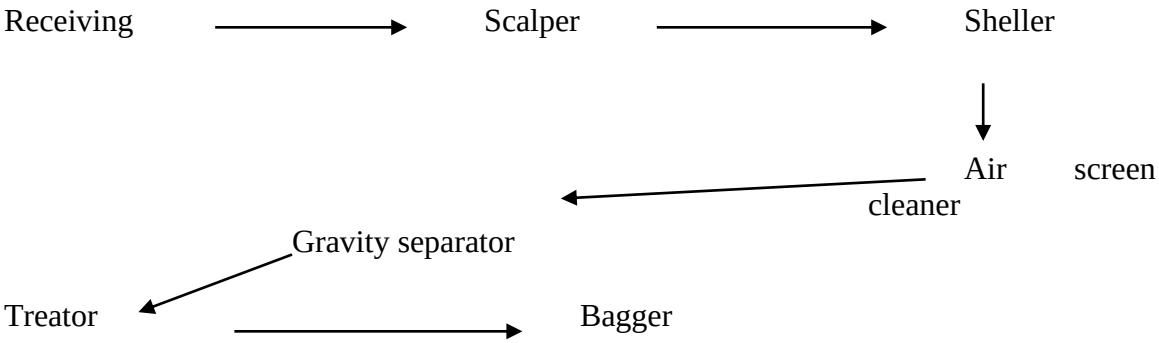
MAIZE



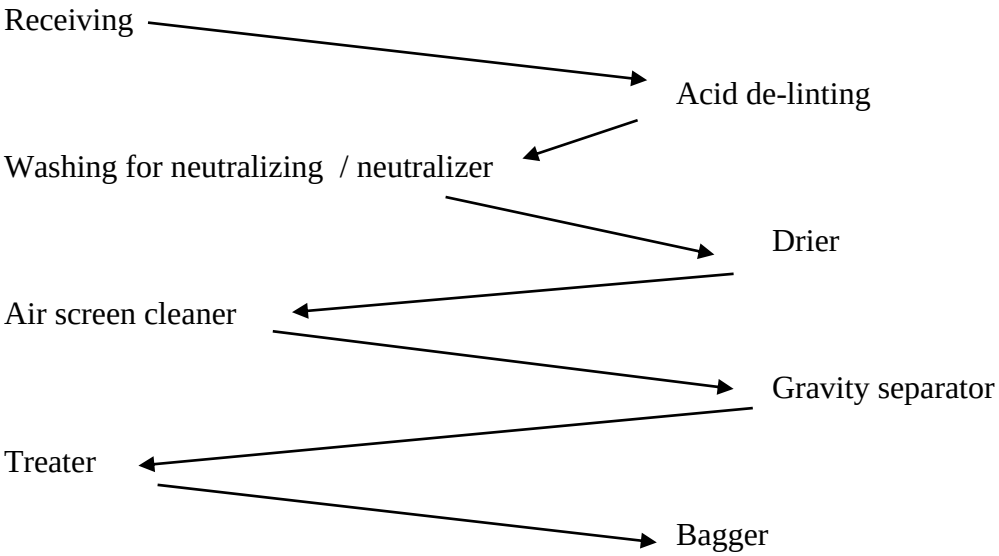
SOYBEAN



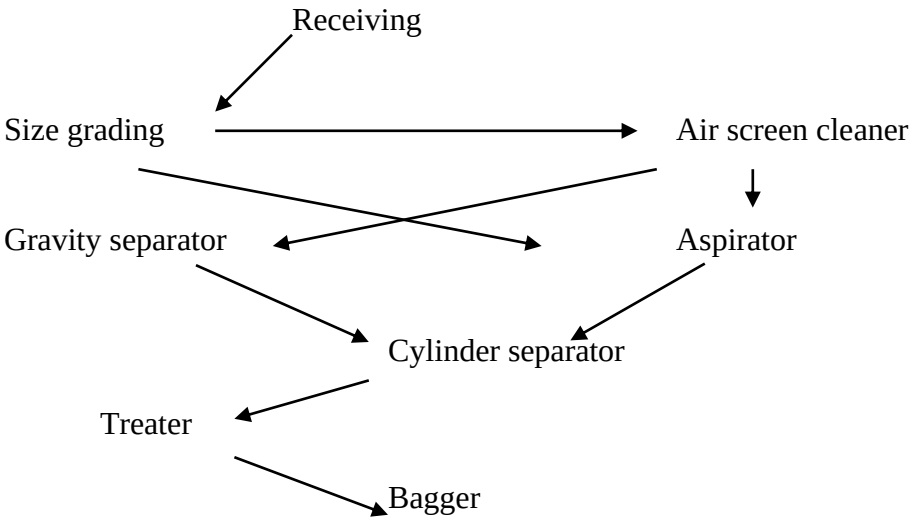
GROUNDNUT



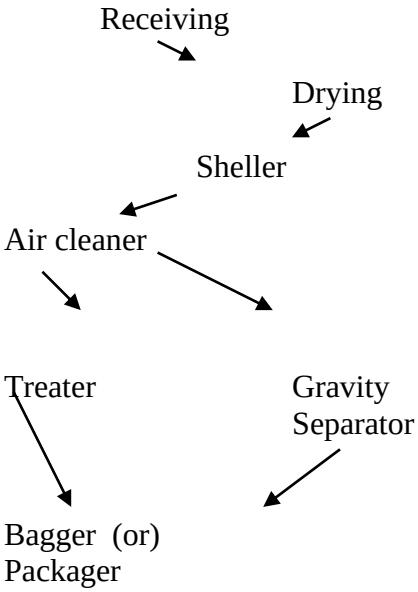
COTTON



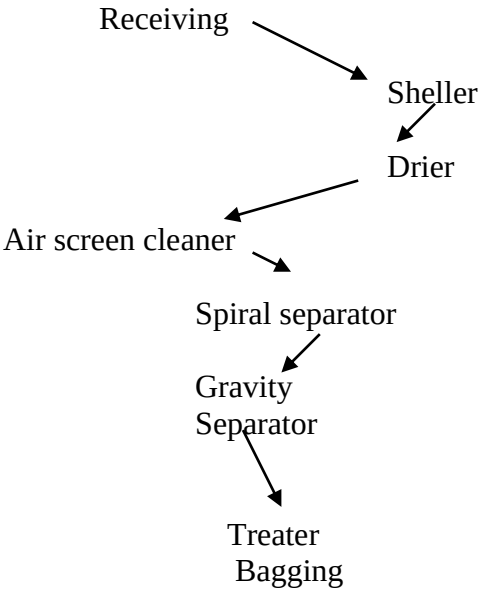
TOMATO, CHILLIES, RADISH, TURNIP, CABBAGE AND CAULIFLOWER



BHENDI



COWPEA AND PEAS



SEED PROCESSING EQUIPMENTS

WORKING OF CLEANER CUM GRADER

The dried seeds should be cleaned and graded with help of a cleaner cum grader. For large scale cleaning and grading the commonly available machine is the "Crippen model seed cleaner cum grader.

It consists of the following parts

1. A hopper in the top for seed filling
2. A flutted roller below the hopper to regulate the seed flow to the screen.
3. Screen (or) sieves

Perforated metal sheet with specific size of perforation in which there are two types.

i) Rectangular perforations for paddy and

ii) Round perforations for seed other than paddy

4. Screen shaking unit : for oscillating the sieves to move the seeds on the screens
5. Screen brushes to remove the blocked seeds
6. Air blower with adjustments for air outlet
7. Collecting outlet
8. Air duct for directing the blown up light particles to outside
9. Collecting bins.

Working principle

When seeds are fed into the hopper , they are guided to fall on the first sieve. The first sieve is a scalping screen which scalps all the foreign materials larger and heavier than seed and the entire quantity of seed pass through the first sieve.The second sieve is a cleaning sieve which removes all the unwanted particles larger in size than the seed.The third sieve is actually the grading sieve which size grades the seed lot and bring into a uniform size and which also screens the undersized, shrivelled , immature seed, dust and dirt. The seeds are then rolled and passed through air column, where they are relived of the light chaffy and other materials by the blowing air.

Adjustments

Flutted roller

The speed of this roller can be adjusted so as to increase (or) decrease the flow of seeds from the hopper to the sieves.

Slope (or) inclination of the screen

The angle of inclination of the screens can be adjusted according to nature of seeds.

Rate of vibration of sieve

This can be adjusted either to increase or to decrease the speed of the rolling seeds on the screen.

Volume of air flow

By increasing (or) decreasing the air inlet.

Choice of screens

According to variety we have to change the screen

Screen dams

Small check dams, which can be provided here and there on the screens so that the seeds can be stopped a while and takes the charge either to pass or to roll.

Types of seed cleaner cum grader

I) Crippen model cleaner cum grader
ii) Clipper model cleaner cum grader
iii) Petkus cleaner cum grader

SEED TREATMENT

It refers to the application of fungicides, insecticides or both or any other treatment given to seed for improving its quality either in storage or in field.

Benefits

1. Prevention of spread of plant diseases
2. Protects seeds from seed rot and seedling blight
3. Improves germination
4. Provides protection from storage insects
5. Controlling soil insects

Methods

1. Disinfection

Eradication of fungal pathogen present inside the seeds. Here the chemicals must actually penetrate into the seeds. E.g. Thiram or Captan

2. Disinfestation

Destruction of surface borne pathogen by means of chemical dips, soaks,dust, ,slurry and liquid. E.g. Carbendazim, Carboxin, 2 gm / kgof seed

3. Protection

Here the seeds and young seedlings are protected from the soil borne organism which cause decay. Here the seeds are treated 24 hours prior to sowing.

Types of seed treatment

a. Dust form - Here the seeds and the chemicals are physically mixed.
b. Slurry form - The seeds are coated with chemicals by using water as an adhesive (e.g.) Captan or thiram 75% w.p (2g / kg with 5 ml of water).
c. Liquid or emulsion - Toxicants are suspended in a liquid diluents.
d. Gaseous form - It is nothing but fumigation. Here the seed bags along with chemicals are kept separately and covered air tightly. The chemicals evaporate and release poisonous gases, which will penetrate quickly into the seeds and kill the pest and diseases. E.g. Celphos, aluminum phosphide, ethylene bromide, carbon tetra chloride.

Biofertilizer treatments

Azospirillum 600 g for seeds of 1 ha using rice kanji as binder for millets and cereals.

Rhizobium 3 packets / ha of seeds. Dry the bacterial culture treated seeds in shade for 15 min before sowing.

There should be an interval of atleast 24 hours after fungicidal treatment for giving biofertilizer treatment.

Sequence of seed treatment

Dormancy

↓

Hardening

↓

Fungicides

↓

Biofertilizers

PRE-SOWING SEED HARDENING

Seed hardening is conditioning the seed to withstand adverse environment and edifice conditions. It is a creation of resistance in the seed for better outgrowth of seedlings.

Steps in seed hardening

Dry seed

↓

Soaking in water for 2-24 hour at 15-25^{o}C

↓

Shade drying (0-24 hours)

↓

Sun drying (1-2 days) to bring back to its original moisture content

↓

Hardened seed

Principles involved

Dry seed

↓ Soaking in water

Imbibition

↓

Permits initial Process of germination → Prevents cell elongation and radicle emergence (Shade and sun drying-drying back to original moisturecontent)

↓

Hardened seed

Physiological basis for seed hardening

1. Greater hydration of colloids
2. Higher viscosity and elasticity of protoplasm
3. Increase in bound water content
4. Increase in intensity of photosynthesis
5. Increase in hydrophilic colloids and decrease in lipophytic colloids
6. Increase in temperature requirement for protein coagulation.
7. More intensive respiration
8. Lower water deficit
9. Increase in water balance of plant
10. More efficient root system

Method of hardening

Seeds are soaked in required quantity of water (seed to solution ratio) depending upon crop seeds and allowed to absorb moisture upto 35 per cent of their weight and spread out in thin layer for drying in shade for 2 to 3 days. During this period the seed get dried almost to the original weight. The soaking duration vary with crop and hardening efficacy can be improved by use of bio-active chemicals.

Chemicals used for hardening

a. Water
b. Aqueous solution of slats - sodium chloride, sodium sulphate, potassium chloride, potassium nitrate, potassium sulphate, calcium chloride, ammonium sulphate, potassium dihydrogen phosphate, zinc sulphate, sodium molybdate, manganese sulphate.
c. Growth promoters: gibberellic acid, chloro choline chloride, kinetin, 2-chloroethyl; phosphoric acid, ascorbic acid, succinic acid.
d. Vitamins : Vitamin K, nicotinic acdi, pantothanic acid, adenin.
e. Plant products: Garlic extract, coconut water, leaf extract of arappu (*Albizia amara*), Prosopis (*Prosopis juliflora*) etc.,
f. Osmoticants: D-Mannitol, Polyethylene glycol.

Crop	Treatment
Paddy	1% KCl for 10 hours in 1:1 ratio
Sorghum	2% KH_2PO4 solution for 16 hours in equal Volume. Soak the seeds in 1% prosopis leaf extract and Pungam leaf extract in 1:0.6 volume for 16 hours and pellet with pungam leaf powder.
Groundnut	0.5% $CaCl_2$ for 6 hours in equal volume
Redgram & Blackgram	100 ppm ZnSO4 for 3 hours in 1/3 volume
Greengram	100 ppm MnSO4 for 3 hours in 1/3 volume

SEED PELLETING

Seed pelleting is enclosing the seed with foreign material to obtain a standard size and it has its own influence on the micro environment of the seed and influences on seedling grown at seed soil interface.

Pelleting process

Pelleting process can be broadly classified into three (1) stamping (2) coating (3) rolling seeds are first mixed with adhesives and then coated with filler materials and rolling for uniformity. Materials used in pelleting are (a) adhesives (b) coating materials and (c) bioactive chemicals.

Adhesives

These are nothing but glues or binders or stickers that are used as media to fix the coating material on the seed coat so as to increases its size and weight or to improve the ballistic property of seed. Use of water alone without adhesives may lead to fragile coats that are extremely prone to dusting and cracking and subsequently to the loss of active ingredient. The physical integrity of the coated seed is given by this adhesive which is important in any handling, transport and planting operations. The common adhseives are (1) gum arabic (2) methyl cellulose (3) gelatin (4) casein and (5) caseinae salts carboxyl Methyl celluylose (CMC) is widely used due to the ease of availability, low cost and low rate. CMC 3% (w/v), Methyl cellulose 5% (w/v) and gum arabic upto 45% are commonly used. Minerals, plastic resins, polyvinyl acetate, insoluble poly electrolyte complexed and poly ethyelene oxide are also used as adhesives in some extent. In addition, polyurethanes (to bring lime in a way that it resists coat abrasion), polyvinyl alcohol and polyvinyl acetate (to bind vermiculate) and poly electrolytes of dextron (to aggregate soil around the seed and thereby improving the aeration) are also used.

Coating materials or the filler materials

Lime, gypsum, dolomite or rock phosphate and charcoal are the filler materials commonly used for pelleting.

Organic materials for pelleting

1. Dried blood:15 parts in 85 parts of dolomite
2. Milk powder:3 parts of 97 parts dolomite
3. Yeast extract :1 part of 99 parts of dolomite

   Since these protect rhizobia on the seed and are called as nutrient pellets. The size of the organic materials should pass through 150 mesh sieve.

Biological material: Leaf powder of neem, arappu, notchi and pungam etc.,

Bio active chemicals

Based on the usage coating / pelleting are classified as

a. Inoculant coating: Rhizobia, AM (Arbuscular Mycorrhizal fungi), and Bacillus of streptomyces are used.
b. Protective coating: Fungicide, pesticides, rodenticides (Mestrenol) methiocarb, endrin (To prevent bird attack)

c. Herbicide coating: Antidot (1-8, naptithetic anhydride) and absorbent (2,4-D) and alcohol).
d. Nutreint coating: Seeds coated with macronutrients such as N,P,K and S and micronutrients such as Mo, Mg, Zn and Mn increase germination and seedling growth.
e. Hydrophilic coating: Use of starch graft polymers can absorb water upto 1000 times of their original weight of water and coating of MgCO3 increase the movement of air and water. These fine particles act as wick (or) moisture attracting material. So it improves seed soil contact. Coating with peroxides of Zn, & Ca increase the O2, supply to seed and make it germinate faster.

Sequence of pelleting

1. Seed _ glue solution (Fevicol) + Thiram @ 75 mg/kg + thin coating of filler talc powder + dolomite 1:1 +micronutreint @ 2g /kg of seed + filler and glue material + aldrin @ 2ml/kg of seed + colour agent.
2. Seed +Emison @ 1g/kg of seed + gum arabic + sand : Red earth + manure mixture 1:1:1

The seed is placed in the mixer and moistened with a sticker solution. Enough treating powder is then added to dry the sticker usually in a volume relationship of a 4 parts powder to one part sticker. The thickness of the seed coating is dependent on the amount of sticker in relation to the amount of seed. The total mixing time should not exceed four minutes since prolonged agitation damages seeds (or) chips of pelleted coat.

Advantages of pelleting

1. Singling of seed is achieved, helpful in precision planting in mechanized farming.
2. Seeds with free wing enables aerial seeding
3. Small seed and irregular shaped seeds are made easy to handle.
4. Accurate dosing of seed with chemical is possible
5. Wastage of chemical is prevented
6. Pelleting acts as inoculant, protective, nutrient, and hydrophilic.
7. Lime pelleting of seed, protect the multiplication of rhizobia in the rhizosphere of acid soils.
8. Stress conditions can be overcome by pelleting even in low water holding capacity.

SEED PRODUCTION PLANNING

Success of seed production depends highly on planning for the production, since for distribution of defined quantity of certified seed to farmers for commercial crop production requires the process (or) initiation of production planning well in advance. To make available to farmers the good quality seed it requires production planning for 3 years ahead. The basic information's required for planning are as follows.

Varieties

1. Seed rate
2. Seed yield at different stages
3. Multiplication ratio
4. Extend of reduction in yield
5. Seed requirement of certified seed
6. Area to be covered with certified seed
7. Processing losses
8. Fruit yield in case of vegetables
9. Seed recovery (%)

The basic formula used in Planning

$$\text{Seed requirement} = \text{Area} \times \text{Seed rate}$$

$$\text{Area required to produce the seed requirement} = \frac{\text{Seed requirement}}{\text{Seed yield}}$$

SEED CERTIFICATION PROCEDURES

SEED CERTIFICATION

It is legally sanctioned system for quality control and seed multiplication and production. It involves field inspection, pre and post control tests and seed quality tests.

PURPOSE OF SEED CERTIFICATION

To maintain and make available to the farmers, through certification, high quality seeds and propagating materials of notified kind and varieties. The seeds are so grown as to ensure genetic identity and genetic purity.

ELIGIBILITY FOR CERTIFICATION OF CROP VARIETIES

Seed of only those varieties which are notified under section 5 of the seeds Act 1966 shall be eligible for certification.

Breeder seed is exempted from certification. Foundation and certified class seeds come under certification.

Breeder seeds is produced by the plant breeder which is inspected by a monitoring team consisting of the breeder, representative of seed certification agency (DDA), representative of NSC (Deputy Manger) and nominee of crop co-ordinator (S-II). The crops shall be inspected at appropriate stage.

SEED CERTIFICATION PROCEDURES OR PHASES OF SEED CERTIFICATION

1. Receipt and scrutiny of application.
2. Verification of seed source
3. Field inspection
4. Post harvest supervision of seed crops
5. Seed sampling and testing
6. Labelling, tagging, sealing and grant of certificate.

1. RECEIPT AND SCRUTINY OF APPLICATION.

a. Application for registration

Any person who wants to produce certified seed shall register his name with the concerned Assistant Director of seed certification by remitting Rs.25/- per crop per season. There are 3 seasons under certification viz., Kharif (June-Sep), Rabi (Oct - Jan) and Summer (Feb-May).

The applicant shall submit two copies of the application to the AD, SC 10 days before the commencement of the season or at least at the time of registration of sowing report.

On receipt of the application, the AD, SC will verify the time limit, variety eligibility and its source, the class mentioned, remittance of fee etc.,

The application, if accepted will be given an application number e.g paddy / k/01-2002-2003 where paddy refers the crop to be registered, K the season 01 the application number and the financial year). The original application is retained and the duplicate is returned to the applicant.

b. **Sowing report** (Application for the registration of seed farm)

The seed producer who wants to produce certified seeds shall apply to the AD, SC in the prescribed sowing report form in quadruplicate with prescribed certification fees along with other documents such as tags to establish the seed source.

Class of seed	Source of seed
1. Foundation Class	Breeder seed
2. Certified Class	Foundation seed
3. Foundation Class stage II	Foundation class stage I
4. Certified Class stage II	Certified class stage I

Separate sowing reports are required for different crop varieties, different classes different stages and if the seed farm fields are separated by more than 50 meters.

Separate sowing reports are also required if sowing or planting dates differ by more than 7 days and if the seed farm area exceeds 25 acres.

The sowing report shall reach the concerned ADASC within 35 days from the date of sowing or 15 days before flowering which ever is earlier. In the case of transplanted crops the sowing report shall be sent 15 days before flowering.

The producer shall clearly indicate on the reverse of sowing report, the exact location of the seed farm in a rough sketch with direction distances marked from a permanent mark like mile stone, building, bridge, road, name of the farm if any crops grown on all four sides of the seed farm etc., to facilitate easy identification of the seed farm by the seed certification officer.

The AD, SC on receipt of the sowing report, scrutinizes and register the seed farm by giving a seed certification number for each sowing report. Then he will send one copy of the sowing report to the seed certification officer, one to the Deputy Director of seed certification and the third to the producer after retaining the fourth copy.

VERIFICATION SEED SOURCE

During his first inspection of seed farm the seed certification officer, will verify whether the seed used to raise the seed crop is from an approved source.

2. FIELD INSPECTION

Objective

The objective in conducting field inspection is to verify the factors, which can cause irreversible damage to the genetic purity or seed health.

INSPECTION AUTHORITY

The seed certification officer authorized by the registering authority shall attend to field inspection.

CROP STAGES FOR INSPECTION

The number of field inspections and stages of crop growth at which the field inspections should be conducted vary from crop to crop. It depends upon duration and nature of pollination of the seed crop.

If the crop is grown for hybrid seed production, the number of field inspections during the flowering stage should be more than in the case of self pollinated / cross pollinated / often cross pollinated varieties.

In hybrid seed production and variety seed production of cross pollinated crops the inspection during flowering should be made without any prior notice of the seed grower to judge the quality of operation undertaken by him to maintain the genetic purity of the crop. But in the case of self pollinated crop the seed grower may be informed about the date of inspection.

In the former case if prior notice is given to the seed grower, it may not be possible to detect the damage by the contaminants whereas in the latter case prior notice will lead to improvement of the quality of the seed production work and thus the quality of seed.

The key points to be observed at each stage of inspection

1. Pre flowering stage (vegetative stage)
    - Verification of seed source
    - Confirmation of acreage given in the report
    - Land requirement to keep check on genetic as well as physical contamination and spread of disease inoculum.
    - Planting ratio
    - Border rows
    - Isolation distance
    - Guide the grower in identification of off types, pollen shedder, diseased plants, shedding tassels etc.,

2. Flowering stage (May be II and IIIrd inspections when 5% of plants begin to flower)
    - Confirm the observations of first inspection were correct.
    - Confirm whether the grower had continued thorough roguing, after the previous inspection.
    - Verify the removal and occurrence of off types pollen shedders, shedding tassels, objectionable weed plants and diseases plants.

3. Inspection during post flowering and pre harvesting stage.
    - Confirm the correctness of observations made in earlier inspectiions.
    - Guide the grower on roguing, based on pods, earhead, seed and chaff characters such as colour, shape and size.
    - Explain to the grower when and how to harvest the crop and process.

4. Inspection during harvest (This is the last inspection conducted on a seed crop)
    - Verify that male parent rows have been harvested separately.
    - Ensure complete removal of off types, other crops, weeds and diseases plants etc.,
    - Seal properly by the certification agency of the threshed produced after initial cleaning and drying.
    - Instruct the seed growers for safe storage and transportation.

MINIMUM NUMBER OF FIELD INSPECTIONS REQUIRED FOR DIFFERENT CROPS FOR CERTIFICATION

CROP	MINIMUM NUMBER OF INSPECTION	STAGES OF CROP
Paddy and wheat	2	Flowering to harvest
Sorghum Hybrids	4	1st before flowering 2nd and 3rd during flowering 4th prior to harvest.
Varieties	3	1st before flowering 2nd during flowering 3rd prior to harvest
Maize		
Inbred lines Single cross Other hybrids	4	1st before flowering Rest during flowering
Varieties	2	1st before flowering 2nd during flowering.
Bajra		
Hybrids	4	1st before flowering 2nd and 3rd during flowering 4th prior or during harvest.
Varieties	3	1st before flowering 2nd during 50 %flowering 3rd prior to harvest
Green gram Black gram Red gram Cowpea	2	1st before flowering 2nd flowering and fruiting stage
Groundnut	2	Flowering to harvest
Sesame	3	1st before flowering 2nd during flowering 3rd from fruit maturity to harvest

CROP	MINIMUM NUMBER OF INSPECTION	STAGES OF CROP
Sunflower	2	Flowering to harvest
Rape and mustard	2	1st before flowering 2nd during flowering to fruiting 3rd from fruit maturity to harvest
Soybean	2	Flowering to harvest
Castor	2	Flowering to harvest
Cotton		
Varieties	2	Flowering to harvest
Hybrids	4	1st before flowering 2nd during flowering 3rd from fruit maturity to harvest
Brinjal Tomato Chilli Bhendi	3	1st before flowering 2nd flowering and fruiting stage 3rd during maturity
Carrot	3	1st early (20-30 days after sowing) 2nd when lifted and replanted 3rd during flowering
Cabbage	3	1st before marketable stage 2nd when the heads have formed 3rd during flowering
Cauliflower	4	1st before marketable stage 2nd during curd formation 3rd when most plants have formed curds 4th during flowering
Onion (seed to seed)	3	1st during early vegetative stage 2nd during bulb formation 3rd during flowering

FIELD COUNTS

The purpose of field inspection is to find out field standards of various factors in the seed farm. It is impossible to examine all the plants in the seed farm. Hence to assess the field standards of various factors random counting is followed.

The number counts taken and the method employed in taking counts vary from crop to crop. It is necessary to take a minimum of 5 counts upto 5 acres and an additional count for every 5 acres or part there of as given below.

Area of the field in acres	Number of counts to be taken
Upto 5	5
6-10	6
11-15	7
16-20	8
21-25	9

Double count

In any inspection, if the first set of counts shows that the seed crop does not confirm to the prescribed standard for any factor, a second set of counts should be taken for that factor. However, when the first set of counts shows a factor more than twice the maximum permitted it is not necessary to take a second count.

On completion of double count assess the average for the two counts, it should not exceed the minimum permissible limit.

NUMBER OF PLANTS FOR A COUNT

S. No	**Crop**	**No. of plants /heads per count**	**Remarks**
1	Soybean, Jute, lucerne, mesta, berseem	1000 plants	Closely planted crops
2	Beans, cluster beans, cowpea, greengram, blackgram, peas, mustard, sesame, bengalgram, saff flower, niger.	500 plants	Medium spaced crops
3	Bhendi, brinjal, chilli, castor, cole crops, cotton, cucurbits, groundnut, maize, potato, redgram, tomato and sunflower.	100 plants	Wide spaced crops
4	Bajra, barley, oats, paddy, wheat, ragi, sorghum	1000 plants	Tillering crops

POINTS TO BE OBSERVED BEFORE COUNTING

1. All plants falling in each count must be examined for each factor
2. In hybrid seed field the prescribed number of the field counts should be taken in each parent separately.

SOURCES OF CONTAMINATION OR FACTRS TO BE OBSERVED

The contaminants are

1. Physical contaminants
2. Genetical contaminants

Physical contaminants are inseparable other crop plants, objectionable weed plants and diseases plants.

Genetical contaminants consist of off-types, pollen shedders and shedding tassels.

a. OFF TYPE

Plant that differs in morphological characters from the rest of the populations of a crop variety.

Off type may belong to same species or different species of a given variety. Plants of a different variety are also included under off types. Volunteer plants and mutants are also off types.

b**. VOLUNTEER PLANTS**

Volunteer plants are the plants of the same kind growing naturally from seed that remains in the field from a previous crop.

C. POLLEN SHEDDERS

In hybrid seed production involving male sterility the plants of ' B' line present in A line are called pollen shedders.

Sometimes A line tends to exhibit symptoms of fertile anthers in the heads of either on the main tiller or side tiller and these are called partials. These partials are also counted as pollen shedders.

D. SHEDDING TASSELS

These plant which shed or shedding pollen in female parent rows. When 5 cm or more of the entire spike, which shed or shedding are counted.

E. **INSEPARABLE CROP PLANTS**

These are plants of different crops which have seeds similar to seed crop.

Crop	Inseparable crop plants
Wheat	Barely, oats, gram and triticale
Barley	Oats, grams, wheat and triticale
Oats	Barley, gram, wheat and triticale
Triticale	Wheat, barley, oats, grams and rye.

F. OBJECTIONABLE WEED PLANTS

These are weeds

1. Whose seeds are difficult to be separated once mixed
2. Which are poisonous
3. Which have smothering effect on the main crop
4. Which are difficult to eradicate once established
5. Difficult to separate the seeds. These seeds cause mechanical admixtures.

S.No	Crop	Common name of the weed	Botanical name
1	Paddy	Wild rice	*Oryza sativa var fatua*
2	Wheat	Wild morning glory	*Convolvulus arvensis*
3	Sunflower	Wild sunflower	*Helianthus spp*
4	Bhendi	Wild okra	*Abelmaschus spp*
5	Rape, mustard	Mexican prickly poppy	*Argemone mexicana*
6	Lucerne	Dodder	*Cuscuta spp.*

G. DESIGNATED DISEASES

The diseases, which may reduce the yield and quality of seeds, are termed as designated diseases.

S.No	Crop	Name of the disease	Casual organism
1	Wheat	Loose smut	*Ustilago tritici*
2	Sorghum	Grain smut	*Sphacelotheca sorghi*
	"	Head smut	*Sphacelotheca reiliana*
3	Pearl millet	Ergot	*Claviceps microcephala*
	"	Grain smut	*Tolyposporium pencillariae*
	"	Downy midew	*Sclerospora graminicola*
4	Cowpea	Anthracnose	*Colletotrichum lindemuthiamum*
5	Green gram	Halo blight	*Pseudomonas phasiolicoa*
6	Gingelly	Leaf spot	*Cercospora sesami*
7	Sunflower	Downy mildew	*Plasmopara halstedii*
8	Brinjal	Phomopsis blight	*Phomopsis vexans*
9	Chilli	Leaf blight	*Alternaria solani*
	"	Anthracnose	*Colletrotrichum capsici*
10	Tomato	Early blight	*Alternaria solani*
	"	Leaf spot	*Stemphylium solani*
	"	Tobacco mosaic virus	*TMV*

LAND REQUIREMENT

The field offered for certified seed production should not have been grown in the previous season with the same crop. If it was grown, the variety should be the same. In that case, the field should be irrigated at least 3 weeks before sowing and ploughed just prior to sowing, in order to destroy germinating seeds.

ISOLATION

Separation of seed fields from fields of other varieties of the same crop, same variety fields not conforming to variety purity requirements and other related species fields and fields affected by diseases to prevent genetic and disease contamination.

The minimum distance to be maintained between the seed crop and the contaminant is called isolation distance.

ISOLATION DISTANCE

Crop	Foundation (m)	Certified seed (m)
Self pollinated crops (Cereals and Millets)		
Paddy	3	3
Wheat	3	3
Pulses		
Green gram	10	5
Black gram	10	5
Soybean	3	3
Bengalgram	10	5
Cowpea	10	5
Lab lab	10	5
Oil seeds		
Groundnut	3	3
Vegetables		
Tomato	50	25
Cluster bean	10	5
French bean	10	5
Peas	10	5
Lettuce	50	25
Potato	5	5
Offen cross pollianted crops		
Millets		
Sorghum		
Variety	200	100
Hybrid	300	200
Pulses		
Redgram	250	100

Oil seeds		
Sesame	100	50
Cotton (Variety)	50	30
Vegetables		
Brinjal	200	100
Chillies	400	200
Bhendi	400	200
Cross pollinated crops (Millets)		
Maize (Varieties)	400	200
Inbred line	400	-
Single cross hybrid	400	-
Double cross hybrid		200
Bajra (hybrid)	1000	200
Bajra (Variety)	400	200
Sunhemp	200	100
Castor	300	150
Sunflower (Variety)	400	200
" (Hybrid)	600	400
Cabbage		
Beetroot		
Raddish	1600	1000
Caulifllower		
Onion	1000	500
Carrot	1000	800
Amaranthus	400	200
Gourds	1000	500

INSPECTION REPORT

The seed certification officer after taking field counts and comparing them with the minimum field standards, the observations made on the seed farm field should be reported in the prescribed proforma to

1. Deputy Director of Seed Certification
2. To the seed producer
3. Assistant Director of Seed Certification
4. Retained with him

ASSESSMENT OF SEED CROP YIELD

It is necessary to avoid malpractices at the final stage during harvest operation. The seed certification officer is expected to fix the approximate seed yield.

L.F.R. REPORT

If the seed crop fails to meet with any one factor as per the standards, L.F.R. report is prepared and the signature of the producer is obtained and sent to Deputy Director of Seed Certification within 24 hours.

RE-INSPECTION

For the factors, which can be removed without hampering the seed quality, the producer can apply for re-inspection to the concerned D. D, S.C. within 7 days from the date of F.I. rejection order.

For re-inspection half of the inspection charge is collected.

POST HARVEST SUPERVISION OF SEED CROP

The post harvest inspection of a seed crop covers the operations carried out at the threshing floor, transport of the raw seed produce to the processing plant, pre-cleaning, drying, cleaning, grading ,seed treatment, bagging and post processing storage of the seed lot.

PRE-REQUISITES FOR PROCESSING

1. Processing report should accompany the seed lot
2. ODV test for paddy should be done at the time of sealing and issue of processing report before processing. If the result exceeds 1% the produce may be rejected.
3. It should correlate with the estimated yield
4. Seed should be processed only in approved processing unit.
5. Field run seed should be brought to the processing unit within 3 months from the date of final inspection. Processing and sampling should be done within 2 months in oil seed crops and 4 months for other crops from the date of receipt in the processing unit. In cotton the kapas from the passed lot should be moved to the ginning factory within 5 days from the date of issue of processing report. The ginning should be done within 3 months from the date of final harvest inspection report. Ginned seeds should be moved to seed processing unit within 5 days of ginning. Inspection and sampling should be done within 3 months after ginning.

INTAKE OF RAW PRODUCE AND LOT IDENTIFICATION

The seed certification officer in-charge of the seed processing plant may after verification of the above stated documents and total amount of seed accept the produce for processing.

After verification he should issue a receipt to the seed grower. Each seed lot has to be allocated a separate lot number for identification.

PROCESSING OF SEED LOT

1. It is done to remove chaff, stones, stem pieces, leaf parts, soil particles etc from the raw seed lot.
2. Grading to bring out uniformity in the seed lot.
3. Seed treatment to protect it from storage pests and diseases.

PROCESSING INSPECTION

1. The processing inspection should be done in the presence of concerned seed certification officer
2. The recommended sieve size should be used for grading.

3. **While processing of paddy**, the work of perfect processing have to be evaluated then and there.

This is done by conducting a float test. Take 400 seeds from the processed seed and put into a tumbler of water. Count the floating paddy seeds. Maximum float admissible is 5%. If the float seed exceeds the limit, adjust the airflow or feeding to perfect the processing.

4. **In maize** before shelling the cobs should be examined for off type and off coloured kernels. Individual cobs should be examined with reference to its varietal characters. The cobs of off types and off coloured kernels should be rejected.
5. **Seed sorting in cotton**.

The ginned seeds will be evaluated for its quality. A maximum of 3% for the following factors can be taken into accounts.

i. Immature seeds
ii. Ill filled seeds
iii. Broken seeds
iv. Stained seeds and
v. Over fuzzy seeds.

Groundnut pod verification

In groundnut 4% ill-filled pods can be allowed

After processing the seeds may be treated, packed weighed and sealed before the seed certification officer. The unit of packing may be equal to the seed rate of 1/2 or one-acre or hectare.

5. SEED SAMPLING AND TESTING

During packing seed certification officer will draw samples according to ISTA procedure and send the sample to ADSC concerned within a day of sampling. The ADSC will in turn send the sample to the STL within 3 days of receipt of the sample to testing seed standards viz., physical purity, germination, moisture content and seed health as prescribed. The seed testing officer will communicate the result to the ADSC concerned within 20 days.

On receipt of the analytical report the ADSC will communicate the result to the producer and seed certification officer.

6. LABELLING, TAGGING, SEALING AND GRANT OF CERTIFICATE

After receiving the seed analytical report, the SCO will get the tag from the ADSC and affixes labels (producers label) and tags (blue for C.S and white for F.S) to the containers and seals them to prevent tampering and grants certificate fixing a validity period for 9 months from the date of testing.

Tagging should be done within 60 days of testing.

RESAMPLING AND REPROCESSING

When a seed lot does not meet the prescribed seed standards in initial test, on request of the producer SCO may take re-sample.

If the difference in germination analysed and required is within 10, then straight away re-sampling can be done. If it is > 10, re-processing and re-sampling may be done.

The producer should request the SCO concerned in writing within in 10 days from the receipt of the result. No charge is collected for re-sampling.

When a seed lot, fails even after free sampling re processing can be taken upon special permission from D.S.C. For such reprocessing a fee of Rs.20/- Q and lab charges Rs.10/ Q is collected.

SEED (CONTROL) ORDER, 1983

Background of the case

The ministry of civil supply through an order dated 24.4.1983 had declared the seed for sowing or planting of food crops, fruits, vegetables, cattle fodder and jute to be essential commodities in exercise of power conferred by Section 2(a) (viii) of Essential Commodities Act, 1955. It was followed by the issue of seed (control) order dated 30th December 1983 by the Ministry of Agriculture, Dept. of Agriculture and Cooperation in exercise of powers contained in section 3 of Essential Commodities Act, which deals with Central Governments power to control, and regulate production, supply and distribution of essential commodities.

The seed (control) order 1983 had been notified as per Gazette notification G.S.R (832(E) dated 30.,12.1983. The notification under reference holds good and remains operative. Joint Secretary (Seeds), Government of India, Ministry of Agriculture, Department of Agriculture and Cooperation has been appointed as Seed Controller for implementation of seed (control) order.

Gist of the Seed (Control) Order 1983.

Issue of licence to dealers

All persons carrying on the business of selling, exporting and importing seeds will be required to carry on the business in accordance with terms and conditions of licence granted to him for which dealer make an application in duplicate in Form 'A' together with a fee of Rs.50/- for licence to licensing authority unless the State Government by notification exempts such class of dealers in such areas and subject to such conditions as may be specified in the notification.

Based on such enquiry as it thinks fit for licensing authority may grant in form 'B' or refuse in provisions of the Order. The refusal to grant licence shall be accompanied by clear recording of reasons for such refusal.

Renewal of licence

A holder of licence shall be eligible for renewal upon an application being made in the prescribed form 'C' (in duplicate) together with a fees of rupees twenty before the expiry of licence or at the most within a month of date of expiry of license for which additional fee of Rs.25/- is required to be paid.

Appointing of licensing authority

The state government may appoint such number of persons as it thinks necessary to be inspector and define the area of such Inspector jurisdiction through notification in the official gazette.

Time limit for analysis of samples by Seed testing lab

Time limit for analysis of samples by seed testing lab and suspension / cancellation of license may be done by Licensing authority after giving an opportunity of being heard to the holder of license, suspend or cancel the license on grounds of mis-representation of a material particular or contravention in provision of the order.

Suspension / Cancellation of licence

The Licensing authority may after giving an opportunity of being heard to the holder of licence, suspend or cancel the licence on grounds of mis-representation of material particular or contravention in provision of the Order.

Appeal

The state government may specify authority for hearing the appeals against suspension / cancellation under this order and the decision of such authority shall be final.

Any person aggrieved by an order of refusal to grant or amend or renew the licence for sale, export / import of seed may within 60 days from the date of Order appeal to the designated authority in the manner prescribed in the Order.

Miscellaneous

The licencing authority may on receipt of request in writing together with Rs.10/- from amend the licence of such dealer.

Every seed dealer is expected to maintain such books, accounts and records to this business in order and submit monthly return of his business for the preceding months in Form 'D' to the licencing authority by 5th day of every month

SEED INSPECTION OR SEED LAW ENFORECEMENT

The responsibility for enforcing various provisions regarding regulation of sale of seeds of notified kinds / varieties rest with the seed inspectors.

The State Government may, by notification in the official gazette, appoint such persons as it thinks fit, having the prescribed qualifications to be Seed Inspectors and define the areas within which they shall exercise jurisdiction.

Every Seed Inspector shall be deemed to be a public servant within the meaning of section 21 of the Indian Penal Code (45 of 1860) and shall be officially subordinate to such authority as the State Government may specify in this behalf.

Qualification of seed Inspectors

A person shall not be qualified for appointment as Seed Inspector unless he is a graduate in agriculture of a university recognized for the purpose by the government and has had not less than one year’s experience in seed production or seed development or seed analysis or testing in seed testing laboratory.

Duties of seed inspectors

In addition to the duties specified by the Act the Seed Inspector shall

a. Inspect as frequently as may be required by certification agency all places used for growing, storage or sale of any seed of any notified kind or variety;

b. Satisfy himself that the conditions of the certificates / labels are being observed;
c. Procure and send for analysis, if necessary, samples of any seeds, which he has reason to suspect, are being produced, stocked or sold or exhibited for sale in contravention of the provisions of the Act or the Rules;
d. Investigate any complaint, which may be made to him in writing in respect of any contravention of the provisions of the Act or the Rules;
e. Maintain a record of all inspections made and action taken by him in the performance of his duties including the taking of samples and the seizure of stocks and to submit copies of such records to the Director of Agriculture or the certification agency;
f. When so authorized by the State Government, to detain imported containers which he has reason to suspect contain seeds, the import of which is prohibited, except and in accordance with the provisions of the Act and the Rules;
g. Institute prosecution in respect of breaches of the Act and the Rules; and
h. Perform such other duties as may be entrusted to him by the competent authority from time to time.

Powers of seed inspectors

1. To take samples of seed of any notified kind / variety from any person selling such seed, or purchaser or consignee and to send such samples for analysis to the seed analyst notified for the area;
2. To enter and search, at all the reasonable times, with such assistance, if any, as he considers necessary, any place in which he has reason to believe that an offence under this Act has been or is being committed and order in writing the person in possession of any seed in respect of which the offence has been or is being committed, not to dispose of any stock of such seed for a specific period not exceeding thirty days, or unless the alleged offence is such that the defect may be removed by the possessor of the seed, seize the stock of such seed;
3. To examine any record, register, document or any other material object found in any place mentioned in clause (2) and seize the same, if he has reason to believe that it may furnish evidence of the commission of an offence punishable under this Act; and exercise such other powers as may be necessary for carrying out the purposes of this Act or any Rule made there under;
4. On demand to pay the cost of seed, calculated at the rate at which such seed is usually sold to the public to the person whom the same is taken.
5. To break –open any container in which any seed of any notified kind or variety may be contained, or to break-open the door of any premises where any such seed may be kept for sale.

   Provided that the power to break-open the door shall be exercised only after the owner or any other person in occupation of the premises, if he is present therein, refuses to open the door on being called upon to do so.

6. Where the seed inspector takes any action under clause (a) of sub section (1), he shall, as far as possible, call not less than two persons to be present at the time when such action is taken, and take their signatures on a memorandum to be prepared in the prescribed form and manner.
7. The provisions of the Code of Criminal Procedure, 1898, shall, so as may be, apply to any search or seizure under this section as they apply to any search or seizure made under the authority of a warrant issued under section 98 of the said code.

Procedure of Seed Law Enforcement

Seed Inspectors should strictly follow the prescribed procedure of seed inspection for carrying out the enforcement work as described in ‘ A handbook of seed inspectors’ published by central seed committee and National Seeds Corporation Limited. They should also carry the necessary equipment and supplies with them while on duty.

SEED TESTING

The science of evaluating the planting value of seed is called seed testing.

Objectives of seed testing

1. To determine their quality, that is ,their suitability for planting
2. To identify seed quality problems and their probable cause
3. To determine the need for drying and processing and specific procedures that should be used
4. To determine if seed meets established quality standards or labelling specifications.
5. To establish quality and provide a basis for price and consumer discrimination among lots in the market

SEED SAMPLING

The first step in seed testing is sampling.

Objective

To draw a portion of seed lot that should represent the entire seed lot.

Introduction

Seed lot: It is a uniformly blended quantity of seed either in bag or in bulk.

Seed size	Maximum quantity per lot
Larger than wheat and paddy	20,000 kg
Smaller than wheat and paddy	10,000 kg
Maize	40,000 kg

Sampling intensity

a. For seed lots in bags (or container of similar capacity that are uniform in size)

Up to 5 containers	Sample each container but never < 5 P.S
6-30 containers	Sample atleast one in every 3 containers but never < than 5 P.S.
31-400 containers	Sample atleast one in every5 containers but never < than 10 P.S.
401 or more containers	Sample atleast one in every 7 containers but never < than 80 P.S.

When the seed is in small containers such as tins, cartons or packets a 100 kg weight is taken as the basic unit and small containers are combined to form sampling units not exceeding this weight e.g. 20 containers of 5 kg each. For sampling purpose each unit is regarded as one container.

For seeds in bulk

Up to 500 kgs	At least 5 P.S
501 to 3000	I.P.s for each 300 kg but not less than 5 P.S
3001-20,000	I.Ps for each 500kg but not less than 10 P.s
20,001 and above	I.P s for each 700 kg but not less than 40.

PRINCIPLES OF SAMPLING

Sample is obtained from seed lot by taking small portion at random from different places and combining them. From this sample smaller samples are obtained by one or more stages. In each and every stage thorough mixing and dividing is necessary.

METHODS OF SAMPLING

a. **Hand sampling**

This is followed for sampling the non free flowing seeds or chaffy and fuzzy seeds such as cotton, tomato, grass seeds etc., In this method it is very difficult to take samples from the deeper layers of bag. To over come this, bags are emptied completely or partly and then seed samples are taken. While removing the samples from the containers, care should be taken to close the fingers tightly so that no seeds escape.

b. Sampling with triers

By using appropriate triers samples can be taken from bags or from bulk.

1. Bin samplers

Used for drawing samples from the lots stored in the bins.

2. Nobbe trier

This name was given after Fredrick Nobbe, father of seed testing. This trier is made in different dimensions to suit various kinds of seeds. It has a pointed tube long enough to reach the centre of the bag with an oval slot near the pointed end. The length is very small. This is suitable for sampling seeds in bag not in bulk.

3. Sleeve type triers or stick triers

It is the most commonly used trier for sampling. There are two types viz.,

1. With compartments
2. Without compartments.

It consists of a hallow brass tube inside with a closely fitting outer sleeve or jacket which has a solid pointed end. Both the inner tube as well as the outer tube have been provided with openings or slots on their walls. When the inner tube is turned the slots in the tube and the sleeve are in line. The inner tube may or may not have partitions.

This trier may be used horizontally or vertically. This is diagonally inserted at an angle of 30^{o}C in the closed position till it reaches the centre of the bag. Then the slots are opened by giving a half turn in clock wise direction and gently agitated with inward push & jerk, so that the seeds will fill each compartment through the openings from different layers of the bag, then it is again closed and with drawn and emptied in a plastic bucket. This trier is used for drawing seed samples from the seed lots packed in bags or in containers.

TYPES OF SAMPLES

1. Primary sample

Each probe or handful of sample taken either in bag or in bulk is called primary sample.

2. Composite sample

All the primary samples drawn are combined together in suitable container to form a composite sample.

3. Submitted sample

When the composite sample is properly reduced to the required size that to be submitted to the seed-testing lab, it is called submitted sample. Submitted sample of requisite weight or more is obtained by repeated halving or by abstracting and subsequently combining small random portions.

4. Working sample

It is the reduced sample of the required weight obtained from the submitted sample on which the quality tests are conducted in seed testing lab.

Weight of submitted sample

The minimum weight for submitted samples for various tests are as follows;

1. Moisture test

100 grams for those species that have to be ground and 50 grams for all other species.

2. For verification of species and cultivar

Crop	Lab only (g)	Field plot & lab (g)
Peas, beans, maize, soybean and crop seeds of similar size	1000	2000
Barley, oats, wheat and crop seeds of similar size	500	1000
Beetroot and seeds of similar size	200	500
All other genera	100	200

3. For other tests like purity and count of other species

Crop	Size of seed lot (kg)	Size of submitted sample (g)	Size of working sample for purity (g)	Size of working sample for count of other species (g)
Paddy	25000	400	40	400
Wheat	25000	1000	120	1000
Maize	40000	1000	900	1000
Sorghum	10000	900	90	900
Bajra	10000	150	15	150
Redgram	20000	1000	300	1000
Greengram	20000	1000	120	1000
Blackgram	20000	1000	150	1000
Bengalgram	20000	1000	1000	1000
Cowpea	20000	1000	400	1000
Soybean	20000	1000	500	1000
Groundnut (pods)	20000	1000	1000	1000
Groundnut (kernels)	20000	1000	600	1000
Gingelly	10000	70	7	70
Sunflower (varieties)	20000	1000	250	1000
Sunflower (hybrids)	20000	1000	125	250
Cotton linted (varieties)	20000	1000	350	1000
Cotton -delinted (varieties)	20000	350	35	350
Cotton linted (hybrids)	20000	350	35	350

Cotton -delinted (hybrids)	20000	250	25	250
Brinjal	10000	150	15	150
Chillies	10000	150	15	150
Bhendi	20000	1000	140	1000
Tomato - varieties	10000	70	7	70
Tomato hybrids	10000	7	7	7
Cabbage	10000	100	10	100
Cauliflower	10000	100	10	100
Knol-Khol	10000	100	10	100

The samples taken may be packed in bags, sealed and marked for identification. For moisture testing the samples should be packed separately in moisture proof polythene bag and kept in the container along with submitted samples.

INFORMATION TO ACCOMPANY THE SAMPLE

Date Kind Variety

Class of seed Lot No.

Quantity of seed in lot (kg):

Test(s) required: (1). Purity (2). Germination and (3). Moisture

Sender's name and address

Types of sample used in seed testing lab

Service sample : Sample received from the farmers.

Certified sample : Sample received from certification agencies or officers.

Official sample : Sample received from the seed inspectors.

MIXING AND DIVIDING OF SEEDS

Objectives

To obtain the representative homogenous seed sample for analysis by reducing the submitted sample to the desired size of working sample

Methods of mixing and dividing

i. Mechanical dividing
ii. Random cups method
iii. Modified halving method
iv. Spoon method
v. Hand halving method

I. MECHANICAL DIVIDING

The reduction of sample size is carried out by the mechanical dividers suitable for all seeds except for chaffy and fuzzy seeds.

OBJECT OF MECHANICAL DIVIDING

- To mix the seed sample and make homogenous as far as possible
- To reduce the seed sample to the required size without any bias.
- The submitted sample can be thoroughly mixed by passing it through the divider to get 2 parts and passing the whole sample second time.
- If necessary 3rd time may be passed to make the seeds mixed and blended so as to get a homogenous seed sample when the same seeds passed through it into approximately equal parts.
- The sample is reduced to desired size by passing the seeds through the dividers repeatedly with one half remain at each occasion.

TYPES OF MECHANICAL DIVIDERS

1. Boerner divider

It consists of a hopper, a cone and a series of baffles directing the seeds into 2 spouts. The baffles are of equal size and equally spaced and every alternate one leading to one spout. They are arranged in circle and are directed inward. A valve at the base of the hopper retains the seeds in the hopper. When the valve is opened the seeds fall by gravity over the cone where it is equally distributed and approximately equal quantity of seeds will be collected in each spout.

A disadvantage of this divider is that it is difficult to check for cleanliness.

2. Soil divider

It is a sample divider built on the same principles as the boerner divider. Here the channels are arranged in a straight row. It consists of a hopper with attached channels, a framework to hold the hopper, two receiving pans and pouring pan. It is suitable for large seeds and chaffy seeds.

3. Centrifugal or Gamet divider

The principle involved is the centrifugal force, which is used for mixing and dividing the seeds. The seeds fall on a shallow rubber spinner which on rotation by an electric motor, throw out the seeds by centrifugal force. The circle or the area where the seeds fall is equally divided into two parts by stationary baffle so that approximately equal quantities of seed will fall in each spout.

II. RANDOM CUPS METHOD

This method is suitable for seeds requiring working sample upto 10 grams provided that they are not extremely chaffy and do not bounce or roll (e.g) *Brassica spp*.

Six to eight small cups are placed at random on a tray. After a preliminary mixing the seed is poured uniformly over the tray. The seeds that fall into the cup is taken as the working sample.

III. MODIFIED HALVING METHOD

The apparatus consists of a tray into which is fitted a grid of equal sized cubical cups open at the top and every alternate are having no bottom. After preliminary mixing the seed is poured evenly over the grid. When the grid is lifted approximately half the sample remains on the tray. The submitted sample is successively halved in this method, until a working sample size is obtained.

IV. SPOON METHOD

This is suitable for samples of single small seeded species. A tray, spatula and a spoon with a straight edge are required. After preliminary mixing the seed is poured evenly over the tray. The tray should not be shaken there after. With the spoon in one hand, the spatula in the other hand using both small portions of seed from not less then 5 random places on the tray should be removed. Sufficient portions of seed are taken to estimate a working sample of approximately but not less than the required size.

V. HAND HALVING METHOD

This method is restricted to the chaffy seeds. The seed is poured evenly on to a smooth clean surface and thoroughly mixed into a mound. The mound is then divided into 1/2 and each half is mound again and halved to 4 portions. Each of the 4 portions is halved again giving 8 portions. The halved portions are arranged in rows and alternate portions are combined and retained. The process is repeated until the sample of required weight is obtained.

PHYSICAL PURITY ANALYSIS

The physical purity analysis of a seed sample in the seed testing lab refers to the determination of the different components of the physical purity viz., pure seed, other crop seeds, weed seeds and inert matter.

Objective

The objective of the purity analysis is to determine whether the submitted sample (by inference the seed lot) confirms to the prescribed standards in regard to purity components.

Method

1. THE WORKING SAMPLE

The purity analysis is done on the working sample of prescribed weight drawn from submitted samples.

The analysis may be made on one working sample of the prescribed weight, or on two sub-samples of at least half this weight, each independently drawn.

2. WEIGHING THE WORKING SAMPLE

The number of decimal places to which the working sample and the components of the working sample should be weighed as below.

Weight of the working sample in gram	Number of decimal places required	Example
<1	4	0.7534
1-9.999	3	7.534
10-99.99	2	75.34
100-999.9	1	753.4
1000 or more	0	753.4

3. PHYSICAL SEPARATION

The working sample after weighing is separated into its components viz., pure seed, other crop seed, weed seed and inert matter.

Pure seed

The seeds of kind / species stated by the sender. It includes all botanical varieties of that kind / species.

Immature, undersized, shrivelled, diseased or germinated seeds are also pure seeds.

It also includes broken seeds, if the size is > 1/2 of the original size except in leguminosae and cruciferae where the seed coats entirely removed are regarded as inert matter.

Other crop seed

It refers to the seeds of crops other than the kind being examined.

Weed seed

It includes seeds of those species normally recognized as weeds or specified under seed act as a noxious weed.

Inert matter

It includes seed like structures, stem pieces, leaves, sand particles, stone particles, empty glumes, lemmas, paleas and chaff.

Awn stalks longer than florets, spikelets are to be removed and treated as inert matter.

4. METHOD OF PURITY SEPARATION

Place the sample on the purity work board after sieving / blowing operations and separate into other crop seeds, weed seeds and inert matter.

After separation identify each kind of weed seeds, other crop seeds as to genus and species. The names and number of each are recorded.

The type of inert matter present should also be noted.

5.CALCULATION

All the four components must be weighed to the required number of decimal places. The percentage of the components are determined as follows:

$$\% \text{ of component} = \frac{\text{Weight of individual component}}{\text{Total weight of all components}} \times 100$$

If there is a gain or loss between the weight of the original samples and the sum of all the four components is in excess of one percent, another analysis should be made.

6. DUPLICATE TESTS

Analysis result near the borderline in relation to the seed standards, one more test is done and the average is reported.

However, if a duplicate analysis is made of two half samples, or whole samples, the difference between the two must not exceed the permissible tolerance.

7. PHYSICAL PURITY ANALYSIS OF GROUNDNUT

It should be carried out on pods and the size of working sample is 1000 grams.

8. DETERMINATION OF HUSKLESS SEEDS

It is required in certain crops like sunflower and paddy.

Four hundred seeds taken from the pure seed and the number of seeds without husk are counted (partly huskless seeds are excluded) and the % is calculated as;

$$\text{Per cent of huskless seeds} = \frac{\text{Number of huskless seeds}}{400} \times 100$$

9. DETERMINATION OF INSEPARABLE OTHER CROP SEEDS AND OBJECTIONABLE WEED SEEDS BY NUMBER /KG

Whole submitted sample is used and the number per kg may be calculated and reported even if the working sample is less than a Kg.

10. DETERMINATION OF OTHER DISTINGUISHABLE VARIETIES (ODV)

Ten times, the size of working sample is used. It is determined based on the morphological characters of the seeds. The authentic samples should be available for comparison. The number of ODV should be calculated and reported as No./kg of seeds.

11. CALCULATING OF RESULTS

The % by weight of each of the component should be calculated to one decimal place.

12. REPORTING RESULTS

The results of each component are given in one decimal place and the total of all components must be 100. Components of < 0.05% shall be reported as Trace.

If the result for a components is nil, this must be shown as '-0.0-' in the appropriate space.

EQUIPMENTS USED FOR PURITY ANALYSIS

1. SEED BLOWER

It is a mechanical device to separate inert matter from the working sample for the crop species like poaceae. It has an electric motor with a fan to blow air at uniform velocity. There are 2 plastic columns one for larger seeds and the other for smaller seeds.

The plastic column is provided with a semi-circular outlet where the terminal velocity of wind can be adjusted. A time clock is also provided for the automatic running of the bowler. The inert matter is separated by stratification using the terminal velocity of air.

2. PURITY WORK BOARD

This is used for effective separation of different components. At the centre of the board, there is an illumination by which the emptiness of the seed is easily identified.

SEED STANDARDS FOR PHYSICAL PURITY

S. No	Crop	Class	
		F.S	C.S
1	Ragi	97.0	97.0
2	Groundnut	96.0	96.0
3	Sesame	97.0	97.0
4	Jute	97.0	97.0
5	Bhendi	99.0	99.0
6	Others	98.0	98.0

GERMINATION TEST

OBJECTIVE

To know the planting value of the seed lot.

GERMINATION

It is defined as the emergence and development from the seed embryo, of those essential structures, for the kind of seed in question, indicates its ability to produce a normal plant under favourable conditions.

PRINCIPLES

Germination tests shall be conducted with the pure seed fraction.

A minimum of 400 seeds are required in four replicates of 100 seeds each or 8 replicates of 50 seeds each or 16 replicates of 25 seeds each depending on the size of the seeds and size of containers of substrate.

The test is conducted under favourable conditions of moisture, temperature, suitable substratum and light if necessary.

No pretreatment to the seed is given except for those recommended by ISTA.

MATERIALS REQUIRED

A. SUBSTRATUM

The substratum serves as moisture reservoir and provides a surface or medium for which the seeds can germinate and the seedlings grow.

The commonly used substrata are sand, paper and soil.

1. **SAND**

a. Size of sand particle

Sand particles should not be too large or too small. The sand particles should pass through 0.80 mm sieve and retained by 0.05 mm sieve.

b. Toxicity

Sand should not have any toxic material of any pathogen. If any pathogen is found, then the sand should be sterilized in an autoclave.

C Germination tray

When we use the sand, germination trays are used to carry out the test. The normal size of the tray is 22.5 x 22.5 x 4 cm. The tray may be either zinc or stainless steel.

B. Method of seed treatment

1. Seeds in sand (s):

Seeds are planted in a uniform layer of moist sand and then covered to a depth of 1 cm to 2 cm with sand.

2. Top of sand (TS)

Seeds are pressed into the surface of the sand.

C. Spacing

We must give equal spacing on all sides to facilitate normal growth of the seedling and to avoid entangling of seed and spread of disease.Spacing should be 1-5 times the width or diameter of the seed.

D. Water

The amount of water to be added to the sand will depend on size of the seed. For cereals, except maize, the sand can be moistened to 50% of its water holding capacity. For large seeded legumes & maize sand is moistened to 60% WHC.

II. PAPER

Most widely used paper substrates are filter paper, blotter or towel (kraft paper). It should have capillary movement of water, at vertical direction (30 mm rise / min.)

It should be free from toxic substances and free from fungi or bacteria.

It should hod sufficient moisture during the period of test.

The texture should be such that the roots of germinating seedlings will grow on and not into the paper.

METHODS

a. Top of paper (TP)

Seeds are placed on one or more layers of moist filter paper or blotter paper in petridishes. The petridishes are covered with lid and placed inside the germination cabinet. This is suitable for those seeds, which require light.

b. Between paper (BP)

The seeds are germinated between two layers of paper.

c. Roll towel method

The seeds are placed between two layers of paper and rolled in towels. The rolled towels are placed in the germinator in an upright position.

d. Inclined plate method

Germination on glass plate with germination paper and kept at an angle of 45^{o}.

III. SOIL

Should be non-caking, free from any large particles. It must be free from weed seeds, bacteria, fungi, nematode or toxic substances. Soil is not recommended for reuse.

A. TEMPERATURE

Required temperature is maintained (most seeds germinate between 20-30^{o}C)

B. Light

Light should be provided for seeds requiring light for germination (e.g.) lettuce and tobacco.

GERMINATION APPRATUS

1. Germination cabinet / Germinator

This is closed chamber where in temperature and relative humidity are controlled. We can maintain the required temperature.

2. Room germinator

It works with same principles as that of germinator. This is modified chamber of larger one and the worker can enter into it and evaluate the seedlings. Provisions are made to maintain the temperature and relative humidity. This is used widely in practice.

3. Counting board

This is used for accurate counting and spacing of seeds. This consists of 2 plates. The basal one is stationary and top one is movable. Both top and basal plates are having uniform number of holes viz., 50/100, when the plates are in different position. After taking the sample, the top plate is pulled in such a way that the holes are in one line so that the fixed number of seeds fall on the substratum.

4. Vacuum counter

Consists of head, pipe and wall. There are plates of 50 or 100 holes which can be fitted to the head. When vacuum is created the plate absorbs seeds and once the vacuum is released the seeds fall on the substrate.

5. Impression board

Made of plastic / wood with 50 or 100 holes per pins. Here the knobs are arranged in equal length and space. By giving impression on the sand it makes uniform depth and spacing for seed.

GERMINATION REQUIREMENTS FOR DIFFERENT CROPS

Crop	Substratum	Temp. (^oC)	First count days	Final Count days	Pre-treatment
Paddy	BP, TP,S	20-30	5	14	Preheat (50^oC) soak in H_2O or HNO_3 24 hours
Maize	Bp, S	20-30	4	7	-
Bajra	TP, BP	20-30	3	7	0.2% KNO_3 (2-3 hours)
Sorghum	TP, BP	20-30	4	10	Prechill
Pulses Redgram	BP,S	30	4	6	-
Blackgram	BP,S	20-30	4	7	-
Greengram	BP,S	20-30	5	8	-
Bengalgram	BP, S	20-30	5	8	-
Cowpea	BP,S	20	5	8	-
Peas	BP, S	20	5	8	-
Castor	BP,S	20-30	7	14	-
Groundnut	BP,S	20-30	5	10	Remove shells
Sunflower	BP,S	20-30	4	10	Ethrel (25 ppm) 48 hrs.
Sesame	TP	20-30	3	6	-
Cotton	BP,S	20-30	4	12	Hot water 85^oC 1 min
Brinjal	TP, BP	20-30	7	14	-
Tomato	TP,BP	20-30	5	14	KNO_3
Chillies	TP, BP	20-30	7	14	KNO_3
Bhendi	BP, S	20-30	4	21	-
Onion	TP, BP	15-20	6	21	Prechill
Carrot	TP, BP	20-30	7	14	-
Radish	TP, BP	20-30	4	10	Prechill
Cauliflower	TP	20-30	5	10	Prechill, KNO_3
Ashgourd	S	30-35	5	14	Light
Bittergourd	BP, S	20-30	4	14	-
Bottlegourd	BP,S	20-30	4	14	-

SEEDLING EVALUATION

ISTA classified the seedlings into different categories based on the development of essential structures.

Categories of seedlings

1. Normal seedlings
2. Abnormal seedlings
3. Hard seeds
4. Fresh ungerminated seeds
5. Dead seeds.

I. Normal seedlings

Seedlings which show the capacity for continued development into normal plant when grown in favourable conditions of soil, water, temperature and light.

Characters of normal seedlings

a. A, well-developed root system with primary root except in certain species of graminae which normally producing seminal root or secondary root.
b. A, well-developed shoot axis consists of elongated hypocotyl in seedlings of epigeal germination.
c. A, well-developed epicotyl in seedlings of hypogeal germination.
d. One cotyledon in monocotyledons and two in dicotyledons
e. A, well-developed coleoptile in graminae containing a green leaf.
f. A, well-developed plumule in dicotyledons.
g. Seedlings with following slight defects are also taken as normal seedlings. Primary root with limited damage but well developed secondary roots in leguminaosae (Phaseolus, Pisum) graminae (maize), cucurbitaceae (cucumis) and malvaceae (cotton).
h. Seedlings with limited damage or decay to essential structures but no damage to conducting tissue.
i. Seedlings, which are decayed by pathogen but it, is clearly evident that the parent seed is not the source of infection.

II. Abnormal seedlings

Seedlings which do not show the capacity for continued development into normal plant when grown in favourable conditions of soil, water, temperature and light.

Type of abnormal seedlings.

A. Damaged seedlings

Seedlings with any one of the essential structures missing or badly damaged so that the balanced growth is not expected. Seedlings with no cotyledons, with splits, cracks and lesions on essential structures and without primary root.

B. Deformed seedlings

Weak or unbalanced development of essential structures such as spirally twisted or stunted plumule or hypocotyl or epicotyl, swollen shoot, stunted roots etc.,

C. Decayed seedlings

Seedlings with any one of the essential structures showing diseases or decayed symptoms as a result of primary infection from the seed which prevents the development of the seedlings.

III. Hard seeds

Seeds which do not absorb moisture till the end of the test period and remain hard (e.g.) seeds of leguminosae and malvaceae.

IV. **Fresh ungerminated seeds**

Seeds which are neither hard nor have germinated but remain firm and apparently viable at the end of the test period.

V. **Dead seeds.**

Seeds at the end of the test period are neither hard nor fresh or have produced any part of the seedlings. Often dead seeds collapse and a milky paste comes out when pressed at the end of the test.

Retesting

If the results of a test are considered unsatisfactory it shall not be reported and a second test shall be made by the same method or by alternative method under the following circumstances.

a. Replicates performance is out of tolerance
b. Results being inaccurate due to wrong evaluating of seedlings or counting or errors in test conditions.
c. Dormancy persistence or phytotoxicity or spread of fungi or bacteria. The average of the two tests shall be reported.

Use of tolerances

The result of a germination test can be relied upon only if the difference between the highest and the lowest replicates is within accepted tolerances.

To decide if two test results of the same sample are compatible again the tolerance table is used.

Reporting results

The result of the germination test is calculated as the averages of 4 x 100 seed replicates. It is expressed as percentage by number of normal seedlings.

The percentage is calculated to the nearest whole number. The percentage of abnormal seedlings, hard, fresh and dead seeds is calculated in the same way. These should be entered on the analysis certificate under appropriate space.

TYPES OF GERMINATION

Two types of seed germination occur and neither appears to be related to seed structure. These two types can be illustrated by observing the germination of bean and pea seeds. Although these seeds are similar in structure ,their germination patterns are quite different.Epigeal germination in beans and hypogeal in peas.

EPIGEAL GERMINATION

During germination the cotyledons are raised above the ground.During root establishment the hypocotyl begins to elongate in an arch which breaks thro' the soil, pulling the cotyledon and enclosed plumule (epicotyl) thro' the ground and projecting them in the air. (eg.) bean, castor, cucurbits and other dicots and onion.

HYPOGEAL GERMINATION

During germination the cotyledons remain beneath the soil while the plumule pushes upward and emerges above the ground. Here the epicotyl (plumule) elongates (e.g.) Peas, grams, mango, grasses and many other sp.

SEEDS STANDARDS FOR GERMINATION

S. No.	Crop	Class of seed	
		Foundation seed	Certified Seed
1.	Paddy	80	80
2.	Maize (inbreds) Single cross Double cross Variety	80 80 - 90	- 80 90 90
3.	Sorghum (Vari.) Hybrids	75 75	75 75
4.	Cumbu	75	75
5.	Ragi	75	75
6.	Blackgram	75	75
7.	Bengal gram	85	85
8.	Green gram	75	75
9.	Horse gram	80	80
10.	Peas	75	75
11.	Pigeon pea	75	75
12.	Castor var.	70	70
13.	Groundnut	70	70
14.	Seasame	80	80
15.	Soybean	70	70
16.	Sunflower	70	70
17.	Cotton	65	65
18.	Jute	80	80
19.	Gourds	60	60
20.	Brinjal	70	70
21.	Chillies	60	60

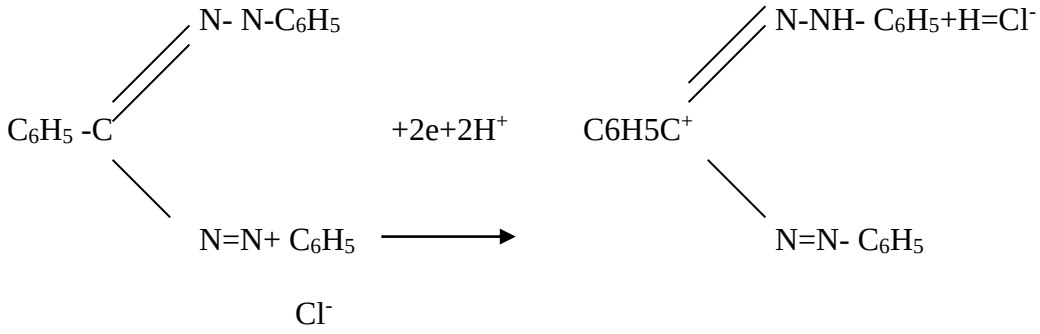
22.	Bhendi	65	65
23.	Tomato	70	70
24.	Cabbage	70	70
25.	Cauliflower	65	65
26.	Carrot	60	60
27.	Radish	70	70
28.	Beetroot	60	60

QUICK VIABILITY TEST

The relatively long periods of time required for completion of germination tests delays the seed marketing. This necessitated the development of rapid methods for estimating the germination capacity of seeds. This test was developed by Lakon (1942) in Germany.

Principle

It is a biochemical test, in which living cells are made visible by reduction of any indicator dye. The indicator used is 2,3,5 triphenyl tetrazolium chloride. Within the seed tissues, it interferes with the reduction processes of living cells and accepts hydrogen from the hydrogenases. By hydrogenation of the 2,3,5 triphenyl tetrazolium chloride, a red stable and non diffusable substance, triphenyl formazan is produced in living cells. The reaction is as follows:



2,3,5 triphenyl tetra, zolium chloride Triphenyl formazan

This makes it possible to distinguish red coloured living parts of seeds from the colourless dead ones. Staining of seeds determines whether seeds are to be classified as viable. Completely stained seeds are viable, partially and comparatively unstained seeds are non-viable.

Field of application

This test is not valid for previously germinated seeds.

Method of tetrazolium testing

a. Testing sample

A representative sample of 50 (or) 100 seeds is usually sufficient. However 200 seeds, in replicates of 100 seeds is recommended.

b. Preparation of solutions

1% solution is used for seeds that are not bisected thro' the embryo, while 0.1% solution is used for seeds in which the embryo is bisected.

The pH of the solution should be between 6 and 8 for best staining. If the pH of the water is not in the natural range, the TZ salt should be dissolved in a phosphate buffer solution. The buffer solution is prepared as follows:

Solution 1: Dissolve 9.078 g of KH_2PO_4 in 1000 ml of water.

Solution 2: Dissolve 11.876 g of $Na_2HPO_4.2H_2O$ in 1000 ml of water.

Take 400 ml of solution 1 and 600 ml of solution 2 and mix them together. In a litre of buffer solution prepared as above dissolve 10 gms of TZ salt. This gives 1 % TZ solution of pH 7.0. This may be further diluted to give lower concentrations.

The solution should be stored in brown bottle to prevent deterioration from light.

Methods of preparation of TZ testing

The seeds are first prepared for staining, then stained and evaluated from light.

Method 1: Bisect longitudinally

(e.g.) maize, sorghum, small grains, large seeded grasses. Soak the seeds in water for 3 to 4 hours. Bisect the seeds by cutting longitudinally thus exposing the main structures of the embryo. Use1/2 of each of seed for testing.

Method 2: Bisect laterally

(e. g) small seeded grasses.

The seeds are cut laterally near the centre of the seed above the embryo. Place embryo end in TZ solution.

Method 3: Pierce with needle

(e.g) small seeded grass.

Puncture the seeds by piercing thro' the seed into the endosperm near the embryo but avoid injury to the embryo.

Method 4: Remove seed coat

(e.g) dicots with seed coats impermeable to tetrazolium

Soak the seeds in water for 3-4 hours and then remove the seed coats and place the seeds in the TZ solution. In some crops like cotton a thin membrane adhering to the cotyledons is also removed in addition to the seed coat.

Method 5: Conditioning only

(e.g) Large seeded legumes

Seeds of soybeans and other large-seeded legumes may swell so rapidly and irregularly when placed directly in water or TZ solution that the seed coats burst. Hence, it is preferably to condition these seeds slowly in moist paper towels overnight before staining, so that they absorb moisture slowly without any damage to the seed.

Method 6: No conditioning or preparation

(e.g.) Small seeded legumes

Seed coats of these seeds are permeable to TZ and the embryos usually will stain without conditioning.

Staining

The prepared seeds should be placed in suitable container (small beakers, petridishes) and covered with TZ solution. Place the containers in an incubator at dark warm conditions of 40^{o}C.

The staining time varies for different kinds of seeds, different methods of preparation, and different temperatures (>1 hr to 8 hrs).

When sample has stained sufficiently the TZ solution should be discarded and the seed sample covered with water immediately. Seed samples can also be kept for 3 days at 10^{o}C for interpretation.

Evaluation of samples

A normal stain appears cherry red.

Monocots - Non viable

1. All structures unstained
2. Shoot largely unstained.
3. Scutellar node unstained.
4. Major areas of coleoptile unstained
5. Central area of scutellum unstained
6. Insect, mechanical or other injuries causing essential structures non-functional.

Dicot - Non viable

1. Embryo completely unstained
2. More than extreme tip of radicle unstained
3. More than 1/2 of cotyledon tissue unstained
4. Deep seated necrosis at cotyledon and embryonic axis juncture or on radicle
5. Fractured radicle

Advantages of TZ test

1. Quick estimation of viability
2. When the seed is dormant, the TZ test is extremely useful
3. Seeds are not damaged (in dicot) in analysis therefore they could be germinated.

Disadvantages of TZ test

1. It is difficult to distinguish normal and abnormal seedlings.
2. It does not differentiate dormant and non-dormant seeds.
3. Since the TZ test does not involve germi. micro organisms harmful to germinating seedlings are not detected.

DETERMINATION OF MOISTURE CONTENT

Objectives

The objective is to determine the moisture of seeds by methods suitable for routine use.

Definition

The moisture content of a seed sample is the loss in weight when it is dried. It is expressed as a percentage of the weight of the original sample. It is one of the most important factors in the maintenance of seed quality.

Methods of moisture determination

1. Air oven method

In this method, seed moisture is removed by drying at a specified temperature for a specified duration.

2. Moisture meters

Moisture meters estimate seed moisture quickly but the estimation is not as precise as by the air oven method.

Weight of the submitted sample

100 gm for species that have to be ground. 50 gm for all other species. The sample should be submitted in polythene bag of 700 guage.

Air oven method for seed moisture estimation

A. materials required

1. Grinding mill

It should be constructed of non-absorbent material. It should grind evenly and should be operated at such a speed that during grinding, it should not cause heating of the ground material. Air currents that might cause loss of moisture must be reduced to a minimum. The finess of grinding should be adjustable.

2. Container

Containers of glass or non-corrosive metal (e.g. Stainless steel) should be used.

3. Oven

A good quality electric air oven with a thermostatic or electronic temperature control for maintaining temperature within = 1^0C is required.

4. Desiccator

5. Analytical balance

6. Sieves : A set of wire mesh sieves with meshes of 0.5 mm, 1,0 mm and 4.0 mm.

B. Grinding

For some seeds (e.g. cereal and cotton) fine grinding is essential before the moisture content is determined. In such cases, at least 50% of the ground material should pass through a wire sieve with meshes of 0.5mm and not more than 10% remain on a wire sieve with a mesh of 1.0 mm. For leguminous seeds, coarse grinding is recommended.At least 50% of the ground material shall pass through a wire sieve with meshes of 4.0 mm.

C. Pre drying

If the species is one for which grinding is necessary and the moisture content is more than 17% (or 10% in the case of soybean and 13% in rice) predrying before grinding is necessary. For this purpose, two 50 gm portions are weighed and placed on to open trays at 130^{o}C for 5-10 min. If seed moisture content is about 25.0% or more it should be predried at 70^{o}C for 2-5 hours, depending on the initial water content. The pre dried seeds should be kept in a closed desiccator for cooling. Then each of the duplicate quantities is weighed separately and about 20 g is ground. The ground material is then subjected to the moisture testing using an air oven as described below.

D. Moisture estimation

It should be carried out in duplicate on two independently drawn 5-10g working samples, weighed with an accuracy of 1 mg. Most species are dried for 1 hr at 130^{o}C, cereals for 2 hrs (130^{o}C) and maize for 4 hrs (130^{o}C). Seeds containing high percentage of oil should be dried at 103^{o}C for 17 hours.

METHODS FOR MOISTURE DETERMINATION

Crop	Grinding	Drying temp ^{o}C	Drying time hours	Predrying necessary above the moisture content %
Paddy	F.G	130	2	13
Ragi	-	103	17	-
Maize	F.G	130	4	17
Cumbu	F.G	130	1	17
Sorghum	F.G	130	2	17
Blackgram	C.G	130	1	17
Greengram	C.G	130	1	17
Cowpea	C.G	130	1	17
Redgram	C.G	130	1	17
Castor	C.G	103	17	17
Groundnut	C.G	103	17	17
Sesame	-	103	17	17
Soybean	C.G	103	17	-
Sunflower	-	103	17	-
Cotton delinted	F.G	103	17	-
Ash gourd	C.G.	130	1	17
Other gourds	-	130	1	17
Brinjal & chilli	-	103	17	-
Bhendi	C.G.	130	17	-
Tomato	-	130	1	-
Cabbage	-	103	17	-

Steps:

1. Empty container along with its cover should be weighed.
2. The submitted sample should be mixed thoroughly and two small portions of seed sample are weighed directly into the containers.
3. After weighing remove the cover or lid of the container and the open container should be kept in the oven which has already been heated to the prescribed drying temperature.
4. At the end of the drying period, container should be closed with its cover or lid.
5. The container should be transferred into a desiccator. The desiccator should be closed and the sample should be allowed to cool.
6. The sample should be weighed again and the moisture content may be calculated to one decimal place by the following formula.

$$m = \frac{m^2 - m^3}{m^2 - m^1} \times 100$$

Where m =seed moisture content.

M1 =weight of the empty container with its cover

M2= weight of the container with its cover and seeds before drying.

M3= weight of the container with its cover and seeds after drying.

The duplicate result of the determination may not differ by more than 0.2% otherwise the analysis should be repeated.

If the material is predried the moisture content is calculated from the results obtained in the predried and dried stages using the following formula.

$$M = S1 + S2 - \frac{S1 \times S2}{100}$$

M = moisture content

S1= moisture percentage lost in predrying stage

S2= moisture percentage lost in drying stage.

MOISTURE METERS: UNIVERSAL OSAW DIGITAL MOISTURE METERS

The principle involved in these moisture meters is that wet grains are good conductors while dry grains are less conductors of electricity. So the moisture content is directly proportional to the electrical conductivity of the seed.

It consists of a compression unit to compress the sample to pre-determined thickness. The thickness setting is very easily read on a vertical and circular scale. The seed material on test is taken in a test cup and is compressed. Then press the push type switch till the reading comes in the display. Here no temperature reading and correlated dial are required. The computer versions of digital moisture meter automatically compensate for temperature corrections.

SEED STANDARDS FOR MOISTURE CONTENT

Crop	Standards	F.S (% max)	C.S (%max)
Paddy			
a.	Open storage	13.0	13.0
b.	Vapour proof	8.0	8.0
Maize			
a.	Open storage	12.0	12.0
b.	Vapour proof	8.0	8.0
Sorghum, Cumbu, Ragi			
a.	Open storage	12.0	12.0
b.	Vapour proof	8.0	8.0
Blackgram, G. gram, R.gram, Cowpea			
a.	Open storage	9.0	9.0
b.	Vapour proof	8.0	8.0
Groundnut			
a.	Open storage	9.0	9.0
b.	Vapour proof	5.0	5.0
Sesame			
a.	Open storage	9.0	9.0
b.	Vapour proof	5.0	5.0
Soybean			
a.	Open storage	12.0	12.0
b.	Vapour proof	7.0	7.0
Sunflower			
a.	Open storage	9.0	9.0
b.	Vapour proof	7.0	7.0
Castor			
a.	Open storage	8.0	8.0
b.	Vapour proof	5.0	5.0
Cotton			
a.	Open storage	10.0	10.0
b.	Vapour proof	6.0	6.0
Cucurbits			
a.	Open storage	7.0	7.0
b.	Vapour proof	6.0	6.0
Brinjal & chillies			
a.	Open storage	8.0	8.0
b.	Vapour proof	6.0	6.0
Bhendi			
a.	Open storage	10.0	10.0
b.	Vapour proof	8.0	8.0
Tomato			
a.	Open storage	8.0	8.0
b.	Vapour proof	6.0	6.0

Crop	Standards	F.S (% max)	C.S (%max)
Cabbage & cauliflower			
a.	Open storage	7.0	7.0
b.	Vapour proof	5.0	5.0
Onion			
a.	Open storage	8.0	8.0
b.	Vapour proof	6.0	6.0
Carrot			
a.	Open storage	8.0	8.0
b.	Vapour proof	7.0	7.0
Beetroot			
a.	Open storage	9.0	9.0
b.	Vapour proof	8.0	8.0
Radish			
a.	Open storage	6.0	6.0
b.	Vapour proof	5.0	5.0

SEED HEALTH TESTING

OBJECTIVES

To determine the health status of a seed lot, which in turn, establishes the sanitary condition of the seed in commerce.

Seed health testing

Science of determining the presence or absence of disease causing agents such as fungi, bacteria and viruses and insects in the seed samples.

The pathogen may be carried with the seeds in the ways.

I. Admixture

Pathogens are independent of seeds but accompany them. Ergot sclerotia are mixed with healthy seeds during threshing.

II. External

The pathogen may be present on seed surface as spores, oospores and chlamydospores as in case of karnal bunt of wheat, covered smut of barley, downy mildew of pearlmillet etc.,

By surface sterilization external seed borne diseases are killed.

III. Internal

Pathogens establish within the seed with definite relationship with seed parts.

Procedure

Working sample

The entire submitted sample, or a portion of it, depending on the test method may be used. Normally the working sample shall not be less than 400 pure seeds.

Methods

1. Examination without incubation

   Such tests give no indication as to the viability of the pathogen.

I. Direct examination

The submitted sample, or a sub sample from it is examined, with or without a stereoscopic microscope and searched for ergots and other sclerotia, nematode galls, smut-balls, insects, mites and evidence of diseases and pests in seed or in inert matter.

II. Examination of imbibed seeds

The working sample is immersed in water or other liquid to make fruiting bodies, symptoms of pests etc., more easily visible, or to encourage the liberation of spores. After imbibition the seeds are examined either superficially or internally, preferably with the help of stereoscopic microscope.

III. Examination of organisms removed by washing

The working sample is immersed in water with a wetting agent or alcohol and shaken vigorously to remove fungal spores, hyphae, nematodes etc., intermingled with or

adhering to the seeds. The excess liquid is then removed by filtration, centrifugation or evaporation and the extracted material examined with the help of a compound microscope.

2. Examination after incubation

After incubation for a specific period, the working sample is examined for the presence of symptoms of disease organisms, pests and evidence of physiological disturbances in the seeds and seedlings.

1. Blotters

These are used when pathogens are to be grown from the seeds or when seedlings are to be examined. The seeds with or without pretreatment are so spaced during incubation as to avoid secondary spread of organisms. Lighting is provided to stimulate sporulation of fungi when needed. Some pathogens can be identified without magnification but a stereoscopic microscope or a compound is often helpful in identifying spores.

Sand, artificial composts and similar media can be used for certain pathogens. The seeds usually without pre-treatment, are sown suitably spaced in the medium so as to avoid secondary spread of organisms and then incubated in conditions favourable for symptom expression.

Agar plates are used to obtain identifiable growth of organisms from seeds. Precautions should be taken to ensure their sterilization. The seeds, normally after pre-treatment, are placed on the surface of sterilized agar and incubated. Characteristic colonies on the agar can be identified, either macroscopically or microscopically. Lighting is often useful and germination inhibitors may be used.

3. Examination of plants

Growing plants from seed and examining them for disease symptoms is sometimes the most practicable method for determining whether bacteria, fungi or viruses are present in the sample. Seeds from the sample under test may be sown or inoculum obtained from the sample may be used for infection tests with healthy seedlings or parts of plants. The plants must be protected from accidental infection from elsewhere and conditions may require careful control.

4. Other techniques

Specialized methods involving serological reactions, phage-plaque formation etc., have been developed for some disease organisms and may be used preferably in consultation with the seed pathologist.

Calculation and expression of results

Results are expressed as percentage by number of seeds affected or as number of organisms in the weight of sample examined. The result must be accompanied by statement of the test method used, including any pre-treatment applied, and of the amount of the sample or fraction examined. The absence of a statement concerning the health condition of the seed does not necessarily that the health condition is satisfactory.

SEED STORAGE

Seed storage

It is the maintenance of high seed germination and vigour from harvest until planting.

Importance of seed storage

Seed storage is important to get adequate plant stands in addition to healthy and vigourous plants.

Factors affecting seed longevity in storage

I. Genetic factors

The storage is influenced by the kind/ variety of seeds. Some kinds are naturally short lived (e.g.) onion soybeans, ground nut etc.,

Within a crop the storage period varies between varieties. Also the storage periods of hybrid and parent are differing.

II. Pre harvest factors

a. Effect of provenance

(e.g.) Red clover seeds grown in Canada stored for 4 years with 80% germination whereas seeds grown in England and Newzeland stored for 3 years with 80% germination. This is due to different climatic conditions and soil types prevailing in different places.

b. Effects of weather

Fluctuating temperature during seed formation and maturity will affect seed storage pre harvest rain may also affect the viability.

c. Pre harvest sanitation spray

In pulses, insect infestation comes from field (e.g.) bruchids.

III. Seed structures

The presence or absence of glumes (lemma and palea) in grasses influence the storage period.

Husk, chaff or both have shown an inhibitory effect on the growth of mould and an increase in life span of cereals seeds.

Generally small seeds escape injury, where as large seeds are more likely to be extensively damaged (e.g) bean, lima-bean and soybean.

IV. Initial quality of the seed

Seed lots having vigourous, undeteriorated seeds store longer than deteriorated lots.

V. Environmental factors

a. Moisture content

The amount of moisture in the seeds is the most important factor influencing seed viability during storage.

Generally if the seed moisture content increases the storage life decreases. If seeds are kept at high moisture content the losses could be very rapid due to mould growth very low moisture content below 4% may also damage seeds due to extreme desiccation or cause hard-seediness in some crops.

Since the life of a seed largely revolves around its moisture content it is necessary to dry seeds to safe moisture contents. The safe moisture contents however depends upon storage length type of storage structure, kind / variety of seed, type of packing material used. For cereals in ordinary storage conditions for 12-18 months, seed drying upto 10% moisture content appears quite satisfactory. However, for storage in sealed containers, drying upto 5-8% moisture content depending upon particular kind may be necessary.

b. Relative humidity and temperature during storage

Relative humidity is the amount of H_2O present in the air at a given temperature in proportion to its maximum water holding capacity. Relative humidity and temperature are the most important factors determining the storage life of seeds. Seeds attain a specific and characteristic moisture content when subjected to given levels of atmospheric humidities. This characteristic moisture content is called equilibrium moisture content. Equilibrium moisture content for a particular kind of seed at a given relative humidity tends to increase as temperature decreases.

Thus the maintenance of seed moisture content during storage is a function of relative humidity and to a lesser extent of temperature. At equilibrium moisture content there is no net gain or loss in seed moisture content.

c. Temperature

Temperature also plays an important role in life of seed. Insects and moulds increase as temperature increases. The higher moisture content of the seeds the more they are adversely affected by temperature.

Decreasing temperature and seed moisture is an effective means of maintaining seed quality in storage.

The following are thumb rules by Harrington are useful measures for assessing the effect of moisture and temperature on seed storage. These rules are as follows:

a. For every decrease of 1% seed m.c. the life of the seed doubles. This rule is applicable between m.c. of 5-14%.

b. For every decrease of 5^oC in storage temperature the life of the seed doubles. This rules applies between 0^oC to 50^oC.

c. Good storage is achieved when the % of relative humidity in storage environment and the storage temperature in degrees Fahrenheit add upto one hundred but the contribution from temperature should not exceed 50^{o}F.

Nomograph

Roberts (172) developed formulae to describe the relationship between temperature, seed moisture content and period of viability. From these relationships it was possible to construct a seed viability nomograph. These nomographs are helpful inpredicting the retention of seed viability in defined storage environment for a particular period or to determine combination of temperature and moisture content which will ensure the retention of a desired level of seed viability for a specific period.

d. Gas during storage

Increase in O_2 pressure decreases the period of viability.

N_2 and CO_2 atmosphere will increase the storage life of seeds.

e. Microflora, insects and mites.

The activity of all these organisms can lead to damage resulting in loss of viability.

The microflora activity is controlled by R.H, temperature and m.c. of seed.

VI . Seed treatment

Treated seeds with fungicides can be stored for longer periods.

Fumigation to control insects will also help in longer period of storage.

Fumigation

Once the seed storage is free of completely free of insects, the most serious source of reinfestation is infested seed which is brought in. Seed may be brought from the field already infested, or it maybe transferred from infested storage. Such infestation is controlled by fumigation.

Fumigation is effective only in gas-tight storage. Numerous effective fumigants are available.

	Dosage	Exposure period
Methyl bromide	16 to 32 mg / cubic meter	24 hours
Hydrogen cyanide	32 to 64 mg/cubic meter	24 hours
Hydrogen phosphide	5 to 10 tablets per tone of seed	3 to 7 hours.

It must be borne in mind that fumigation, particularly repeated fumigation, may seriously reduce the vigour and even the germination capacity of seeds. This is particularly true of seeds with a high moisture content. Seeds with moisture content greater than 14 per cent should be dried to below this value before fumigation.

VII. Types of packing materials

Moisture vapour proof containers can help in longer storage than the moisture pervious containers.

VIII. **Use of dessiccants**

Desiccant like silica gel can maintain the m.c. in equilibrium with the R.H. of 45%. It is kept @ 1 kg/10 kg of seeds. When the blue silica gel turns to pink colour it should be dried at 175^{o}C in oven and then again placed in the container.

SEED PACKING MATERIALS

Seed packing

Is the process of filling, weighing and sewing of bags with seed. Factors to be considered while selecting the packaging materials are:

1. Kind of seeds to be packed
2. Quantity of seed
3. Value of seed
4. Cost of packaging material
5. Storage environment in which the packed materials will be held.
6. Period of storage.

Classification of packaging materials or containers

1. Moisture and vapour pervious containers

These containers allow entry of water in the form of vapour and liquid. These are suited for short-term storage. The seeds in these containers will attain seed equilibrium moisture with the surrounding atmosphere (e.g.) cloth bags, gunny bags, paper bags etc.,

2. Moisture impervious but vapour pervious containers

These allow entry of water in the form of vapour and not in liquid. The seeds in these containers can't be carried over for long period in hot humid conditions. (e.g.) polythene bags of > 100 gauge thickness and urea bags.

3. Moisture and vapour proof containers

These containers will not allow entry of moisture in the form of liquid or vapour. These are used for long term storage even in hot humid conditions if the seeds are sealed at optimum m.c (e.g.) polythylene bags of >700 gauge thickness, aluminum foil pouches, rigid plastics etc.,

Certified seeds of cereals, pulses and oil seeds are normally packed either in gunny bags or cloth bags. However, paper bag, aluminum foil pouches and polyethylene bags are used for packaging flower and vegetable seeds.

Types of storage requirements

The type storages are based on the time of storage. It can be classified into 4 types.

a. Storage of commercial seeds
b. Storage of carry-over seeds
c. Storage of foundation seed stocks
d. Storage of germplasm seeds

a. Commercial seeds

The largest storage need is for the storage of seed from harvest until planting. The storage period ranged from a few days to 8 or 9 months.

Here seeds must be dried to a m.c of < 14% for starchy seeds and less than 11% for oil seeds.

b. Carryover seeds

About 20-25% of stored seeds may have to be carried over through one growing season to the second season. This storage period is usually between 1-year &11/2 years.

Seeds can be stored in steel bins with tight fitting lids or in moisture proof bags.

c. Foundation seed stocks

F.S can be stored for several years, since genetic drift is minimized by reproducing foundation or stock seeds. This seeds can be stored at R.H. of about 25% and temp. at 30^{o}C or a R.H. of 45% and temp. of 20^{o}C. This can be achieved by using a dehumidifier. Store the seeds with polythene bags of > 700 gauge thickness.

d. Germplasm seeds

These seeds are to be stored for many years. Basic requirements for such very long-term storage are coldest temperature and seed m.c. in equilibrium with20-25% R.H. storage rooms can be, maintained at 5^{o}C and 10^{o}C and 30% R.H. Here the seeds should be dried to lower level.

Seed storage sanitation or godown sanitation

1. Storage environment should be free from insects and rodents
2. Chemicals such as insecticides, fertilizers should not be stored along with seeds.
3. Storage room should be kept cool and dry.
4. Fumigation may be done whenever needed.
5. Use wooden pallets for arranging the bags in cris-cross manner for effective ventilation on all sides of the bags.
6. Seed bags should be stacked upto 6-8 tires depending upon density of seeds.
7. Restacking once in 3 months or less is important for prolonging seed viability.
8. Before storage disinfect the godowns by spraying malathion 50% E.C. @ lit /100 m2 area.
9. If old gunnies, cloth bags and containers are to be used these should be fumigated with aluminium Phosphide.
10. Size of the stack should be 30 x20 feet to facilitate fumigation under gas proof or polythene covers.
11. Periodical inspections should be carried out and control measures to be taken i.e. Malathion 50% E.C. @ lit /100 m2 should be applied in every 3 weeks.

It must be borne in mind that fumigation, particularly repeated fumigation may seriously reduce the vigour and even the germination capacity of seeds. Seeds with m.c. greater than 14% should be dried to below this value before fumigation.

Maintenance of viability in storage

1. Store well mature seeds.
2. Store normal coloured seeds.
3. Seeds should be free from mechanical injury.
4. Seeds should be free from storage fungi or microorganisms.
5. Seeds should not have met with adverse conditions during maturation.
6. Storage environment or godown should be dry and cool.
7. Seeds should be dried to optimum m.c
8. Required R.H. and temperature should be maintained during storage.
9. Seeds should be treated with fungicides before storage.
10. Storage godown should be fumigated to control storage insects, periodically.
11. Suitable packaging materials should be used for packing.