Practical Manual: B. Sc. (Hons.) Agriculture
Experiential Learning Program
(Seed Production & Technology)
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Laboratory Manual

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1. Introduction

Production of genetically pure and otherwise good quality pedigree seed is an exacting task requiring high technical skills and comparatively heavy financial investment. During seed production strict attention should be given to the maintenance of genetic purity and other qualities of seeds in order to exploit the full dividends by introduction of new superior crop plant varieties. In other words, seed production has to be carried out under standardized and well-organized condition.

A series of booklets have been published on various aspects of seed systems to build the capacity of various field groups, who are involved in the efforts to develop the entrepreneurship in seed production. This manual has attempted to deal with the production of good quality seeds of rice, maize, seedless cucumber, onion and solanaceous crops. The characteristics of good quality seeds have been defined. Factors influencing seed production and the ways to maintain pure accessions like isolation distance, bagging technique, rouging has been dealt with.

Every farmer in our country needs healthy seeds which are genetically pure, with high seed vigour and good germination percentage. Timely availability of good quality seeds at reasonable price ensures good yield and profit to the farmers. The seeds play an important role in agriculture and acts as a carrier of the genetic potential of varieties. Quality seed production which follows efficient certification procedures plays a major role in the increase of food production of our country. To ensure this, the government has prescribed standards and has brought in seed production techniques, testing, certification and marketing procedures through the Seeds Act, 1966.

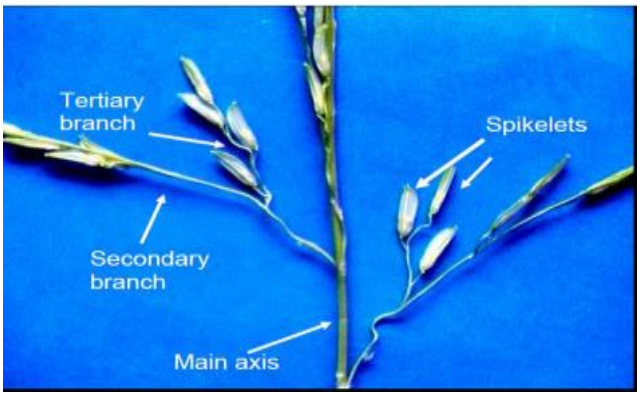
This manual has been written for the final year students of agriculture who want to specialize themselves in seed production of some important crops. It is hoped that the students will be benefitted by this manual.

2. PRACTICAL NO-1

CERTIFIED SEED PRODUCTION OF RICE

Rice (*Oryza sativa* L.)

- The rice is self pollinated crop with less than 0.1% natural out crossing
- Certified seed of open pollinated rice is the progeny of foundation seed.
- Depending on the situation and production procedure, certified seed can be of two sub-classes, certified seed stage-I and certified seed stage-II.
- Certified seed stage-I is produced from the foundation seed; but when certified seed is produced from certified seed stage-I it is called certified seed stage-II.
- Certified seed stage-II cannot be used for any other seed production purposes.
- The genetic purity of the certified seed should be maintained at 99 percent.
- The certified seed tag is blue in colour and it depicts all relevant information about the certified seed lot packed in the bag.

CERTIFIED SEED PRODUCTION OF RICE	
2.1. Floral Biology	➢ The rice inflorescence is a panicle that bears single flowered spikelets, having 6 stamens. ➢ The flower is surrounded by lemma, palea and glumes. ➢ The blooming of rice normally occurs between 8.00 am to 11.00 pm. ➢ The flowers in a single panicle bloom over a period of 7-10 days, but most of the flowers bloom between 2nd and 4th days after emergence of the panicle from boot leaf. ➢ Blooming of the spikelet starts at the top of the panicle and proceeds downwards. ➢ Anthesis starts at the time of blooming of the spikelet. ➢ High day temperature, high solar radiation and low night temperature promote panicle production.  **Fig-1: Panicle of Rice**

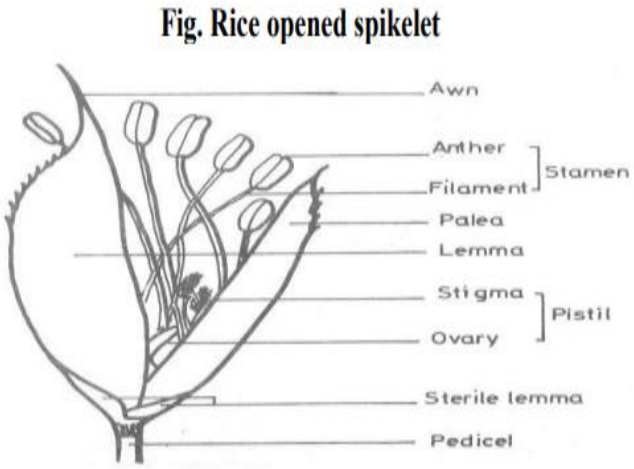


Fig-2: Opened Spikelet of Rice

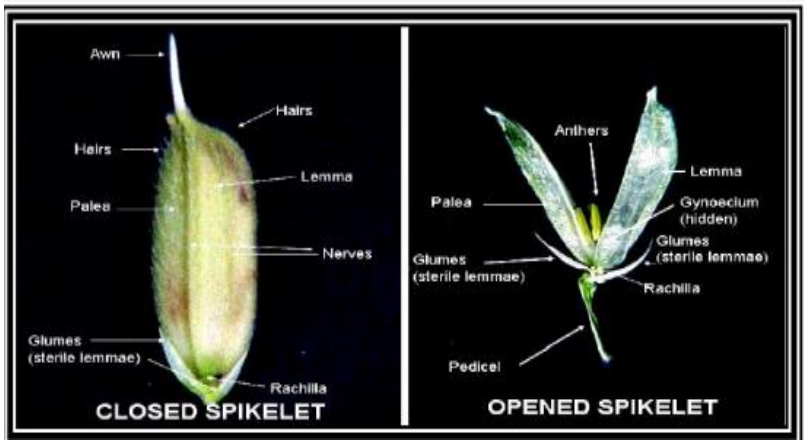


Fig-3: Opened & Closed Spikelet of Rice

- **Spikelets:** The spikelets are single-flowered, each with a short stalk.
- **Glumes:** There are two small glumes at the base of each spikelet.
- **Floret:** The floret consists of the lemma, the palea, two lodicules, the androecium and the gynoecium.
- **Androecium:**
  i. The androecium consists of six stamens arranged in two whorls whose filaments are short in earlier stage.
  ii. The filament elongates immediately after floret opening and brings anther to the level of stigma.
  iii. The total number of pollen grains per anther is reported to be directly correlated with anther size.
  iv. Normally 2-3 pollen grains are required per stigma to fertilize one egg cell.
- **Gynoecium:**
  i. The gynoecium is monocarpellary and has a superior ovary,

	with two feathery stigmas on a style. ii. Receptivity of stigma is maximum during the first 3 days after opening of spikelet and then is gradually lost after 7 days. iii. Stigma exertion, large stigmatic area and its receptivity, all play a major role in determining high seed set in CMS parent. ➢ **Lemma:** The lemma is large and hairy. It is awned 5-nerved structure. ➢ **Palea:** The palea is hairy, smaller than the lemma and is present opposite to it. It is three-nerved structure. After maturity, the lemma, the palea and the glumes remain attached on the seed as a cover called husk. **Flower:** The flower is bisexual, zygomorphic and bracteate.
2.2. Soil Requirement & Field Preparation	A viable seed production requires specific location having fertile field with proper irrigation and drainage system, sufficient sunshine during flowering, free of off-type plants, provision of 3 meters and no serious disease and insect problems.
2.3. Seed Rate & Nursery Bed Preparation	➢ The seed bed area should be fixed and the land should be kept fallow after seedlings are uprooted. ➢ Only precaution to be taken here is, not to allow the left-over seedlings to flower and mature there ➢ The area should be ploughed and the leftover seedlings should be destroyed. ➢ Depending upon soil and climatic condition two types of seed bed can be prepared, dry seed bed and wet seed bed ➢ Seed Rate: 30-40 kg/ha **Dry Seed Bed:** ➢ The selected seed bed plot is to be thoroughly ploughed and the soil is to be powdered by the use of rotavator (if possible). ➢ A 40 cm width drain at 4 sides of the plot should be prepared so that excess water can be drained out through this channel. ➢ From one side, 1 meter width bed should be prepared and 30 cm gap should be there in between two beds. ➢ The seed bed should be raised seed bed with furrows in the form of drain at both sides. ➢ The soil of the bed should be dressed and leveled.  **Fig-4: Seed Bed Preparation with Rotavator**

	  **Fig-5: Dry Seed Bed** **Fig-6: Seedlings in Dry Seed Bed** **Wet Seed Bed:** ➢ The selected seed bed area should be properly ploughed, watered and kept for 7-8 days for soil to get soaked. ➢ Initial puddling should be done. ➢ The land should be left for 4-5 days and then final puddling should be followed by laddering.   **Fig-7: Preparation of Wet Seed bed** **Fig-8: Seedlings of Wet Seed bed** ➢ A drain should be made of 40 cm width all around the seed bed area. ➢ A seed bed should be prepared of 1.5 meter width one after another, giving 30 cm gap between two beds. ➢ After 2-3 days seedlings will come up. ➢ The seed bed should be irrigated as per requirement.
2.4 Treatment of Seeds before Sowing	➢ A gunny bag should be filled up to 3/4th of the space, and completely submerged for 20-24 hrs. Extra space should be kept in the gunny bag because the seed under water will swell and require more space. ➢ After 24 hours the seed bags should be taken out from water and kept at a higher place so that the water will flow out of the bag. ➢ The bag should be kept on the floor with gunny bag at the bottom and above as cover to give a bit of warmth. ➢ If the outer side of the gunny bag dries off then water should be sprayed to keep it wet. ➢ After 2-3 days seeds will start germinating. Once the seeds get germinated, the pre germinated seeds should be used for dribbling in

	the wet seed bed.
2.5. Sowing of Seeds	➢ The seeds should be sown in 2 cm depth. ➢ After sowing, irrigation should be done through the water channel. ➢ After 4-5 days, seeds will germinate and seedlings will come up. ➢ The seed bed should be irrigated as per requirement.
2.6. Transplanting & Isolation Distance	**Land preparation** ➢ Rice can be grown both by direct seeding and transplanting methods. ➢ In upland situation direct seeding is preferred while in medium land transplanting method is prevalent. ➢ First one summer ploughing is needed and then the field should be left for 15-20 days. ➢ Then the plot should be watered and kept for a week so that the soil will get completely soaked and the drop out rice seeds will either germinate or get decayed. ➢ After seven days, a wet ploughing (initial puddling) should be done which spoils the germinated rice seeds and helps open up the soil. ➢ After 3-4 days, the final puddling should be done and leveling should be done thoroughly before transplanting **Transplanting**

Fig-9: Summer Ploughing

Table-1: Seedling age with duration of crop in certified seed production of rice

Variety	Seedling Age
Early Duration	14-21 days
Medium Duration	25-30 days
Late Duration	35-40 days

➢ Seed production plots must be line transplanted due to easiness of crop management.
➢ Spacing of seedlings is as follows:

Table-2: Spacing of seedlings with duration of crop in certified seed production of rice

Duration	Line to Line Spacing (cm)	Plant to Plant Spacing (cm)
Early	15	10
Medium to Late	20	15

	➢ In seed production plots one seedling per hill should be transplanted ➢ 2-3 cm of water should be kept in the field after transplanting. **Isolation distance:** ➢ Though strictly self-pollinated, windy conditions but 2-5% cross pollination occurs. ➢ The isolation distance of 3 meters from nearby other varietal plot should be maintained during seed production.  **Fig-10: Isolation Distance** ➢ Time Isolation: In time-isolation the varietal plots are arranged in such a way where, the nearby varieties do not flower at the same time. So, there will be no chance for cross pollination.
2.7. Roguing in Seed Production Plot	Removal of off types is called roguing. To raise a pure seed crop it is important to remove these off types from the seed production plots. For roguing, the following points are to be taken care of: ➢ Difference in plant height among the population ➢ Difference in leaf characters like, leaf size, shape and colour. ➢ Difference in flowering time i.e., if any plant flowers much earlier or much later than the variety. ➢ Difference in flag leaf shape, size and position. ➢ Difference of panicles from the original crop. ➢ Differ of grain type than the original grain of the variety. ➢ Once proper roguing is complete, the seed production plots get field level purity which is an important factor for seed certification.  **Fig-11: An off-type in Seed Plot**

Fig-12: Removal of Off-type Plants (Roguing)

2.8. Irrigation, Fertilizer Application & Weed management

Weed management

- Proper preparation of plot for transplanting suppresses the initial weed growth to a considerable limit.
- The irrigation channels should be kept clean which reduces weed.
- While growing Rabi-rice, herbicide should be applied.
- A manual hand weeding should be done after 25-30 days of transplanting.
- Later, manual hand weeding is needed if required.

Irrigation

- In comparison to other crops, rice cultivation requires more water.
- To restrict weed growth after transplanting 2-3 cm depth of water in the field should be maintained for a month.
- More water should not be kept as it will affect the tillering of the rice plant.
- Once tillers come up, 3-5 cm depth of water should be maintained in the field till milking stage of the panicles.
- Shortage of water during panicle initiation and milking stage leads to more chaffy grains in the panicle.
- After milking stage, reduce the water level in the field should be reduced to 2-3 cm only.
- Once tips of panicle ripen or before 15 days of harvesting the total water from the field should be drained and allowed to dry
- Nitrogen, Phosphorus and Potash should be applied at the rate of 100:50:50 kg per hectare.

Table-3: Fertilizer application in certified seed production of rice

Fertilizer	No of Application	Time of Application	Quantity of Application
Nitrogen Fertilizer	1st	Before transplanting as basal dose	1/3rd of total quantity
	2nd	After 40-45 days of crop growth	-Do-
	3rd	Panicle Initiation (20-25 days before flowering) or booting	-Do-
Phosphatic	1st	Basal dose before	Total quantity

	Fertilizer		transplantig	
	Potash Fertilizer	1st	Basal before transplanting	3/4th of total quantity
		2nd	Panicle Initiation (20-25 days before flowering)	1/4th of total quantity

2.9. Plant Protection Measures

Table-4: Plant protection in certified seed production of rice

Name of Insects	Management Practices
Gundhi bug	Spraying of chloropyrifos 20%+cypermethrin 2% EC @ 1 L in 200L water. Application of Malathion 5 % dust @ 6-8 kg/acre at morning time.
Stem borer	Application of Cartap hydrochloride 50 SG/ Fipronil 5 SG @1kg/ha in 200L water at 15 days intervals.
Plant hopper	Spraying of Imidaclorpid 17.8% EC @ 1.2 L/ha
Rice hispa	Spraying of Chloropyriphos + Supermethrin solution or Quinolphos 25 EG @ 1.25 L in 200L of water.

Name of Diseases	Management Practices
Bacterial Leaf Blight	Spraying of Streptocyclin/Agrimycin 60 g or 80 g+500 g blitox or phytolon or fupravit in 500 L of water 2-3 times at 10-15 days interval.
Blast & Sheath Blight	Spraying of fungicides like Tricyclozol, Hexaconozol or Propiconozol @ 200ml/ acre in 200 L of water
False smut	Seed treatment with Thiram + Carbendazim (2:1 ratio) @ 3 g/kg seeds
Khaira disease	Application of Zinc sulphate @ 20-30 kg/ ha
Brown spot	Spraying of one of these: Carbendazim (0.1%), Diathane M 45(0.25%), Tilt (0.1%), or Hinosan (0.1%) 2-3 times at 10-12 days interval

2.10. Harvesting, Threshing, Drying and Grading of Seeds

Harvesting

- For early varieties the harvesting should be done after 25 days of flowering
- For late varieties the harvesting should be done after 35 days of flowering
- Harvesting should not be done much earlier than the expected date which leads to harvesting of some half matured grains causing reduction in yield
- Harvesting should not be delayed much which leads to the breaking of panicles from the plant creating difficulty during threshing and yield loss.
- Generally mechanical harvesting by reaper or combine harvester should not be used in seed plots because these processes do not safeguard the quality.
- If combine harvester is used then it should be ascertain that the machine is cleaned properly and no grains of other rice varieties are struck up inside the harvester drum (the drum of the combine harvester

is the vulnerable point).

Threshing

- Threshing should be done immediately unless the harvested material is laid in the field for 2-3 days for further drying. In that case, threshing may start after 3 days.
- For threshing purpose, a concrete threshing floor is always good. If it is not available, then an area should be cleaned, dressed with cow-dung paste and used for threshing
- One variety should be brought at a time for threshing so that there will be no chances of mixing.
- Once threshing of one variety is over, the threshing floor and threshing machine should be cleaned and then the next variety should be brought for threshing.

Drying

- During harvesting the seed moisture should be in the range of 20-23%.
- After threshing and cleaning this seed moisture should be at a level of 13% or less so that the seed can be stored.

Fig-13: Drying of Quality Seed

- The seeds should be dried on the clean threshing floor in 3 cm thick layer.
- After every 30 minutes, the seeds should be altered so that both sides of the seed get equally exposed to sunlight. If not altered properly, then one side of the seed will be fully dried and will shrink a bit, and on the other side a crack will develop; which will affect the germination percentage.
- It is better to dry the seed on a tarpaulin so that it becomes easy to gather the seed into a heap and cover it; and if rain comes at once (as it happens in coastal belt), the tarpaulin cover can save the seed from getting wet.

Grading

- Grading is the removal of smaller and shrivelled seeds from the well filled healthy seeds.
- Processing should be done by grading machine which cleans the seed lot.
- The processed seed looks healthy and uniform in size.
- During grading, straw particles, gravels, soil etc. come out through the

	first exit. ➢ Chaff comes out through the second exit. ➢ Through the third exit half-filled shrivelled grains and smaller size seeds are screened out ➢ Through the ultimate exit clean, healthy and uniform sized seeds are delivered.  **Fig-14: Seed Grader**
2.11. Seed Testing: Germination % & Viability of the Produced Seed	➢ Germination is the ability of seeds that produce or are likely to produce seedlings under a suitable environment which is expressed in percentage. ➢ This can be well determined with the following two methods. **Wet filter paper method** ➢ Seeds are germinated on wet filter paper placed in petri-dishes. ➢ The petri-dishes should be kept under controlled conditions for germination. ➢ Germinated seeds should be counted and percentage of germination is calculated. ➢ Generally, 4 samples should be plated for a reliable test. $$\text{Germination \%} = \frac{\text{Total number of Seeds Germinated}}{\text{Total number of Seeds Plated}} \times 100$$  **Fig-15: Wet Filter Method of Germination**

	Tetrazolium method ➢ The chemical 2,3,5-triphenyl tetrazolium chloride (or Tetrazolium chloride in short) is colourless, but it develops intense red colour when it is reduced by living cells. ➢ Seeds sgould be soaked overnight in tap water ➢ All seeds should be splitted longitudinally by a scalpel so that a portion of the embryo is attached with each half of the seed ➢ One half of each seed should be placed in a petri dish and covered with 1% aqueous solution of tetrazolium chloride for 4 hours ➢ Seeds should be washed under tap water ➢ The seeds should be counted in which the embryo is stained red

3. PRACTICAL NO-2

CERTIFIED SEED PRODUCTION OF HYBRID RICE

Hybrid Rice (*Oryza sativa* L.):

The rice is self pollinated crop with less than 0.1% natural out crossing

- In rice WA (Wild Abortive) source of cytoplasm is used in hybrid seed production.
- 3 line breeding approach (A, B & R line) for rice hybrid has been developed by the scientist Yuan Long Ping in China during 1973- first time in the world.
- For commercial hybrid development in rice there are four different approaches:

1. Three line method or CMS system
2. Two line method or PGMS (Photosensitive Genetic male Sterility)/TGMS (Thermosensitive Genetic Male Sterility) system
3. One line method or Apomixis system
4. Chemically induced male sterility method

- The source of cytoplasm used in hybrid seed production of rice is WA (Wild Abortive).
- Dr. Yuan Long Ping and his team in Hainan Island of Southern China developed the practical usable CMS system in rice during 1970.
- Dr. Yuan Long Ping reported the first attempt of identification of Three Line Approach for hybrid rice during 1973.
- Later on Dr. Yuan Long Ping developed the first hybrid rice based on CGMS in the year 1977 using the Wild Abortive male sterile cytoplasm

CERTIFIED SEED PRODUCTION OF HYBRID RICE (A X R) (CGMS)	
3.1 Floral Biology, Emasculation & Crossing Techniques	➢ The rice inflorescence is a panicle that bears single flowered spikelets, having 6 stamens. ➢ The flower is surrounded by lemma, palea and glumes. ➢ The blooming of rice normally occurs between 8.00 am to 11.00 pm. ➢ The flowers in a single panicle bloom over a period of 7-10 days, but most of the flowers bloom between 2nd and 4th days after emergence of the panicle from boot leaf. ➢ Blooming of the spikelet starts at the top of the panicle and proceeds downwards. ➢ Anthesis starts at the time of blooming of the spikelet. ➢ High day temperature, high solar radiation and low night temperature promote panicle production.

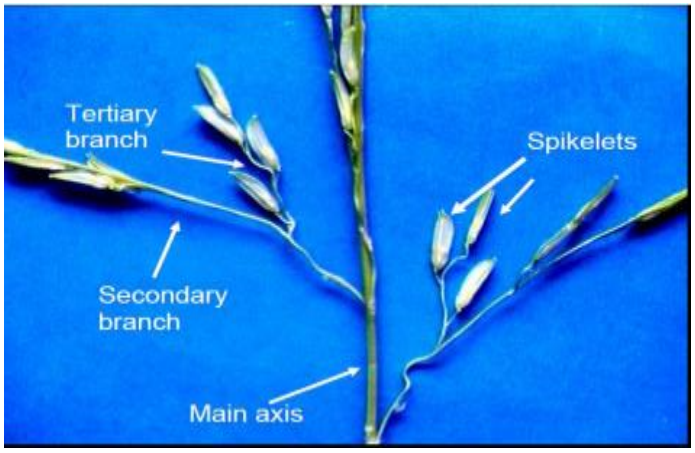


Fig-16: Panicle of Rice

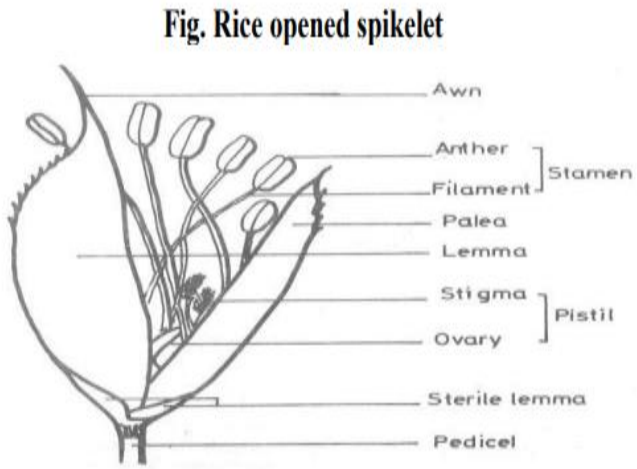


Fig-17: Opened Spikelet of Rice

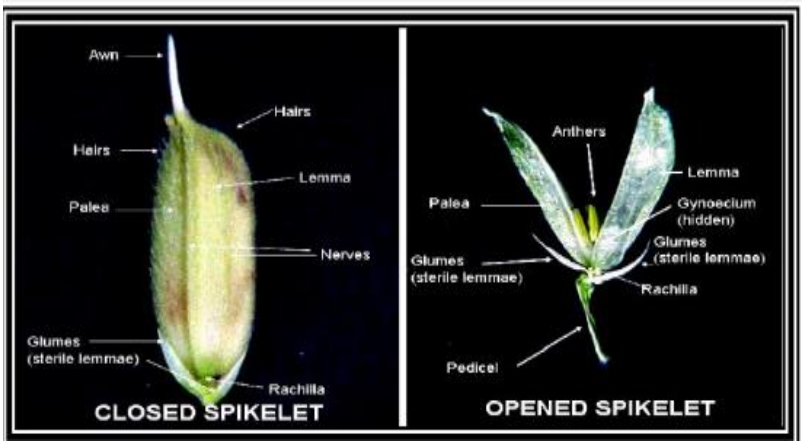


Fig-18: Opened & Closed Spikelet of Rice

- **Spikelets:** The spikelets are single-flowered, each with a short stalk.

	➢ **Glumes:** There are two small glumes at the base of each spikelet. ➢ **Floret:** The floret consists of the lemma, the palea, two lodicules, the androecium and the gynoecium. ➢ **Androecium:** v. The androecium consists of six stamens arranged in two whorls whose filaments are short in earlier stage. vi. The filament elongates immediately after floret opening and brings anther to the level of stigma. vii. The total number of pollen grains per anther is reported to be directly correlated with anther size. viii. Normally 2-3 pollen grains are required per stigma to fertilize one egg cell. ➢ **Gynoecium:** 4. The gynoecium is monocarpellary and has a superior ovary, with two feathery stigmas on a style. 5. Receptivity of stigma is maximum during the first 3 days after opening of spikelet and then is gradually lost after 7 days. 6. Stigma exertion, large stigmatic area and its receptivity, all play a major role in determining high seed set in CMS parent. ➢ **Lemma:** The lemma is large and hairy. It is awned 5-nerved structure. ➢ **Palea:** The palea is hairy, smaller than the lemma and is present opposite to it. It is three-nerved structure. After maturity, the lemma, the palea and the glumes remain attached on the seed as a cover called husk. ➢ **Flower:** The flower is bisexual, zygomorphic and bracteate. **Anthesis and Mode of Pollination:** The flower may open from 7 a.m. to 4 p.m., depending upon the season. Most of the flowers start opening at the apex and the flowering proceed downward in the panicle, but in the branches, it is not strictly so. In rice three types of pollination are possible: • In the usual process the anther burst as they emerge and pollinate the stigma (leading to self-pollination). • The anthers burst open and pollination takes place before blossoming, generally at high temperature and under low humidity (leading to self-pollination). • Under certain temperature and humidity conditions, the anthers may emerge from the flower without bursting. **Emasculation:** It is the removal of the stamens from spikelets. Several methods have been used for emasculating rice: **Standard method:** • This is most widely used method of emasculation in rice.

	• All the immature and mature stamens should be removed from spikelets • The glumes should be separated with the help of a pair of forceps and all the six stamens should be removed gently • To speed up the emasculation, suction may be used. • Emasculation is generally performed in the evening and the pollination is done next morning. • After emasculation, the female plant should be covered with butter paper bags. Tagging is also done.
3.2. Soil Requirement & Land Preparation	A viable seed production requires specific location having fertile field with proper irrigation and drainage system, sufficient sunshine during flowering, and no serious disease and insect problems. **Favourable climatic condition** ➢ Detailed information on the weather data of a given locality is necessary for fixing the seeding dates. ➢ Seeding of the parental lines should be planned in such a way that the flowering in both parents coincides with the most favorable climatic conditions, which are as follows: i. Overall daily mean temperature of $24^{o} – 30^{0}$ C ii. Relative humidity ranging from 70 – 80 % iii. The differences between day and night temperatures should not be more than 80 $–10^{o}$ C (5^{0} -7^{0} C is optimum). iv. Sufficient sunshine with moderate wind velocity (2-3m/sec). v. There should not be rains continuously for three days during the period of flowering. Yield will be adversely affected if overall daily mean temperature during flowering is below 20^{0} C and above 35^{0} C. **Required area for nursery bed preparation** Around 600-800 m^2 nursery area is required for transplanting one-hectare land. **Puddling** ➢ Before seeding, puddling the seedbed field twice (at an interval of 6-7 days) and keep the water continuously for 4-5 days. ➢ After that draining the excess water and puddling (2-3 times) in wet condition to destroy weeds, weed seeds and germinated rice seeds. **Nursery bed preparation** i. Preparing raised seedbeds (5-10 cm height) of 1m width of any convenient length. ii. Providing drainage channels (30 cm) in between seedbeds to

drain excess water.

Fertilizer application in nursery bed

i. Applying recommended fertilizer and manures (500: 500: 500g/100 m^2 N, P, K and 50 kg/100 m^2 FYM) to the nursery beds.

ii. Doubling the phosphorus dose where low temperature retards seedling growth and applying zinc shulphate @ 3-4 kg/1000 m^2 in zinc deficient area.

iii. For proper seedling growth, applying urea @ 600-800g/100m^2 after 15 days of sowing.

iv. Avoiding excess nitrogen application in nursery; it affects the flowering synchronization in parental lines.

3.3. Seed Rate & Sowing of A & R Lines

Seed rate

i. Sowing of pre-germinated seed uniformly on the seedbed (@ of 1-2kg seed/20 m^2)

ii. Use of 15 kg of `A' line seed and 5 kg of `R' line seed to produce sufficient seedlings to grow in one hectare each.

Seed sowing of A & R line

The sowing sequence of seed parent and pollen parent in the hybrid rice seed production plot depends on the growth duration of seed parent (A line) and pollen parent (R line). Therefore, to attain the complete synchronization in parental lines and long duration availability of pollens, male parent (B/R line) must be sown in three staggered date (at 3-4 days interval) and transplanted as per patterns given in table.

A. Seed parent (A line) has 10 days longer growth duration than pollen parent (R line):

In this situation sowing of A line is to be completed first. Three staggered sowing of R line is to be started on 6th day of sowing of CMS line and would be completed with 4 days interval. 24-26 days old seedlings of the `A' line should be transplanted. All R lines should be transplanted 10 days later of CMS line planting.

Table-5: Sowing sequence and seedling age for transplanting of A & R line with A line's duration 10 days more than R line

Seed Parent (CMS line)	Pollen Parent (R line)	Sowing sequence	Seedling age for transplanting (days)
A line		0 day	24-26
	First R line	6th day	28-30
	Second R line	10th day	24-26
	Third R line	14th day	20-22

B. In case seed parent (A line) has 10 days shorter growth duration than pollen parent (R line):

Sowing of R line has to be done in three staggered date with 4 days of interval. Sowing of CMS line needs to be done on 14th day of first sowing of R line. The seedlings of the R line are to be transplanted when the age of the 2nd date sown R line reaches 24-26 days. All three staggered sown R lines are to be transplanted simultaneously. Later, 24-26 days old seedlings of the A line are to be transplanted.

Table-6: Sowing sequence and seedling age for transplanting of A & R line with A line's duration 10 days less than R line

Seed Parent (CMS line)	Pollen Parent (R line)	Sowing sequence	Seedling age for transplanting (days)
	First R line	0 day	28-30
	Second R line	4th day	24-26
	Third R line	8th day	20-22
A line		14th day	24-26

C. In case seed parent (A line) has same growth duration as pollen parent (R line):

In such case, first sowing of R line has to be done 4 days before sowing of CMS line. CMS line and second staggered sowing of R line need to be done simultaneously on 4th. Last sowing of R line has to be done on 8th day. Transplanting of both A and R lines to be done simultaneously.

Table-7: Sowing sequence and seedling age for transplanting of A & R line with same duration

Seed Parent (CMS line)	Pollen Parent (R line)	Sowing sequence	Seedling age for transplanting (days)
	First R line	0 day	28-30
A line	Second R line	4th day	24-26
	Third R line	8th day	20-22

Seed bed management

i. Managing the seedbed properly for getting healthy and vigorous seedlings for transplanting.

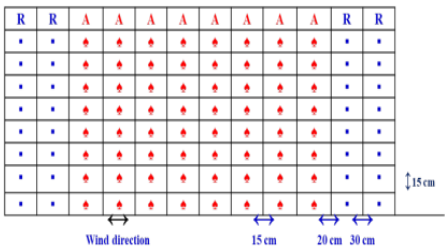
ii. To avoid the fungal diseases in nursery, seed treatment with Carbendazim 50% WP @ 4g/kg seed should be ensured.

iii. For proper seedling growth, maintaining the optimum moisture in nursery is important

Fig-18: Nursery Preparation and Sowing of Germinated Seeds

3.4. Transplanting & Row Ratio of A & R Lines	i. Seedlings of both, A and R lines should be transplanted when they attain the age of 21- 25 days. ii. Transplanting of older seedling (one-day old seedling may cause half day delay in flowering and vice-versa) delays flowering and transplanting of younger seedling advances flowering. iii. If the transplanting of seedlings of 'A' line is delayed, then delay transplanting of the 'R' line by the same number of days is necessary.  **Fig-20: Mixing of Staggered Sown A/R Line Seedlings** iv. One or two seedlings per hill of the 'A' line and 3-4 seedlings per hill of R (male lines) lines to be transplanted. v. One or two seedlings per hill of the 'A' line and 3-4 seedlings per hill of R (male lines) lines are to be transplanted. **Row ratio & row direction in transplanting of A & R lines** i. The row ratio or row proportion refers to the number of rows of the male parent (R line) to that of the female parent (A line) in a seed production plot. ii. In hybrid rice seed production plot, 2:6 male:female is recommended. iii. However, the row ratio may vary from region to region, depending on weather, management and parental lines. iv. R and A lines can be planted in several row ratios of 2:6-14 for hybrid seed production but for maintaining the CMS line, it should not exceed 2:6-8. v. To encourage out-crossing, 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.

Fig-21: Row ratio, Row direction & Planting Pattern



vi. Characteristics of the parental lines (A & R lines) to determine row ratio

- .Height of the pollinator
- Growth and vigor of the pollinator
- Size of the panicles and amount of residual pollen
- Duration and angle of floret opening in CMS lines
- Stigma exertion of CMS lines

Transplanting of R line

- Transplanting of seedlings of R line should be done in paired rows.
- A space of 115-145 cm inside block between paired rows of 'R' line seedlings should be left for transplanting 6 rows blocks of 'A' line seedlings.

Fig-22: Planting Layout of R Line: flowering duration of R line is more than a line

- Transplant 2-3 seedlings per hill with a row-to-row distance of 30 cm and plantto-plant spacing of 15 cm.

	 **Fig-23: Planting Layout of R Line: flowering duration of R & A line is same** **Transplanting of CMS (A line)** • Transplanting of 'A' line seedlings in blocks of 8 rows should be done in between the paired rows of 'R' lines (**Fig-21**). • Transplanting should be done with 1-2 seedlings per hill at a spacing of 15cm x 15cm 20 cm wide space should be kept between A line rows and nearest R line row.
3.5. Synchronization of Flowering of A & R Line	**Cause of incomplete synchronization of flowering between parental lines:** i. Microclimatic changes in the field or in the environment, which cause advancement or delay (4-6 days in either direction) in flowering. ii. Excess application of nitrogen and less water availability cause delay, iii. Extra dose of phosphorus and flooding causes advancement in flowering. **Corrective Measures:** i. Spraying 1% solution of Phosphoric acid before 3rd stage of panicle development (up to 7-9th days of panicle initiation) ii. Application of single super phosphate @ 50-60 kg/ha in male row and 100 kg/ ha in female row. This causes 4-5 days advancement in flowering. iii. Delaying in the flowering can also be achieved by spraying 2% solution of urea or 50-60 kg/ ha nitrogen in male and 75-100 kg/ha in female rows before 3rd stage of panicle development. This causes 4-5 days delay in flowering. iv. Some other corrective measures as given in Table-4, can also be successfully applied in flowering adjustment of parental lines in seed production plots. Dual corrective measures of opposite effect on male and female parents will be more

effective in getting good response

Table-8: Approaches for delaying in flowering

Name	Chemical quantity		Stage of Application	Adjustment Possible (Days)
	Male	Female		
Urea broadcasting **Urea spray**	50-60 kg/ha 1-2%	75-100 kg/ha 1-2%	Before 3rd stage (booting)	4-5 2-3
Paclobutrazol spray	1.0 kg/ha	1.5 kg/ha	Before 3rd stage	6-8
Draining out water			1st – 5th stage	2-3
Leaf clipping	Effective	Effective	7th – 8th stage	2-3
Removing panicles	1-3 times	1-3 times	At heading	5-6
Delayed GA3 application	Effective	Effective	At 40-50% flowering	1-2

Table-9: Approaches for advancing in flowering

SSP broadcasting	50-60 kg/ha	100 kg/ha	Before 3rd stage	4-5
MOP broadcasting	10-20 kg/ha	30-40 kg/ha	Before 3rd stage	4-5
GA3 application	10-15 g/ha	10-15 g/ha	At heading	2-3
Boric acid	100 g/ha	150 g/ha	Before 3rd stage	1-3

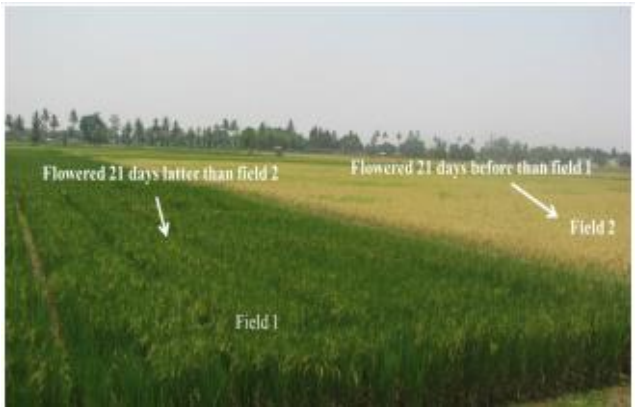
3.6. Method of Improving Seed Setting in Hybrid Seed Production

Supplementary Pollination

- Supplementary pollination is a technique of shaking the pollen parent so that the pollen is shed and effectively dispersed over the A line plants.
- Methods of supplementary pollination:
  - i. Rope pulling method
  - ii. Shaking the pollen parent with the help of two bamboo sticks

Fig-23: Supplementary Pollination through Stick Shaking

	➢ Time of supplementary pollination: i. Peak anthesis time i.e. 8.30 a.m. to 10.30 a.m. when 30-40 % of the spikelets are opened. ii. This process is repeated 3–4 times during the day at an interval of 30 minutes. Duration of supplementary pollination: 7-10 days during the flowering period.  **Fig-25: Supplementary Pollination through Rope Pulling**
Flag leaf clipping	➢ Normally the flag leaves are erect and longer than the panicles and they come on the way of easy pollen dispersal thus affecting the out-crossing rate. ➢ The clipping of flag leaf helps in free movement and wide dispersal of pollen grains to give higher seed production. ➢ Stage of flag leaf clipping: Booting stage. ➢ Process of flag leaf clipping: Only half or two-third portion of flag leaf should be removed. ➢ Flag leaf clipping should not be done in the plots infested with diseases as this might spread the disease further.  **Fig-26: Flag Leaf Clipping**
Application of GA3 (Gibberelic acid)	➢ Most of the Wild Abortive based CMS lines have imperfect panicle exertion with 10-15% spikelets are enclosed. ➢ Application of GA3 promotes stigma exsertion and receptivity ➢ Promotes exsertion and growth rate of secondary and tertiary tillers ➢ Adjust flowering in parental lines by influencing flowering ➢ **Time of spraying:**

	i. 8-10 am and 4-6 pm ii. First 40% of GA3 should be applied during 8-10% panicle emergence stage. iii. Remaining 60% of GA3 should be applied on the following day ➢ **Dose of spraying:** i. 40-50 g/ha ii. 1 g of GA3 should be dissolved in 25-40 ml of ethyl alcohol
3.7. Isolation distance, Roguing of off-types & Weeding	➢ **Spatial isolation:** 100-meter distance between hybrid seed production plots and plots of other varieties, and500-meter distance for CMS line maintenance.  **Fig-26:Spatial Isolation** ➢ **Time isolation:** Wherever it is difficult to have space isolation, a time isolation of over 21 days would also be effective. It means that the heading stage of the parental lines in hybrid seed production plot should be 21 days earlier or later than that of other varieties grown in the vicinity.  **Fig-28: Time Isolation** ➢ **Barrier isolation:** i. In some places, the natural topographic features such as

mountains, rivers, forests etc. can serve as the most effective barrier.

ii. A crop barrier with maize, sugarcane and Sesbania (Dhaincha) covering a distance of 30 m would also serve the purpose of isolation.

iii. Artificial barrier with polythene sheets and seed nets of about 3 m height can also be used in case of small scale seed production.

Fig-29: Physical Barrier

Roguing

- Roguing is the removal of undesirable rice plants from the hybrid seed production plots.
- The purity of hybrid rice seeds used in commercial production must be more than 98%.
- The purity of the restorer and CMS lines must be more than 99%.
- **Important stages of rouging:** The important stages for roguing are maximum tillering, flowering and just before harvesting.

Roguing at maximum tillering:

i. The off-types could be identified by their morphological differences from the true to type plants.

ii. Therefore, it is essential to know the characteristic features of parental lines, which help in easy identification of rogues and efficient roguing.

iii. Any plant found outside the rows (figure 9) has to be removed as they may be volunteer plants.

iv. All those plants which are either too tall or too short than the seed or pollen parent should be removed.

v. The off-type plants could be identified by difference in their leaf blade size, shape and leaf sheath colour.

Roguing at flowering:

i. Roguing at flowering is extremely important as it is the stage when we can identify many off-types which look similar to the parental lines during the early stages of growth.

ii. All the off-type plants that flower very early or very late should be removed.

iii. The plants which differ from parental line plants in respect of leaf size, shape, angle, panicle shape, size and pigmentation should be carefully removed.

iv. All the plants should be removed from A line that have plumpy yellow anthers.

v. Plants in the A line should not have fertile pollen.

vi. The off-types in A lines can also be distinguished from their fully exserted panicles (imperfect panicle exsertion occurs in CMS).

vii. Care should be taken to remove the plants, which are highly infested with pests and diseases.

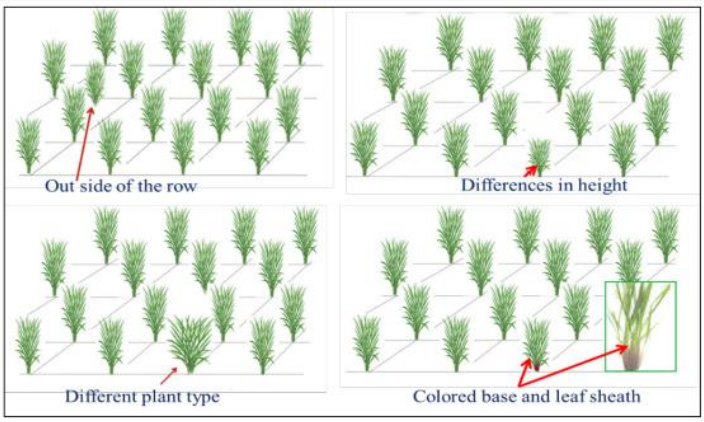


Fig-30: Roguing at Tillering Stage

Fig-31: Roguing at Flowering Stage

Roguing just before harvest:

- Before harvesting, the plants in A line rows should be thoroughly checked and those plants which show normal seed set (more than 70% seed set) should be removed.
- It is necessary to remove all the off-types that have different grain characters as compared to that of A line plants.

<table>
<tr><td></td><td>The grain size, shape, colour and pigmentation of A line plants should be critically examined for effective roguing.

Weeding

Table-10: Herbicide application & time for hybrid rice seed production
<table>
<tr><th>Name</th><th>Dosage</th><th>Time of Application</th></tr>
<tr><td>Butachlor</td><td>1.5 l/acre</td><td>Within 48hrs of transplanting</td></tr>
<tr><td>Benthiocarb (50 EC)</td><td>3 l/ha</td><td>Within 3-4 days after transplanting</td></tr>
<tr><td>Anilofos (30 EC)</td><td>3 l/ha</td><td>Within 3-4 days after transplanting</td></tr>
<tr><td>Eraze-strong/Segment granules</td><td>4 kg/acre</td><td>After 8 days of transplanting with sand</td></tr>
</table></td></tr>
<tr><td>3.8. Study of Characters of Male Sterile (A) & Restorer (R) Lines</td><td>Characteristics of CMS line (A line)
An ideal CMS line should have
➢ stable male sterility over environments
➢ adaptability to target environment for which rice hybrids have to be developed
➢ easy restorability, so that many elite lines can be used as male parents
➢ good out crossing ability to result in higher seed yield
➢ good combining ability and
➢ good grain quality so that rice hybrids can be developed with acceptable grain quality.

Characteristics of Restorer line (R line)
➢ stable restorability over environments
➢ adaptability to target environment for which rice hybrids have to be developed
➢ easy restorability
➢ good out crossing ability to result in higher seed yield
➢ good panicle exsertion
➢ high pollen load
➢ good combining ability and
➢ good grain quality so that rice hybrids can be developed with acceptable grain quality.</td></tr>
<tr><td>3.9. Application of Fertilizer & Irrigation</td><td>In India, recommended dose of N: P: K for Kharif season is 100:50:50 kg/ha whereas for Rabi it is slightly more i.e. 120:60:60.</td></tr>
</table>

Table-11: Fertilizer dosage and application time for hybrid rice

Fertilizer	No of Application	Time of Application	Quantity of Application
Nitrogen Fertilizer	1st	Before transplanting	25% of total quantity
	2nd	Maximum tillering	-Do-
	3rd	Panicle Initiation (20-25 days before flowering	-Do-
	4th	Milking stage (5 days after flowering)	-Do-
Phosphatic Fertilizer	1st	Basal dose before transplantig	Total quantity
Potash Fertilizer	1st	Basal before transplanting	3/4th of total quantity
	2nd	Panicle Initiation (20-25 days before flowering	1/4th of total quantity

Irrigation

- Three centimeter water layer up to 12-15 days of transplanting and 5-6 centimeter up to dough stage should be maintained.
- Within ten days after transplanting gap filling should be done.
- Weed management should be done either by two-time manual weeding
  i. First after 21 days and
  ii. Second after 42 days of transplanting

3.10. Plant Protection

Table-12: Important plant protection measures for hybrid rice seed production

Name of Insects	Management Practices
Gundhi bug	Spraying of chloropyrifos 20%+cypermethrin 2% EC @ 1 L in 200L water. Application of Malathion 5 % dust @ 6-8 kg/acre at morning time.
Stem borer	Application of Cartap hydrochloride 50 SG/ Fipronil 5 SG @1kg/ha in 200L water at 15 days intervals.
Plant hopper	Spraying of Imidaclorpid 17.8% EC @ 1.2 L/ha
Rice hispa	Spraying of Chloropyriphos + Supermethrin solution or Quinolphos 25 EG @ 1.25 L in 200L of water.

Name of Diseases	Management Practices
Bacterial Leaf Blight	Spraying of Streptocyclin/Agrimycin 60 g or 80 g+500 g blitox or phytolon or fupravit in 500 L of water 2-3 times at 10-15 days interval.
Blast & Sheath Blight	Spraying of fungicides like Tricyclozol, Hexaconozol or Propiconozol @ 200ml/ acre in 200 L of water
False smut	Seed treatment with Thiram + Carbendazim (2:1 ratio)

	@ 3 g/kg seeds
Khaira disease	Application of Zinc sulphate @ 20-30 kg/ ha
Brown spot	Spraying of one of these: Carbendazim (0.1%), Diathane M 45(0.25%), Tilt (0.1%), or Hinosan (0.1%) 2-3 times at 10-12 days interval

3.11. Harvesting Threshing, Drying, Grading, Germination % & Viability Test of Hybrid Seeds

Harvesting

- All R lines should be harvested first.
- The harvested R lines should be kept in a safe place separately.
- After R line harvesting, a final roguing in seed parent should be done carefully, where the plants showing more than 70% seed setting should be removed.
- Then the seed parent plants should be harvested.

Figure-32: Harvesting: First A/R lines are harvested. Then final roguing in A line rows followed by harvesting

Threshing

- The 'A' line parent and 'R' line parent harvests should be kept separately from each other.
- The A and R lines should be threshed separately.
- Before starting threshing, all the threshing equipment, threshing floor and tarpaulin should be thoroughly cleaned.
- New gunny bags should be used for storing the seeds.
- Two labels for each bag need to be prepared– one to place inside the bag and one to attach to the bag outside.
- Each label should contain the following information:
  - i. Name and Address of Grower
  - ii. Name of the parent
  - iii. Name of the location
  - iv. Season and year

Date of harvest

Drying

- During harvesting the seed moisture should be in the range of 20-23%.
- After threshing and cleaning this seed moisture should be at a level of 13% or less so that the seed can be stored.

Fig-33: Drying of Quality Seed

- The seeds should be dried on the clean threshing floor in 3 cm thick layer.
- After every 30 minutes, the seeds should be altered so that both sides of the seed get equally exposed to sunlight. If not altered properly, then one side of the seed will be fully dried and will shrink a bit, and on the other side a crack will develop; which will affect the germination percentage.
- It is better to dry the seed on a tarpaulin so that it becomes easy to gather the seed into a heap and cover it; and if rain comes at once (as it happens in coastal belt), the tarpaulin cover can save the seed from getting wet.

Grading

- Grading is the removal of smaller and shrivelled seeds from the well filled healthy seeds.
- Processing should be done by grading machine which cleans the seed lot.
- The processed seed looks healthy and uniform in size.

Fig-34: Seed Grader

- During grading, straw particles, gravels, soil etc. come out through the first exit.
- Chaff comes out through the second exit.
- Through the third exit half-filled shrivelled grains and smaller size seeds are screened out
- Through the ultimate exit clean, healthy and uniform sized seeds are delivered.

Seed Yield: 5-10 q/ha

Purity percentage: Maximum pure seed (97%) and inert matter (2%) is recommended as physical purity percentage.

- Germination is the ability of seeds that produce or are likely to produce seedlings under a suitable environment which is expressed in percentage.
- This can be well determined with the following two methods.

Wet filter paper method

- Seeds are germinated on wet filter paper placed in petri-dishes.
- The petri-dishes should be kept under controlled conditions for germination.
- Germinated seeds should be counted and percentage of germination is calculated.
- Generally, 4 samples should be plated for a reliable test.

$$\text{Germination \%} = \frac{\text{Total number of Seeds Germinated}}{\text{Total number of Seeds Plated}} \text{X } 100$$

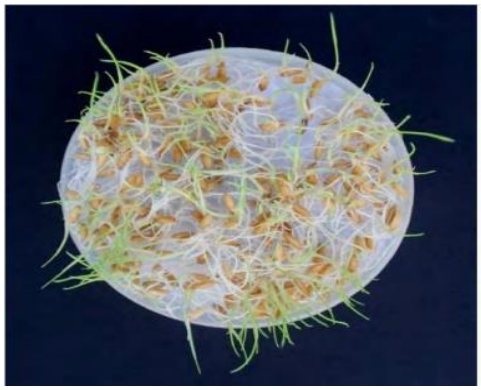


Fig-35: Wet Filter Method of Germination

Tetrazolium method

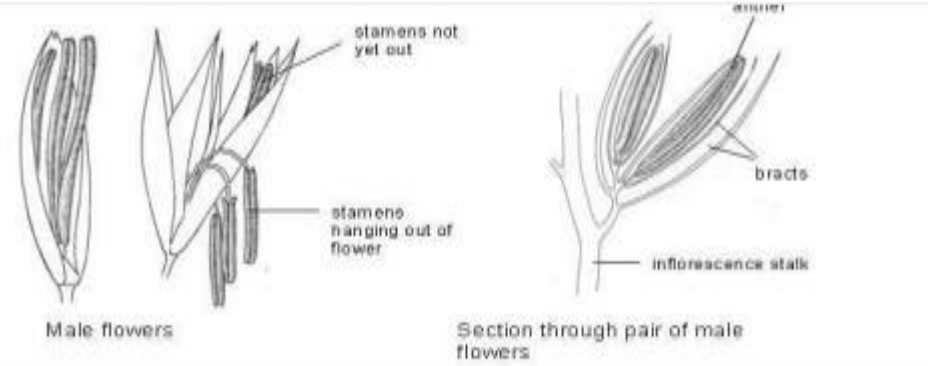
- The chemical 2,3,5-triphenyl tetrazolium chloride (or Tetrazolium chloride in short) is colourless, but it develops intense red colour when it is reduced by living cells.
- Seeds sgould be soaked overnight in tap water
- All seeds should be splitted longitudinally by a scalpel so that a portion of the embryo is attached with each half of the seed
- One half of each seed should be placed in a petri dish and covered with 1% aqueous solution of tetrazolium chloride for 4 hours
- Seeds should be washed under tap water
- The seeds should be counted in which the embryo is stained red

4. PRACTICAL NO-3

CERTIFIED SEED PRODUCTION OF HYBRID MAIZE

Hybrid Maize (*Zea mays*):

- Maize hybrid seed provides farmers with varieties containing improved genetics, such as high yield potential and unique trait combinations to counter diseases and adverse growing conditions.
- The quality of hybrid seed depends greatly on field production methods, both in adherence to quality assurance standards and implementation of appropriate agronomic management.
- Hybrid maize seed production involves crossing a female parent population with a male parent in isolated fields.
- Each hybrid variety is composed of a specific combination of a female (seed bearing) and male (pollen providing) parents.
- The field management of the two parents is also important and requires attention to timing of planting, elimination of off-types, removal of tassels from the females before pollen shedding, separate harvesting of the female seed and careful shelling and processing of the seed to maintain seed quality.

CERTIFIED SEED PRODUCTION OF HYBRID MAIZE	
4.1. Floral Biology, Crossing Techniques & Detasselling	Maize bears monoecious flowers. Staminate flowers are produced in tassel and Pistillate flowers are on the shoot in the axil of leaf. **Staminate flower (tassel):** ➢ The main stem of the maize plant terminates in a tassel, bearing two flowered staminate spikelets. ➢ Each staminate flower having lemma, palea and three stamens. ➢ As the tassel flower opens, the anthers are pushed-out by the elongating filaments and pollen grains are come out from the extruded anthers. ➢ Pollen shedding usually brings 1-3 days before the silk have emerged from the shoots of the same plant (protandry nature) and usually continues for a period of 3-4 days after the silks on the plants are ready to be pollinated.  **Fig-36: Staminate Flower of Maize**

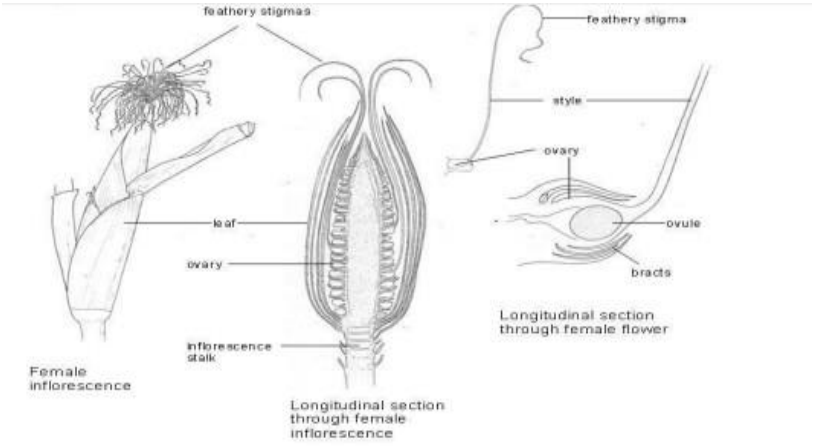


Fig-37: Pistillate Flower of Maize

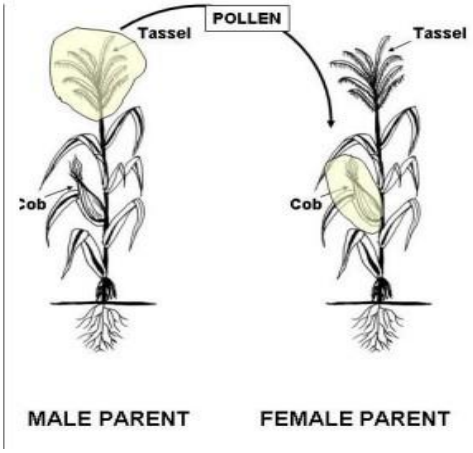


Fig-38: Maize Plants

Pistillate flowers (silk / spadix):

- The shoots arise as branches from nodes about mid-way of the stalk.
- Each shoot is composed of a shank from which the husk arises and terminates in the ear on which the pistillate flowers are borne.
- The spikelets are borne in pairs.
- Each spikelet normally contains one fertile and one sterile ovule. This results in an even number of rows of kernels on the ear.
- Fresh silks functions both as a stigma and style, being receptive to fresh pollen throughout their entire length
- Fertilization of the ovule usually occurs within 12-28 hours after the silk have been pollinated.

Crossing technique: As the maize is a monoecious plant, detesseling of male inflorescence from plant ensure the process of emasculation and desire pollen

from selected inbred line is dusted on female inflorescence previously protected with paper bags.

Maize hybrid

Hybrid maize seed is produced by using designated female and male parents, removing the tassels from the female plants before silk emergence and allowing male plants to provide the pollen for fertilizing the silks.

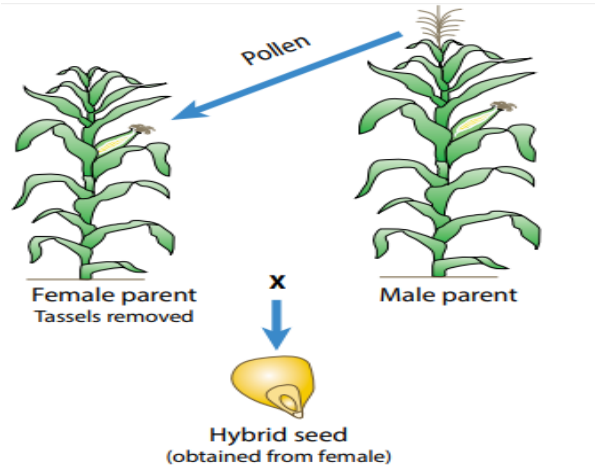


Fig-39: Hybrid Maize Seed

Seed production

Hybrid seed production in maize involved two parents to produce following types of hybrids.

Single Cross Hybrid: Hybrid seed produced by controlled crossing between two selected inbreds (A x B)

Double Cross Hybrid: Hybrid seed produced by crossing between two Certified single crosses [(A x B) x (C x D)]

Three Way Cross Hybrid: Hybrid seed produced by crossing between an inbred used as male and a Certified single cross hybrid [(A x B) x C] as female parent

Top Cross Hybrid: Hybrid seed produced by crossing of inbred line with a Certified open pollinated variety.

Double Top Cross Hybrid: Hybrid seed produced by the crossing between a certified single cross and a certified open pollinated variety.

Fig-40: Single Cross Hybrid

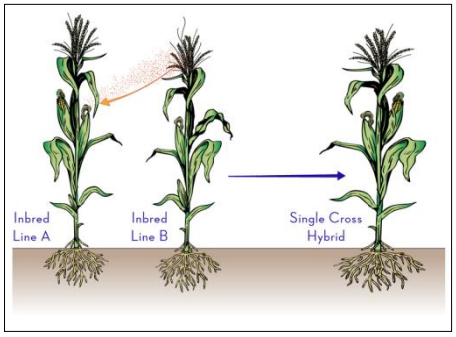
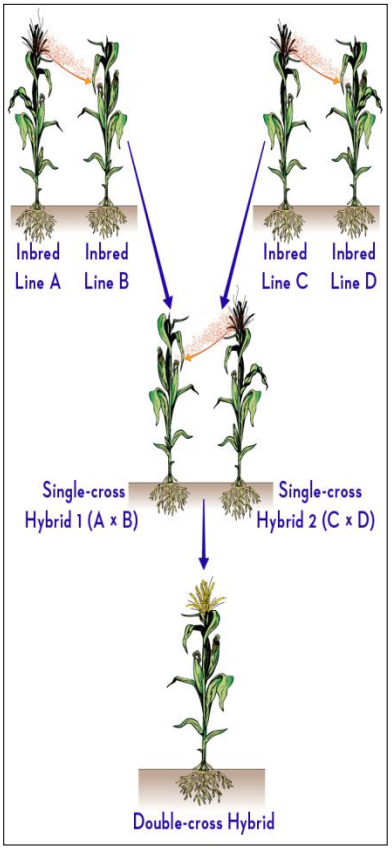


Fig-41: Double Cross Hybrid



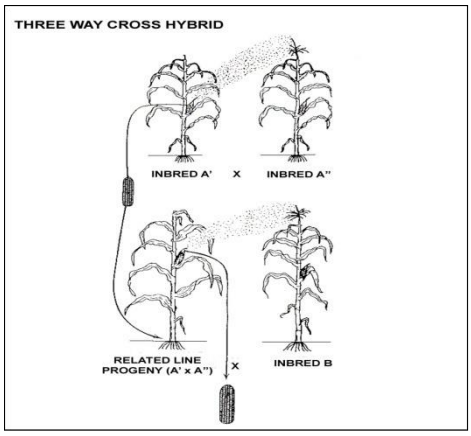


Figure-42: Three Way Cross Hybrid

Nucleus and Breeder's Seed Production Programmes: Nucleus and Breeder's seed of male and female parents are produced by selfing. Isolation of 600 meters from the field of other varieties is required.

Foundation Seed Production Programme: Inbred lines and single cross hybrids are produced as Foundation seed.

Certified Seed Production Programme: Production of single, double, three way top and double top cross hybrid is known as certified seed which is taken at recommended isolation distance

etasseling is the removal of tassel from female parent.

Time of Detasseling:

- Detasseling should be commenced when the top 3-4 cm of the tassel is visible above the leaf whorl.
- Detasseling is done when the tassel emerges out of the boot leaf, but before anthesis.
- Anthers take 2-4 days to dehisce after complete emergence. Only in few cases, the anthers dehisce before its complete emergence. In such

	case detasseling should be done earlier. ➢ Detasseling should be done daily till all the seed parents get detasselled. **Method of Detasseling:** ➢ The stem should be held below the boot leaf in left hand and the base of the basal in right hand and should be pulled out in a single pull. ➢ The entire should be grasped so that all the pollen parts are fully removed. ➢ The leaves should not be broken or removed as removal will reduce yields and will result in lower quality of seed.  **Fig-43: Detasseling in Maize** **Precautions while Detaselling:** ➢ It should be ensured that entire pollen bearing part is removed from seed parent ➢ The tassels should not be held too low on the stalk as otherwise plant tops may be pulled out ➢ Detasseling should be carried out without interruption irrespective on any type of hindrance ➢ Female row should be cleared of all suckers, lodged and damaged plants The detasseling should be started from the same side to identify escaping plants
4.2. Equipments for Hybridization	**Butter paper bag** It is required to cover the female flower cob in the process of hybridization **Tassel bag** It is required to cover the male flower tassel in the process of hybridization

4.3. Soil Requirement & Land Preparation	➢ Accessibility – the seed field needs to be inspected regularly and therefore must be easy to reach throughout the season ➢ The previous crop should not be maize in the field, to minimize the possibility of re-growth. ➢ The field should be sufficiently isolated from contaminant maize crops. ➢ The land should be well leveled with good drainage ➢ Sandy loam to silky loam soils with 5.5-7.5 pH is suitable
4.4. Sowing of Seeds	**Kharif – 1st fortnight of** June **Rabi – 1st fortnight of** October **Summer –** 2nd fortnight of January **Sowing method –** Drilling **Depth of Seeding –** 2-4 cm **Spacing** - 75 x 20 cm Row to row: 75 cm Plant to plant: 20 cm **Planting Ratio (Male:Female) -** 6:2 for Single Cross Hybrid 4:2 Double Hybrid  **Fig-44: Male and Female Rows in a Maize Hybrid Seed Production Field** 

Fig-45: Distinct Male and Female Plant Rows at Different Crop Stages, from Early Vegetative to Flowering

Seed rate: 20 kg/ha Female Line
5 kg/ha Male Line

Staggering

Normally both the parents flowered at same time but in some hybrids staggering for 7 days is required for synchronization of flowering.

Isolation distance

Table 13: Recommended isolation distance for seed production programme of hybrid and its parents in hybrid maize

Contaminants	Isolation Distance		
	FS	CS	
	Inbred	Single	Hybrid
Maize with same kernel colour and texture	600	600	600
Maize with different kernel colour and texture	600	600	300
Field of same inbred/hybrid seed production not confirming MSCS	600	600	200
Field of other hybrid having common male parent confirming MSCS	-	5	5
Field of other hybrid having common male parent not confirming MSCS	-	600	200

	Field of other hybrid having different parent	-	600	200
	Teosinte	600	600	300

4.5. Roguing, Weeding & Intercultural Operations

- From the 6- to 12-leaf stage and before tassels emerge, off-types from both male and female rows should be removed periodically based on position of cob, colour of silk, arrangements of seeds in cob, leaves etc.
- Off-types are usually clearly identifiable with characteristics distinctly different from the parent plants.
- Shedding tassels in the female parent rows with more than 5 cm of branch length should be removed.

Table-14: Distinguishing characteristics of maize plants during the vegetative and flowering stages

Leaf	Angle	**Between blade and stem**
	Attitude of blade	Straight or curved
	Blade	Width
	Sheath	Anthocyanin colouration
Stem	**Internodes**	Anthocyanin colouration
	Brace root	Anthocyanin colouration
Plant		Height
		Ratio of height of insertion of ear to plant height
Tassel	**Axis**	Length above lowest side branch
		Length above upperside branch
	Anthesis	Time of pollen shedding
	Glume	Anthocyanin colouration of base of glume
		Anthocyanin colouration of glumes excluding base
	Spikelets	Density
	Anthers	Anthocyanin colouration
	Lateral Branches	Angle between main axis and lateral branches
		Attitude
		Number of primary lateral branches
Ear	**Silk**	Time of emergence
		Anthocyanin coloration
		Intensity of anthocyanin coloration

Time of Roguing:

- Post Emergence: Roguing of easily identifiable volunteer plants should

be done.

- Vegetative Development: Roguing of off-type plants that deviate from the given genotype with respect to root and stalk development, plant type, pigmentation, leaf and stem pubescence, etc. should be done.
- Flowering Stage:
  - **a.** Roguing on male plants should be completed before the beginning of pollen shedding.
  - **b.** Roguing on female plants should be completed soon after silk-emergence.

Intercultural operations

- Earthing up should be done timely
- The side shoots should be removed whenever they appear.

Weeding

- Timely weeding and intercultural operations are essential.
- Pre emergence herbicide i.e., Simazin 50 WP or Atrazine 50 WP at 2.5 kg/ha in light soils and 3 kg/ha in case of heavy soils should be applied to keep the seed plot free from weed.
- The herbicide should be applied on same day or one day after sowing.

4.6.Application of Fertilizer & Irrigation

Fertilizer application

- For quality seed 10 tonnes of FYM or compost per ha should be applied at least 2-3 weeks before sowing.
- For a good seed crop, total requirement of major nutrients per ha is 120 kg N; 60 kg P_2O_5 and 30 kg K_2O.
- It is desirable to apply 10 kg of Zinc in the form of Zinc Sulphate at the time of sowing.

Table-15: Fertilizer application in seed production of hybrid maize

Fertilizer	No of Application	Time of Application	Quantity of Application
FYM	1st	2-3 weeks before sowing	Total quantity
Nitrogen Fertilizer	1st	Before/at transplanting as basal dose	50 kg
	2nd	Top dressing 3-4 weeks after sowing (at knee high stage)	50 kg
	3rd	Top dressing 6-7 weeks after sowing (at flowering stage)	50 kg
Phosphatic Fertilizer	1st	Basal dose before or at transplanting	Total quantity
Potash Fertilizer	1st	Basal dose before or at transplanting	Total quantity
Zinc	1st	Basal dose before or at transplanting	Total quantity

Irrigation

- Irrigation should be applied properly to provide adequate moisture in

the soil.

- The crop should be irrigated once in 8 days in case of sandy loam soil, once in 15 days in heavy soil depending upon the weather conditions.
- Critical periods of irrigation are germination, tasseling, silking and grain formation.

Drainage is as important as irrigation as maize is sensitive to excess water. The bunds should be cleaned so that the excess water is removed through the channels.

4.7. Plant Protection

Dsease Control:

- If Downy Mildew (causal organism) is noticed the affected plants should be removed and the crop should be sprayed with 40 g Zineb in 18 litres of water.
- For Leaf Blight and Rust the crop should be sprayed with 40 g Zineb in 18 litres of water.
- The spray should be repeated after 10-12 days.
- If required 750 litres of spray mixture could be used per hectare.

Pest Control:

Table-16: Pest control measures for seed production in hybrid maize

Insect/Pests	Measures	Time of Application
Stem Borer	• Spraying the crop with 36 ml Endosulfan 35 EC in 18 litres of water • Using about 350 litres of spray mixture per ha. • Repeating the same spray after two weeks	First symptoms of pin holes in the top whorls of leaves are noticed or when aphids are noticed on leaves and tassels
	• Spraying Endosulfan into leaf whorls, • Applying 7.5 kg Carboryl 4% granule or 7.5 kg Lindane 1% granule, or 7.5 kg Endosulfan 4% granule per ha • Repeating the same after 3 weeks	If pest still persists in the leaf whorls
Corn Worm	• Spraying the cobs with 72 gm Carbaryl 50 W.P. in 18 litres of water or • Dusting the cobs with Malathion 5% dust at 30 kg/ha • Using about 375	If pest persists in the cobs

		litres of spray mixture per ha.	
	Root Grub	• Incorporation of 20 kg Phorate granules or 25 kg Carbofuran granules or 30 kg Disulfotan 5% granule or 25 kg Quinalphos 5% grnaule or 35 kg of blended product of Carbaryl 4% + Gamma BHC per ha	Two to three weeks after the first rain (April-May), irrespective of sowing/planting time
4.8. Harvesting & Drying of Seeds	**Harvesting** ➢ Harvesting should be done when the moisture content falls to 20-25%. ➢ The male plants should be harvested first and removed from the field then the female plants should be harvested. **Seed yield (q/ha)** Single Cross Hybrid: 6-8 Double Cross Hybrid: 10-25 **Plucking of Cobs:** ➢ The ears should be removed from the standing plants and they are piled to open for twenty four hours and they are spread for drying in the sun. In this method stalks may be used as green fodder. **Stalk Cutting:** ➢ The plants should be cut and piled up in the shade and the cobs should be removed after two or three days of harvesting. The dried plants could be used for haymaking. ➢ The earlier harvested crop usually yields less and is poor in protein content. For silage making late dough stage is preferred. **Sorting & drying of maize ears** ➢ After harvest, sorting out all off - type maize ears, particularly those showing different colours and texture, and the diseased ears, before placing them in bins to dry. ➢ Sorting at this time considerably reduces the task of sorting after the maize ears have been dried to the desired extent (10 to 12 percent moisture content).		
4.9. Development & Release of Varieties	**Number of inspections** Four (Seed certification officers). First before flowering and remaining three during flowering		

Seed standard

Table-17: Seed standards in hybrid maize seed production

Sl. No.	Parameters	FS	CS
1	Physical Purity (%) (min)	98	98
2	Inert matter (%) (max)	2	2
3	Other crop seed (max)	5/kg	10/kg
4	ODV seeds (max)	5/kg	10/kg
5	Germination % (min)	90	90
6	Moisture Content (%) (max)		
a	Moisture previous	12	12
b	Moisture vapour proof	8	8

Field standard

Table-18: Field standard (%) in hybrid maize seed production

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

Table-19: Field standards-specific in hybrid maize seed production

Specific Factors	Certified Stage (%)
Off types shedding pollen when 5 % or more of seed parent in receptive silk	0.5
Seed parent shedding pollen when 5 % of the seed parent is having receptive silk	1.0
Total of pollen shedding tassel including tassel that had shed pollen for all 3 inspections conducted during flowering on different dates	2.0

4.10. Processing of Seeds

Shelling & shortage

- After harvest, ears should be dried in sun for 4 to 5 days and shelled at 12 to 15% moisture.
- Shelling is done by hand or power Sheller driven by electric current or tractors are available in the state.
- After shelling, the grain should be dried for 2 to 3 days, cleaned and stored at 8 to 10 per cent moisture.
- Maize ears can be harvested at relatively high moisture content (30-35 per cent), if the facilities for artificial air drying are available.

	➢ If such facilities are not available the harvesting has to be delayed until the seed moisture content has been reduced to 15%. ➢ An early harvest prevents losses in the field due to bird damage, stalk breakage, ear rot etc. **Processing, treating & bagging** ➢ After drying the seeds should be processed by using 10.50 mm R x 6.40 mm R sieve for all types of maize except popcorn. ➢ After cleaning and grading, the seeds having a moisture content of not more than 12% shall be packed in polythene lined gunny bag or cloth bag and kept on wooden pallets in a dry ventilated seed store with proper labeling. The seeds should be treated with Thiram or Captan 75% WP at 2 g per kg before storing.
4.11. Seed Testing: Seed Weight & Germination %	**Seed index** ➢ Seed index is the weight of 100 seeds of crops. ➢ Seed index is generally used for bold seeds such as Rajma, Pea, Maize etc. ➢ They are a bit large in size. So – The weight of 100 seeds can be analysed to get proper data. **Test weight** ➢ Test weight is the weight of 1000 seeds ➢ Test Weight Of Crop gives the information about the grain quality and measure of bulk density of grain i.e if there is proper grain fill or not. ➢ There are standard test weights for different crops which are obtained by different experiments. ➢ If the test weight of the seeds produced is less than standard value, then – the seed isn't good for further production. ➢ 1000 seeds are being counted and the weight is calculated. **Germination %** ➢ The most common seed quality test is the germination test, which measures seed viability under ideal conditions. ➢ For a maize seed lot, 4 replications of 100 seeds each should be sown either in sand or on a paper substrate and placed under adequate moisture conditions at either 25°C (with 12 hours light/day) or 20° and 30°C alternating. ➢ The number of normal and abnormal seedlings and un germinated seeds are determined at 4 and 7 days after initiation.

5. PRACTICAL NO-4

CERTIFIED SEED PRODUCTION OF GREEN GRAM

Green Gram (*Vigna radiata* L.):

- Green gram is cultivated in India, Burma, Srilanka, Pakistan, China, Fiji, Queens land and Africa.
- India is the major producer of green gram in the world and grown in almost all the States.
- It is grown in about 36 lakh hectares with the total production of about 17 lakh tonnes of grain with a productivity of about 500 kg/ha.
- The important green gram growing States in the country are Orissa, Maharashtra, Andhra Pradesh, Madhya Pradesh, Gujarat, Rajasthan and Bihar. In Gujarat, it is cultivated in an area of about 1.73 lakh hectares with the production of 0.72 lakh tonnes with an average yield of 414 kg/ha (Average of 2004-05).
- It is mainly cultivated in the districts of Kutch, Banaskantha, Sabarkantha, Mehsana, Surendranagar and Ahmedabad, however, almost all districts are growing green gram in the State.
- Green gram is a self pollinated crop where 0.5-3% of cross pollination occurs.

CERTIFIED SEED PRODUCTION OF GREEN GRAM	
5.1. Floral Biology	➢ Flowers are in an axillary or terminal receme, peduncle up to 13 cm in length with clusters of 10 to 20 flowers. ➢ Corolla is yellow in colour and papilionaceous, sometimes curved 5-10 cm long. Small flowers are borne in capitates clusters on the end of long hairy peduncles. ➢ Petals are five in numbers, three kinds of petals, 1 standard, 2 wings and 2 keels. ➢ Androecium: male reproductive part stamen has got two parts anther and filament. ➢ Gynoecium : Female reproductive part made up of stigma, style and ovary. Gynoecium is monocarpellary with a superior unilocular ovary. ➢ The stigma is hairy and placentation is marginal. ➢ Keel encloses reproductive organs, 10 stamens and one gynoecium.  **Fig-46: Flower of Green Gram**

Fig-47: Single Flower of Green Gram **Fig-48: Open Flower of Green Gram**

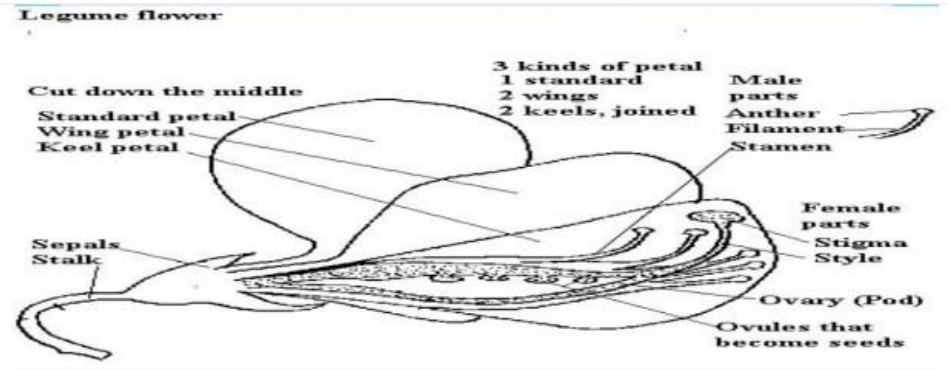


Fig-49: Floral Biology of Green Gram

Anthesis and pollination:

- Pollination occurs at night prior to opening of the flowers.
- Anthers start dehiscing from 9 a.m. and complexly dehisced by 3 a.m.
- A stigma is by then receptive and is thoroughly covered with pollen.
- Flower open between 6 a.m. and 8 a.m. and remain open till 11 a.m. later they close between 2 p.m. and 4 p.m.
- Pollen shedding takes place long before the petals open.
- Cleistogamy occurs to an extent of 40 %.
- Pollination is effected in the bud stage on the night previous to the opening of the flower.

5.2. Soil Requirement & Land Preparation

Climatic requirement

- It requires a hot and warm climate
- It is best suited for areas having an annual rainfall of 60-75 cm
- There should not be any water logging

Soil requirement

- Land should be free of volunteer plants.
- The previous crop should not be the same variety or other varieties of the

	same crop. ➢ It can be the same variety if it is certified as per the procedures of certification agency ➢ It can be grown on variety of soil from sandy loam to black cotton with good drainage facilities ➢ Saline and alkaline soils are not suitable for seed production **Land preparation** ➢ Field should be prepared by one or two ploughing followed by two or three cross harrowing and planking to make the field levelled and to minimize the loss of moisture by evaporation from the soil. ➢ For summer season crop pre-sowing irrigation should be given immediately after harvesting of the previous crop.  **Fig-46: Land Preparation for seed production of Green Gram**
5.3. Seed Rate & Treatment of Seeds	**Seed rate** ➢ **Kharif or Rabi crops:** 15-20 kg/ha ➢ **Spring & Summer crops:** 25-30 kg/ha **Seed treatment** ➢ All discoloured seeds should be removed and use only normal coloured seeds (olive green in greengram). ➢ Bruchid infested seeds should not be selected for sowing. ➢ If the presence of hard seed percentage exceeds more than 10 %, the seeds should be scarified with commercial H_2SO_4 for 2 min. ➢ Both for the garden and dry land ecosystem, the seeds should be harden in 100 ppm MnSO4 for 3h in a seed to solution ratio of 1:0.3 ➢ The seeds can be soaked in 3 % cowpea sprout extract for 3 h in seed to solution ratio of 3:1 ratio.
5.4. Sowing of Seeds	**Time of sowing** ➢ **Kharif Season:** 1st fortnight of June ➢ **Rabi Season:** 1st fortnight of October ➢ **Summer Season:** In the middle of March **Spacing** ➢ **Kharif or Rabi crops:** 30 cm x 10 cm ➢ **Spring & Summer crops:** 25 cm x 10 cm

5.5. Application of Fertilizer & Irrigation

Fertilizer application

- Nitrogen and Phosphate fertilizer should be applied as basal application at the rate of 20kg and 40 kg per hectare respectively.
- Well decomposed FYM should be applied @25 kg/ha during land preparation.

Fig-47: Fertilizer Application

Foliar Application:

- Spraying of 2% DAP at the time of first appearance of flowers and second spraying 15 days after first spraying to enhance seed set.
- Spraying of NAA 40 ppm at first flowering and second spraying after a fortnight to reduce the flower drop. NAA can be mixed with insecticides and fungicides.
- Spraying of 0.1 % Brassinoloid on 35th and 45th day after sowing (or) spraying with 3 % cowpea extract at 30 days after sowing (or) spraying with 0.5 % Nutrigold at 30 / 40 days after sowing

Irrigaton

- For rainfed crop drainage should be very good as the crop is sensitive to water logging condition
- For summer season crop 5-6 irrigation may be given at 20-25 DAS and subsequent irrigations should be at an interval of 12-15 days
- Irrigation should not be given at full bloom stage
- Irrigation should be given at late flowering and early pod filling stage

5.6. Isolation Distance & Roguing of Off-types

Isolation distance

For certified / quality seed production leave a distance of 5 m all around the field from the same and other varieties of the crop

Roguing

- The off-types and severely diseased plants should be removed
- 2/3 inspections should be done

5.7. Weeding

- 1-2 weeding should be done
- 1st weeding: 20-25 DAS
- 2nd weeding: 40-45 DAS
- Fluchloralin and Pendimethalin should be applied @0.5 kg/ha as pre-emergence

5.8. Plant Protection

Table-20: Plant protection in seed production of green gram

Pest Management

Name of Pests	Measures	Time of Measures
Hairy Caterpillar	• Dusting of 2% Methyl Parathion @ 25-30 kg/ha • Spraying of 1.5 litres of Endosulfan in 1000 litres of water for 1 ha land	For young caterpillar For full grown catterpillar

	Leaf Hopper • Phorate 10% granules @ 10 kg/ha • Spraying with Monocrotophos 36 EC @1 ml/litres of water Basal application **Disease Management** **Disease Name** / **Measures** / **Time of Measures** **Cercospora Leaf Spot** — Spraying of Carbendazim @500g/ha — Initiation of disease and 10 days later **Rust** — Application of Mancozeb @1000 g/ha — Initiation of disease and 10 days later **Powdery Mildew** — Spraying of Carbendazim @500g/ha or Wettable Sulphur @1500 g/ha — Initiation of disease and 10 days later **Yellow Mosaic Virus** — Spraying of Methyl Dematon 25 EC 500 ml/ha — Should be repeated after 15 days
5.9. Harvesting, Threshing & Drying of Seeds	**Harvesting** ➢ The pods should be harvested 30-35 days after the 50 per cent flowering for green gram. ➢ At this stage the colour of majority of the pods (80%) will be brown in green gram. ➢ The pod moisture content should be about 17-18%. ➢ The pods should be harvested as pickings if the flowering period is longer. **Threshing** ➢ The seeds should be threshed either with pliable bamboo stick or with pulse thresher **Drying** ➢ The pods should be dried to 8-9% moisture content **Seed yield:** 8-10 q/h
5.10. Grading & Processing of Seeds	**Seed grading** ➢ Grade the seeds using BSS 7 x 7 wire mesh sieve for large seeded varieties. ➢ Do not select the discoloured and broken seeds for seed **Processing** • Seed treatment is an important processing process • The seeds should be treated with carbendazim @ 2g kg-1 of seed along with carbaryl @ 200 mg kg-1 of seed (or) • The seeds should be treated with halogen mixture (CaOCl2 + CaCO3 + arappu (*Albizzia amara*) leaf powder mixed in the ratio of 5:4:1) @ 3g

kg-1 of seed as eco – friendly treatment

Seed storage

- Store the seeds in gunny or cloth bags for short term storage (8-9 months) with seed moisture content of 8 – 9%.
- Store the seeds in polylined gunny bag for medium term storage (12- 15 months) with seed moisture content of 8 – 9 %.
- Store the seeds in 700 gauge polythene bag for long term storage (more than15 months) with seed moisture content of less than 8

Field standards

Table-21: General field standard requirements for green gram seed production

Contaminants	Minimum Distance (m)	
	FS	CS
Field of other varieties	10	5
Fields of same variety not conforming to varietal purity requirements of certification	10	5

Table-22: Specific field standard requirements for green gram seed production

Factor	Maximum permitted (%) (At final inspection)	
	FS	CS
Off-types	0.10	0.20
Plants affected by seed borne diseases	0.10	0.20

Seed standards

Table-23: Seed standards for green gram seed production

Factor	Standards for each class	
	FS	CS
Pure seed (minimum)	98.0%	98.0%
Inert matter (maximum)	2.0%	2.0%
Other crop seeds (maximum)	5/kg	10/kg
Weed seeds (maximum)	5/kg	10/kg
Other distinguishable varieties (maximum)	10/kg	10/kg
Germination including hard seeds (minimum)	75%	75%
Moisture (maximum)	9.0%	9.0%
For vapour-proof containers (maximum)	8.0%	8.0%

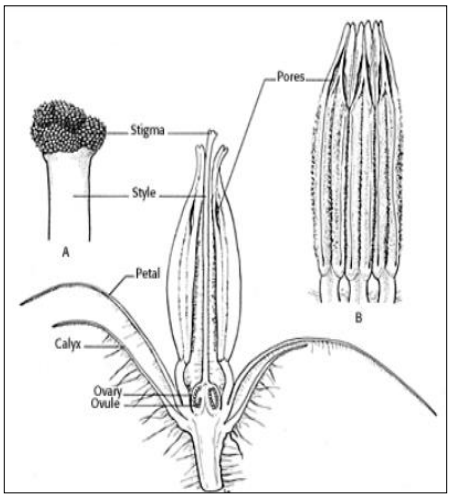
5.11 Germination % & Viability of the Seeds	**Germination %** ➢ The most common seed quality test is the germination test, which measures seed viability under ideal conditions. ➢ For green gram seeds 4 replications of 100 seeds each should be sown on a paper substrate and placed under adequate moisture conditions at either 20° and 30°C alternating. ➢ The number of normal and abnormal seedlings and un germinated seeds are determined at 4 and 7 days after initiation.

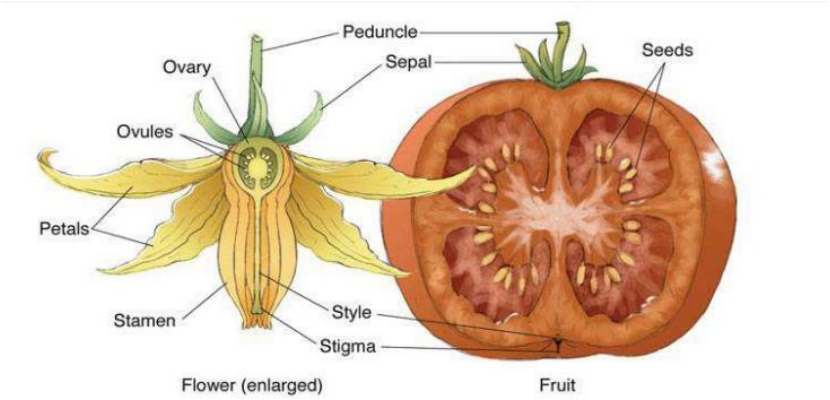
6. PRACTICAL NO-5

CERTIFIED SEED PRODUCTION OF TOMATO

Tomato (*Lycopersicum esculentum*):

- Tomato is one of the most important vegetable crops grown extensively in the tropical and subtropical belts of the world.
- It is grown mainly fresh market and to a little extent for processing. Increased attention is now being bestowed to breeding and production of tomato.
- Tomato is a typical day neutral plant. It requires temperature of 15-20° C for fruit setting.
- Tomato is a self pollinated crop.
- Self fertilization is favoured by the position of receptive stigma within the cone anthers and the normal pendant position of the flower.
- Production of tomato can further be increased if improved cultural practices are combined with good quality seeds.
- The quality seed production techniques in tomato comprises of the following steps.

CERTIFIED SEED PRODUCTION OF TOMATO	
6.1. Floral Biology	 **Fig-48: Longitudinal Section of Tomato Flower**  **Fig-49: Floral Biology of Tomato** ➢ The flowers are bisexual, radially symmetric. ➢ The flower consist of five parts i.e., calyx, corolla, sepals, petals and anthers. ➢ The calyx is united at the base. ➢ The corolla is also united at the base.

	 **Fig-50: Tomato Flower with Fruit** ➢ **Anthesis:** Starts at 6 AM and maximum flower opening till late morning. ➢ **Dehiscence:** 8 AM – 11 AM. ➢ **Receptivity of stigma:** 16 hrs before and 5 days after anthesis.
6.2. Soil Requirement & Land Preparation	➢ Tomato seed production requires sandy soil, rich in nutrients and organic substances and requires good drainage to avoid stagnation. ➢ The pH should be between 6 and 7, as it prefers neutral or sub-acidic soils, but it also adapts to slightly alkaline soils as long as they are supported by adequate organic fertilisation. ➢ Selection of suitable land for tomato seed production is important where the previous crop should not be the same variety to avoid the contamination due to volunteer plants.
6.3. Nursery Bed Preparation & Management	➢ The nursery grown in late October and transplanted in the first week of December produces excellent seed crop. ➢ The seeds should be sown in raised nursery bed of 15-20 cm height, in rows of 3-4 cm gap and covered with sand. ➢ Twenty five nursery beds of size 2-2.5 m long and 1 to 1.25 m wide will raise enough seedlings to transplant one hectare. ➢ 2 kg of DAP may be applied 10 days before pulling out of seedling.
6.4. Seed Treatment & Seed Sowing	**Seed treatment** ➢ The seed required for one hectare are to be inoculated with *Azosprillum*. ➢ For this, the seeds should be first mixed with the required quantity of rice gruel and then with 150 g of *Azosprillum* after shade drying it can be used for sowing. **Method of seed production** ➢ Seed to seed **Stages of seed production** ➢ Tomato is a self pollinated crop, hence either three or four generation model could be adopted as below

	➢ Breeder seed → Foundation Seed → Certified Seed ➢ Breeder seed → Foundation Seed I → Foundation Seed II →Certified Seed **Seed rate** ➢ 300 to 400 g/ha **Season** ➢ It is highly suitable both for kharif (May – June) and rabi season (November - December)
6.5. Transplanting	Transplant the seedlings when 7.5 – 10 cm height, with 20-25 days old preferably at evening time. **Spacing** ➢ It varies from 60 x 30 cm **Isolation distance** ➢ For seed production of tomato, minimum of 50 m is required for varieties for foundation seed production and 25 m for certified seed production
6.6. Manuring & Irrigation	**Manuring** ➢ 25 tons of FYM per ha should be applied after thorough preparation of the field and fine tilth. ➢ Nitrogen, Phosphate and Potash fertilizer should be applied @ 100 : 100: 100 Kg/ha of which, 50% of the N should be applied as basal dressing and remaining 50% of N as top dressing in two split doses at just before flowering and fruit formation stages. **Irrigation** ➢ In order to reach its full potential in the seed production process, tomatoes require a high-water supply, especially in the phase immediately after transplant. ➢ It is therefore important to choose a correct irrigation technique. ➢ Drip irrigation, compared to other irrigation methods, is very efficient as it locates the water directly near the root system and avoids waste caused by wind or evapo-transpiration. ➢ The low rainfall of drip irrigation allows a careful control of the depth of watering, avoids deep leakage of nutrients, avoids soil compaction due to the action of sprinkling water and saves such a precious resource as water, avoiding water logging.
6.7. Roguing of Off-types	➢ The rouging should be done carefully on individual plant basis. ➢ The roguing should be done based on the plant characters (determinate / indeterminate), leaf, branching and spreading characters and also based on fruit size, shape and colour. ➢ Plants which are differing in morphological characters from that of the seed crop should be removed to avoid cross pollination ➢ The plants affected by early blight, leaf spot and mosaic (TMV) diseases should be removed from the seed production field. **Field inspection** ➢ Seed crop should be inspected at least three times during the crop

season, the first before flowering, second during flowering and fruiting stage and third at mature fruit stage prior to harvesting.

Table-24: Specific field requirements in tomato seed production

Factors	FS	CS
Off-types (maximum)	0.1%	0.2%
Plants affected by seed borne diseases (maximum)	0.1%	0.5%

6.8. Plant Protection

Table-25: Disease management in tomato seed production

Name of Disease	Measures
Damping off (nursery)	• Treating the seeds with *Trichoderma viride* 4 g/kg or *Pseudomonas fluorescens* 10 g /kg of seed 24 hours before sowing. • Application of *Pseudomonas fluorescens* as soil application @ 2.5 kg/ha mixed with 50 kg of FYM Stagnation of water should be avoided. • Drenching with Copper oxychloride at 2.5 g/lit at 4 lit/sq.m.
Leaf Spot	• Spraying of Zineb or Mancozeb 2 g/lit.
Leaf Curl	• Spraying systemic insecticides like Methyl demeton or Monocrotophos or Dimethoate at 2 ml/lit to kill the insect vector, whitefly.
Tomato Spotted Wilt Virus	• Application of Carbofuran 3 G 1 kg *a.i.*/ha in nursery at sowing and second application at 1.25 kg *a.i.*/ha 10 days after transplanting in mainfield and three sprays of triazophes 35 EC 1.5 ml/lit @ 25, 40, 55 days after transplanting.

Table-26: Pest management in tomato seed production

Name of Pests	Measures
Fruit Borer	• Setting up pheromone traps @ 12/ha. • Collection and destruction of damaged fruits and grown up caterpillars. • Spraying of endosulfan 35 EC 2 ml/lit or carbaryl 50 WP 2 g/lit or *Bacillus thuringiensis* 2g/lit or quinalphos 2.5 ml/lit. • Release of *Trichogramma chilonis* @ 50000/ha release coinciding with flowering time and based on ETL. For *Helicoverpa armigera*: *H.a.*NPV 1.5 x

		1012 POBs/ha • For *Spodoptera litura*: *S.l.* NPV 1.5 x 1012 POBs/ha. Providing poison bait with carbaryl 1.25 kg, rice bran 12.5 kg, jaggery 1.25 kg and water 7.5 lit.
	White fly	• Installation of yellow sticky traps to attract the adult. • Spraying of dichlorvos 76 WSC @ 1 ml/lit or triazophos 40 EC 2 ml/lit or fish oil rosin soap 25 g/lit. or dimethoate 2 ml/lit or methyl demeton 25 EC 2 ml/lit along with wetting agent. • Removing alternate weed host *Abutilon indicum*
6.9. Harvesting	In tomato germination of seed is effected by stage of fruit maturity. Fruits on turning to ripe red, red and over ripe stages are found to be good for extracting good quality seed.	
6.10. Seed Extraction	➢ The fruits from in between 6-7 harvest should be used for seed extraction. ➢ The seed viability depends on the method on which the seeds were extracted and hence, it is more important to choose proper methods of seed extraction. ➢ Before seed extraction, the fruits are to be graded for true to type and selection of medium to large size fruits for getting higher recovery of quality seeds. **Acid Extraction Method:** ➢ The acid method of seed extraction is the best method for tomato seed extraction. ➢ The fruits are to be crushed into pulp and taken in a plastic containers (or) cement tank. ➢ Then 30 ml of commercial Hydrochloric acid per kg of pulp is added and should be stirred well and allowed for ½ hour. ➢ In between this duration the pulp may be stirred well for one or two times. This facilitates the separation of seed and pulp. ➢ After ½ hour, the seeds will settle down at the bottom and then the floating fraction is to be removed. ➢ The collected seeds should be washed with water for three or four times. **Precautions:** ➢ Only plastic or stainless steel containers or cement tank must be used while following acid method ➢ The usage of iron or zinc containers should be avoided, which will affect the viability potential of the seeds and as well damage to the	

containers due to chemical reaction with acid.

- For large scale seed extraction the tomato seed extractor can be used.
- The seeds extracted by this machine may again be treated with commercial Hydrochloric acid @ 2-3 ml/kg seed with equal volume of water for 3-5 minutes with constant stirring.
- And then seed should be washed with water for to four times.

Acid Extraction Method

Fig-51: Seed Extraction in Tomato Seed Production

Fig-52: Extracted Seeds in Tomato Seed Production

Fig-53: Acid Treatment in Tomato Seed Prodction

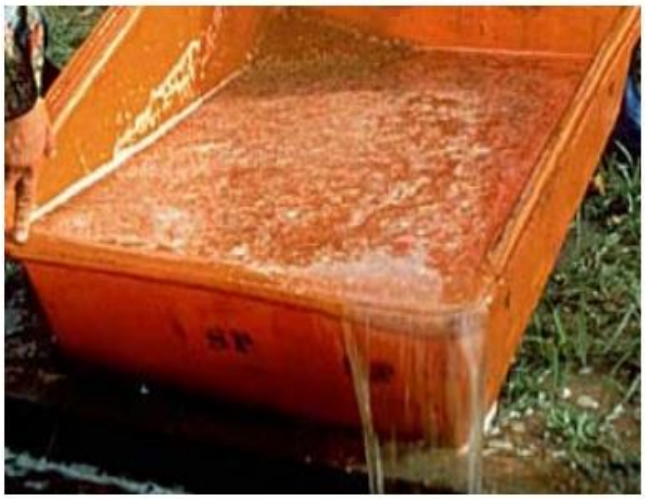


Fig-54: Seed Cleaning in Tomato Seed Production

6.11. Drying & Grading	➢ Seeds are to be dried in the shade. ➢ It should never be dried in hot sun. ➢ The safe moisture content of the seed for grading is 8 to 9 per cent. ➢ Seeds can be graded using 6/64'' round perforated sieve.
6.12. Storage	➢ The seeds dried to safe moisture content after treating either with Captan or Thiram @ 2 g/kg can be stored for 15 months in moisture vapour pervious containers, while it can be stored in moisture vapour proof containers for 30 months. **Seed yield** ➢ 100-120 kg/ha **Varieties** **Indeterminate Varieties**: Pusa Ruby, Solan Gola, Yaswant (A-2), Sioux, Marglobe, Naveen, Ptom-9301, Shalimar- 1, Shalimar-2. Angurlata, Solan Bajr, Solan Sagun, Arka

	Vikas. Arita Saurbh. **Determinate Varieties:** Roma (EC-13513), Rupali, MTH-15, Ptom-18, VL-1, VL-2, HS 101, HS 102, HS 110, Pusa Early Dwarf, Pusa Sheetal, Floradade, Arka Meghli, Co.1, Co.2, Co.3 (Marutham), PKM.1, Py1, **Hybrids:** COTH-1, Pant Hybrid-2, Pant Hybrid-10, Kt-4. Pusa Hybrid-l-4, Arka Shreshta, Arka Vardan, Arka Abhijit, Navell 1 &2 (Sandoz), Rupali, Sonali, MTH 6