SST 421 COMMERCIAL HYBRID SEED PRODUCTION 0+2

PRACTICAL

Seed production techniques in hybrids - rice, maize, sorghum, pearl millet, cotton - sunflower - tomato, bhendi - isolation - land selection - seed crop management - season, staggered sowing, spacing, planting ratio - border rows - nutrient management - synchronization - supplementary pollination - rogueing - identification of off types, pollen shredders, partials, shedding tassels - detasseling - emasculation and dusting, - indices of physiological maturity - harvesting - threshing / extraction - drying - cleaning - grading - treatments - packaging - storage - visit to hybrid seed production plots and proviate seed industries.

Enterprise management - business project preparation - cost and return - financial management and investment analysis market promotion.

PRACTICAL SCHEDULE

1. Study of seed production technique in hybrid rice - season - staggered sowing - planting method - foliar application.
2. Identification of off types, pollen shedders - practising supplementary pollination - rope pulling.
3. Study of seed production techniques in hybrid maize - season - planting ratio - border rows.
4. Identification of off types, shedding tassels - practising detasselling.
5. Study of seed production techniques in sorghum hybrid - season synchronisation - planting ratio - border rows.
6. Identification of off types, pollen sheeders - foliar application.
7. Study of seed production technique in pearl millet hybrid season - planting ratio - border rows.
8. Identification of off types - pollen shedders - partials - jerking operation.
9. Study of seed production techniques in cotton hybrid - season planting - block method.
10. Identification of off types - practising emasculation and dusting acid delinting.
11. Study of seed production techniques in sunflower hybrid season - planting ratio - foliar application.
12. Identification of off types - pollen shedders - practising supplementary pollination

13. Study of seed production techniques in tomato hybrid - season - planting method.
14. Identification of off types - practising emasculation and dusting
15. Study of seed production techniques in bhrndi hybrid - season - planting ratio and method.
16. Identification of off types - practisin emasculation and dusting .
17. Mid semester examination
18. Study of the maintenance of field standards - rouging stages.
19. Identification of physiological maturity stages in rice maize, sorghum, pearl millet.
20. Identification of physiological maturity stages in cotton, sunflower, tomato, bhendi.
21. Study of harvesting methods.
22. Practising threshing methods in rice, maize, sorghum, pearl millet, sunflower.
23. Practising kapos grading - ginning in cotton.
24. Practising seed extraction methods in tomato and bhendi
25. Practising grading and upgrading in different hybrids.
26. Study of packaging materials - storage techniques for different hybrids.
27. Visit to commercial hybrid seed production plot.
28. Visit to private seed companies.
29. Enterprise management - managerial functions, functional areas of management - characteristics, problems and prospects of small business.
30. Business project preparation - steps involved with case studies.
31. Cost and return - cost of production - fixed, variable cost - returns, break-even analysis.
32. Financial management and investment and investment analysis.
33. Market promotion - visit to the concerned commercial unit.
34. Practical examination.

REFERENCE BOOKS

1. Agarwal, R.L. 1993. Seed Technology - Oxford and IBH Publishing Co., New Delhi.
2. Agarwal, P.K. 1994. Principles of Seed Technology, ICAR Publication, New Delhi.
3. Desai, B.B., P.M. Kotecha and D.K. Salunkha. 1988. Seeds Hand Book. Marcel and Dekker Inc., New York.
4. Neema, N.P. 1989. Principles of Seed Certification and Testing - Allied Publishers Pvt. Ltd., New Delhi.
5. Tunwar, N.S. and S.V. Singh. 1988. Indian Minimum Seed Certification Standards Published by Central Seed Certification Board, New Delhi.

Exercise No. **Date :**

SPECIFIC TERMINOLOGIES WITH HYBRID SEED PRODUCTION

Hybrid seed production technology involves unique techniques. Hence involve new terminologies to indicate unique techniques. Some of them are as follows.

Seed : A mature ovule consisting of an embryonic plant together with a store of food, all surrounded by a protective coat.

Pure Live Seed (PLS) : The percentage of pure seeds in a seed lot that have the ability to germinate. The percentage of PLS is determined by multiplying per cent germination by per cent pure seed dividing by 100.

F_1 Hybrid : Denotes the first generation offspring from the mating of two parents.

Hybrid vigour : The increase in vigour of hybrids over their parental inbred types; also known as heterosis.

Nick : In hybrid seed production, the condition existing when two inbred plants flower and are ready for sexual crossing at the same time.

Inbreds : A plant with successive self fertilization of parents throughout several generations.

Genotype : A hereditary make up of the plant or variety which determines its inheritance

Genetic Drift : A gradual or sometimes abrupt change in the germplasm balance of a cross pollinated variety causing a chagne in its characteristics usually applied to grass or legumes when seed is reduced to adoption. The shift may be caused by selective differences in mortality of flower type under different environment.

A line : The female male sterile line used in CGMS system of hybrid seed production.

B line : Isogenic male fertile line of A line used for maintenance of A line in CGMS system (Maintainer line).

R line (Restorer line) : It is a male line which restore the fertility of A line in CGMS system.

Border Row : Planning of male parent around the plot for adequate supply of pollen and also prevent the contamination of other pollen.

Market Plant : The plant that is sown along with the male line to indicate male line.

Synchronisation : It is adjustment of growth of male and female lines in such a way both attain flowering in one at the same time for effective seed setting

Jerking : It is the shake given to the early parent or removal of flowering part of early parent.

Staggered Sowing : It is the time adjustment adopted between the female and male line at the time of sowing for synchronised flowering.

Emasculation : Removal of the male organ in the bisexual flower to create sterility in the female parent.

Dusting : Application of pollen of the male parent on stigma of the female parent.

Electric Bee : Electrically operated instrument used for supplying of pollen to female parent.

Supplementary Pollination : Techniques that are adapted to provide adequate pollen for crossing between male and female parent.

Pollen Shedder : The presence of B line in A line is called pollen shedder.

Partials : Plant that are shedding pollen with a part of either earhead or panicle.

Shedding Tassel : It is the remaining part or newly emerged tassel shedding pollen after detasseling.

Metazenia : The effect of foreign pollen on the female parental line is called Zenia. The expression of Zenia in same year with colour modification is called metazenia.

Selfed bolls : Balls that are produced without emasculation and dusting.

Abnormal Seedlings : Seedlings which do not show the capacity for continued development into normal plant and die prematurely even when grown in good quality soil and under favourable conditions of water supply, temperature and light.

Dormancy : An internal condition of the chemistry or stage of development of a viable seed which prevents its germination when the conditions normally considered to be suitable for germination are provided; also applied to buds.

Genetic Purity : Trueness to type; variety purity; plants / seeds conforming to characteristics of the variety as described by the breeder.

Germination : The resumption of growth by the embryo and development of a seedling from the seed, and the ability to develop into a normal plant under favourable conditions in the soil.

Hard Seed : Seeds that have a seed coat impervious to water or oxygen required for germination. Sometimes overcome by scratching or scarifying the seed coat or removal by brief immersion in sulphuric acid and thorough washing, generally *leguminosae* and *Malvaceae* are hard seeded.

Normal Seedling : The seedling which shows the capacity for continued development into normal plant when grown in good quality soil and under favourable conditions of water, temperature and light.

Off Type : Plant or seed deviating significantly from the characteristics of a variety as described by the breeder in any observed respect.

Other Crop Seed : Seeds of plant which have grown as crops, other than the main crop.

Other Seeds : These include seed and seed-like structures of any plant species other than that of pure seed.

Planting Ratio : The recommended ratio in which the male and female parental lines are planted to make a crossing in hybrid seed production.

Pure Seed : The seeds of the species stated by the sender, or found to predominate in the purity test. It includes all botanical varieties and cultivars of that species even if

immature, undersized, shrivelled, diseases or germination, provided they can be definitely identified as of that species.

Rogue : An off-type plant; undesirable plant.

Vigour : It is the sum total of all seed attributes which favour rapid and uniform stand establishment in the field.

Exercise No. **Date :**

TOOLS EMPLOYED IN HYBRID SEED PRODUCTION

A hybrid is the first generation progeny of a cross between two genetically different identical inbredlines. The individual lines are known as inbreds.

Requisites of hybrid seed production

1. Breeders responsibilities :

(a) Develop inbred lines

(b) Identification of specific parental lines

(c) Develop system for pollen control

2. Major problems for breeders & producers

(a) Maintenance of parental lines

(b) Separation of male and female reproductive organs

(c) Pollen exchange

3. Genetically it makes no difference, which parental line is used as the male or female; but seed produces must consider the following characteristics of parental lines.

Female Parent	**Male Parent**
High seed yield	Good pollen production
Good seed characteristics	Long shedding period
Male sterility	Plant height
Lodging resistant	Fertility restoration

Basic procedures for hybrid seed production

1.Development and identification for parental lines

2. Multiplication of parental lines

3. Production of single crosses (maize, Figure 1)

(a) Planting ratios (b) Planting date (s) – "nick"

Production of double cross hybrids (maize only, Figure 2)

Among them the separation of male and female reproductive organ plays a major role in F_1 hybrid seed production. The tools employed to produce hybrid seed may be broadly divided into two. It may be through genetic modification or through manual management.

Tools based on modification of genetic structure

1. Genetic male sterility system

It is determined by a single gene Ms the homogenous recessive genes msms results in male sterility. Stability often influenced by environmental condition and are modified by modified gene.

Hybrids developed based on GMS is available in redgram and cotton.

2. Cytoplasmic male sterility system

The sterility is determined by the cytoplasm of the female parent which is derived almost entirely from the female gamete and this in more stable under the wider environmental condition than genetic sterility system. Cytoplasmic male sterility is most useful when fruit or seed is not desired i.e. flowers, onion, potato. Non fruiting plants bloom over a longer period of time and the flowers remain fresh longer.

3. Cytoplasmic genetic male sterility

In this system both cytoplasm and nuclear gene are involved in creation of sterility. Here plants are available in 3 different form. The offspring from the male sterile plants are not necessarily sterile although the cytoplasm is sterile. This is due to the presence of genetically controlled restorer factor (Rf). Then this female line is crossed with male (with dominant gene) to get hybrid.

Crops with CGMS hybrids

Rice, sorghum, cumbu, sunflower.

II. Manual modification

Hybrid seeds are also produced manually by modifying the plant structure by removal of male organ from female plant before anthesis. This system is possible only

when the male and female parts of a single flower or plants are separate. The avaiable techniques are

1. Emasculation

This is being adopted in bisexual perfect flowers where the androecium is removal with case. By removing the anther column / or male part from female line, the sterility of female line is created and is dusted with the pollen of desired male parent.

2. Detasseling in maize

This is possible as maize is monoceious and removal of male organ (tassel) is possible before flowering. Here the male sterility is created by manual removal of the tassel and crossed with desired male parent.

Exercise No. **Date :**

HYBRID SEED PRODUCTION IN PADDY

Botanical Name	:	*Oryza sativa*
Chromosome number [2n]	:	24
Family	:	Poaceae
Inflorescence	:	Panicle
Pollination	:	Self-Pollination
Panicle Emergence	:	4 –5 days after boot leaf emergence
Flower Opening Pattern	:	Tip of primary & secondary branches and proceeds downward.
Duration of Flowering	:	6-8 days
Time of Anthesis	:	7.00 –10.00 A.M
Speciality with flowering	:	Flower remain open for 10 minutes and afterwards it closes.
Anther dehiscence	:	Either before or after flower opening [independent of spikelet opening]
Temperature favorable for flowering	:	24 -28^{0}C
Favourable RH for flowering	:	70-80%
Difference between day and night temperature	:	8-10^{0}c
Stigma receptivity	:	3 days
Pollen viability	:	10 minutes
Selfing technique	:	Bagging
Crossing technique	:	Emasculation

Methods

- ❖ Hand Emasculation

- Clipping (cutting off 1/3rd portion of the spikelet)
- Wet cloth method (cover with wet cloth for opening of anther)
- Hot water emasculation (Immerse pollen grain in hot water at 42^0C 2-3 minutes
- Vacuum method (vacuum emasculation)
- Rhind's methods of emasculation (Flask method)

Origin of High yielding variety : Dwarf gene of the mutant variety [Dee-Gee-Woo-Gen](DGWG) discovered at Taiwan in 1960

First Report on Heterosis : Jones of USA 1926

Ramaiah of India 1933

Hybrid rice initation : During 1964 by Yuan Long Ping of China (Father of hybrid rice)

Gene responsible for male sterility : wild abortive or WA

Breeding technique for commercial hybrid seed production : Cytoplasmic geneic male sterility system

Stages of seed production for certification : Breeder seed – foundation seed certified **seed**

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Seed Multiplication work at different Stages

Breeder Seed stage : A (AxB), B, R lines are raised separately under isolation.

Foundation Seed stage : A (AxB) and R lines raised separately under isolation.

Certified seed stage : A and R line are crossed under isolation to get hybrid.

Systems of hybrid seed production :

- Three line method or CGMS system (popular)
- Two line method or environmental genetic male sterility (EGMS) system that involve PGMS (photosensitive genetic male sterility) and TGMS (Thermosensitive male sterility system was developed in China and low temperature hilly areas of Tamil Nadu

Popular hybrids :

CORH1	:	(IR 62829A x IR 10198- 66–2R)
CORH2	:	IR 58025A x C 20R
ADTRH1	:	IR 58025A x IR 66R

Genes involved in EGMS :

- ❖ One or two pairs of recessive nuclear genes (cytoplasm involved)

Advantages of EGMS system :

- ❖ Maintainer lines are not involved
- ❖ Choice of parents are more.
- ❖ No negative effect on sterile cytoplasm

Genes for fertility restoration in CGMS system : Rf1 and Rf2

COMMERCIAL HYBRID SEED PRODUCTION TECHNIQUE

Land requirement :

- ❖ Select fertile soil
- ❖ No rice variety to be raised for past 2 reason
- ❖ Should have protected irrigation and drainage system with sufficient sunshine
- ❖ Should not be any serious disease or any insect problem

Isolation

• Space isolation	:	Foundation seed stage : 200 m Certified seed stage : 100 m
• Time isolation	:	20 days either earlier or later for other varieties compared with MS line.
• Barrier isolation	:	• 30m of wood lot / tall crops • plastic sheets of 2m height
Season	:	April, May, December, January.

Seeds

Seed selection	:	• Purchase from authenticated source with tag and Bill. • For Foundation stage - (A & B lines)

- For Certified stage - (A & R lines)

Seed rate : Female : 20 kg /ha
: Male : 10 kg /ha

Seed Treatment :

Dormancy breaking : Soak in 0.5% KNO_3 for 16 h.

Biofertilizers : Pellet with *Azospirillum* @300 kg^{-1} of seed

Pest protection : Slurry treatment with Bavistin / Thiram @2g k^{-1} of seed.

Main field Transplanting

Spacing : Between A line - (15 x 15cm)
Between A and R line - (20 x15cm)
Between R line - (30 x 15cm)

Nursery Management :

- Keep irrigation channels separately for the parental lines
- For Dec-Jan sowing take up staggered sowing for male twice or thrice with the interval of 10-15 days (3,10,15daysfor effective seed setting)
- Keep the nursery area free of weeds.
- Apply DAP @ 2 kg / cent as basal to get vigorous seedlings.
- For April-May sowing sow the male 5 and 10 days after female line
- Even split application of fertilizer N is favourable for production of vigorous seedlings.

Age of transplanting : A line : 25 days

R line : 14,18,20 days

Intercultivation

Weeding :
- Pre-emergence herbicide Butachlor @ 1 lit / ac
- Hand weeding is done before panicle initiation

Irrigation : Field should have 5cm of standing water.

Supplementary Pollination

:

- Application of 2% DAP spray to late parent.
- Rope pulling - moving of rope from male to female line in wind direction.
- Rod driving – moving rod from male to female row in wind direction
- Leaf clipping (more than 2/3 of flag leaves are removed)
- GA3 application @ 75g/ha

GA 3 Spray :

- Application of GA3 can adjust physical and biochemical metabolism of rice plant and helps in hybrid seed production by stimulating the elongation of young cells.
- In most of the CMS lines, about 20-30% of the spikelets of a panicle are inside the flag leaf sheath (exertion is only 70%).
- GA_3effects exertion of panicle completely out of flag leaf sheath.
- The dose of 75 g/ha using knopsock sprayer and 40 g/ha with ultra low volume sprayer is recommended.
- The application of GA3 is recommended in 3 splits from panicle initiation days as follows :

  1st Spray : At 10 % of the panicle initiation.

  2nd Spray : Next day of first spray.

  3rd Spray : Next day of second spray.

- Spraying should be done at 8 t0 10 am and 4 to 6 pm.

Advantages of GA3 application

- Enhances panicle and stigma exertion
- Speed up growth of late tillers and increase effective tillers
- Flag leaf angle is increased

- Reduces untilled grains
- Enhances seed setting and seed yield.

Rouging

Plants to be removed	A line	B line	R line
Diseased plants	All	All	All
Parental lines	R line & B line	A line & B line	R line & A line
Early flowering plant	All	All	All

Rogues / off types : Based on variation in phenotypic characters

Physiological Maturation

Duration : 27-30 days after flowering

Symptom : Straw yellowing of grain

Harvest :
- When 80% of the population, the seed become straw yellow in colour the crop is ready for harvest.(Harvestable maturation)
- The male parent is harvested first.
- Care should be taken to avoid admixture of male and female line.
- Female line should be threshed separately in a well closed threshing floor.
- Seeds dried under sun / shade to 12% moisture content.

Storage

- Use cloth bag or gunny bag for short term storage
- Use 700 gauge polyethylene bag for long term storage.
- Cool places improve storability.
- Stack bags upto 8 bag height for protection of seed quality avoiding crushing of lower bags

Seed Standards

Standards	CS	FS
❖ Physical purity (%)	98	98
❖ Other crop seed	10	20
❖ Other designated variety	0.05	0.20
❖ Genetic purity (%)	98	98
❖ Germination (%)	80	80
❖ Moisture (%)	13	13
❖ Inert matter (%)	2	2

Seed Yield

Hybrid yield (F_1) : 800-1200 kg ha^{-1}

Exercise No. **Date :**

HYBRID SEED PRODUCTION IN SORGHUM

Botanical Name	:	*Sorghum bicolor*
Chrosomosome (2n)	:	20
Family	:	Poaceae
Inflorescence	:	Compact / loose panicle
Type of Pollination	:	Often cross pollination.
Flowering of panicle	:	2-4 days after panicle emergence
Flowering pattern	:	From tip proceeds downwards
Duration of flowering	:	7 days (within panicle)
Pollen viability	:	10-20 minutes
Pollen colour	:	Lemon yellow, older pollen turn orange.
Stigma receptivity	:	Initiates 2 days before flower opening and remains for several days.
Flower anthesis	:	2.00 AM to 8.00AM
Selfing technique	:	Bagging
Crossing technique	:	Emasculation

Breeding technique for Commercial production **:** Cytoplasmic genetic male sterility (CGMS)

Popular hybrids of their parents **:**

CSH5	:	2077A x CS3541
COH2	:	2219A x IS3541 (Kovilpatti Tall)
COH3	:	2077A x CO21
COH4	:	296A x TNS30
CSH 14	:	AKMS 14A x AKR 150
CSH 16	:	27 A x C 43
CSH 17	:	AKMS 14A x RS 673

Stages of seed multiplication	:	Breeder seed – foundation seed – certified seed.

Seeds produced in different stages

Nucleus seed stage	:	Maintenance of basic source by seed to row progenies.
Breeder Stage	:	A (AxB), B and R line are multiplied
Foundation Stage	:	A (AxB) and R line are multiplied
Breeder and foundation seed stage	:	Multiplication of male sterile line or maintenance of A and B line
Certified seed stage	:	A x R – F1 hybrid produced.
Certified seed stage	:	Production of hybrid seed
Foundation seed production	:	A and B line are raised in 4:2 ratio with 4 rows of B line as border row and allowed for cross pollination. The seeds from A line will be collected as A line seeds (multiplied).
Certified seed production	:	Hybrid seed production

Commercial in Hybrid seed production techniques

Land requirement :

- Should be fertile with good drainage
- Previous crop should not be sorghum.
- Avoid problem soils

Season :

- Best season November - December
- Flowering coincide with rain will result in washout of pollen.
- Temperature for seed setting 37°C

Isolation distance :

	FS	CS
Normal	300	200
On presence of Johnson grass	400	400
On presence of forage sorghum	400	200

Seeds and sowing

Seed	:	• Must be from authenticated source • Use suitable class of seed (Foundation seed for certified seed production)
Seed rate	:	A line : 8 kg ha^{-1} R line : 4 kg ha^{-1}
Pre-sowing treatment	:	• Seed hardening with 2% Potassium dihydrogen phosphate for 16 hrs with seed to solution ratio of 1:0:6 and drying back to original moisture content. • Seed pelleting with pungam leaf powder @ 300g/kg of seed • Seed treatment with 5% carbofuran 3G to protect seed from shootfly infection

Sowing

Type of sowing	:	Either by direct sowing or transplanting
Type of nursery	:	Raised bed
Advantages of transplanting	:	• Main field duration reduced by 10 days • Shoot fly attack at initial stage can be minimised. • Seedling with chlorotic, downy mildew and attack may be eliminated. • Population can be maintained • Seed rate reduced by 1/5th
Sowing depth	:	2 cm
Field preparation	:	Ridges and furrows
Spacing	:	A line : 45 x 30cm R line : 45 x solid row spacing.

Main field

Field preparation	:	Ridges and furrows
Planting ratio	:	Foundation seed stage : 4:2 (A:B) Certified seed stage : 5.2 (A:R)
Border rows	:	4 rows of male (either B or R line) to , supply adequate pollen.
Live markers	:	• Live plants used for identification of male line live markers are used. • It should have distinguishable morphological characters. • Live markers can be sunflower, daincha etc.

Manures and Fertilizers

Compost	:	12.5 t / ha
NPK	:	100:50:50 kg ha^{-1}
Basal	:	50:50:5 kg ha^{-1}
Top dressing	:	• 25kg N after last ploughing • 25kg N after boot leaf stage (45 days)
Micronutrient mixture	:	12.5 kg/ha
Foliar spray	:	Spray 2% DAP thrice at 10 days interval after 1st flowering to enhance seed set.
For problem soil	:	In calcareous soil spray 0.5% $FeSO_4$ thrice during crop growth (30, 40 & 50 days after sowing) to male plant to improve pollen viability and to enhance seed set.
Synchronization Techniques to increase seed set	:	• Give hardening seed treatment to late parent and pelleting to early parent. • Take up staggered sowing depending on hybrid and location. Eg. Under Coimbatore condition (Nov – Dec) take up the sowing of parental lines as follows.

CSH 5	:	Sow MS2077A (♀), 10-15 day earlier then CS3541(♂)
K-Tall	:	Sow MS2219A (♀), 3-5 days later than IS 3541(♂).
3. CSH 6	:	Sow the parents simultaneously.
4. CSH 9	:	Sow MS 296A 7-10 days earlier then CS3541.

- ❖ Application of 1% urea spray to lagging parent or primordial initiation stage (35-40 days)
- ❖ Withhold irrigation to the late parent to make early flowering.
- ❖ Spray malic hydrazide 500ppm or CCC 300 ppm to the advancing parent at 45th day

Roguing : Do it in both parents.

In female line remove : off types, wild types, pollen shedders, rogues, partials, volunteer plants, diseased plants, R line, mosaic plants, late / Early flowering plant

In male line remove : Rogues, A line, Diseased plants, Late / early flowering plants, Wild types

Weed Management :

- Spray atrazine 50WP @ 500 g ha^{-1} on 3rd day after sowing as pre emergence herbicide.
- Use sprayers fitted with flat nozzle using 900 litre of water per hectare
- The field should be weed free upto 45 days.
- Hand weeding done of 30-35 days

Irrigation

1st irrigation	:	Immediately after sowing
Life irrigation	:	3rd day after sowing
Subsequent irrigation	:	Once in a week
Critical stages	:	• Primordial initiation stage • Vegetative stage • Milky stage

Pest and Disease

Shoot fly :

Nursery	:	Spray endosulfan 35 EC 18 ml/120 sq.mm or Demeton 25 EC 12 ml
Direct sown	:	Endosulfan 35 EC 500 ml (250 l of spray fluid ha^{-1})
Stem borer	:	Endosulfan 4G 15 kg ha^{-1} or Endosulfan 35 EC 750 ml ha^{-1}
Mites	:	Spray 3.75 kg of wettable sulphur

Designated disease : 1. Kernel smut

2. Head smut

Sugary disease of sorghum :
- It is specific to hybrid
- Occur due to low seed set
- Spray rogor 0.03% (or)
- Endosulfan 0.07%

Pre harvest sanitation spray :
- Endosulfan 0.07%
- Bavistin @ 10 g / 10 lit,to avoid black mould and earhead bug.

Harvesting

Physiological maturation (PM)

Duration	:	40-45 days after 50% flowering
Seed moisture at PM	:	Around 30%
Visual symptom	:	Formation of dunken layer on seeds
Seed moisture content at Harvestable maturity	:	Around 20-25%
Harvesting technique	:	Harvest male first and then female
Effect delay harvest	:	Mould attack, amenable for field damage , yield and quality reduced

Threshing

Seed moisture content	:	15-18%
Technique	:	• Beating with plible bamboo sticks

- Use mechanical threshers to avoid mechanical damage

Drying : Dry under sun to reduce the moisture content to 8%

Processing : Use OSAW cleaner cum grader using 9/64" round perforated metal sieve as main screen.

Seed Treatment : Thiram @ 2 g kg^{-1} of seed halogen mixture @ 3 g kg^{-1} of seed

Seed storage : Storability : 2-3 years
Storage insect : *Sitophilus oryzae*
Moisture previous container : Cloth bag (for short term storage)
Moisture vapour proof storage - 700 gauge polybag (long term storage)

Seed yield : 3000 kg ha^{-1}

Seed standards

	Foundation seed	**Certified seed**
Physical purity (%)	98	98
Inert matter (%)	2	2
Other crop seed	5 kg^{-1}	10 kg^{-1}
Weed seed	10 kg^{-1}	20 kg^{-1}
Other distinguishable variety	10 kg^{-1}	20 kg^{-1}
Ergot disease by number	0.020%	0.040%
Moisture content		
Moisture pervious container	12	12
Moisture vapour proof container	8	8

Midstorage correction : Hydration dehydration with Disodium hydrogen phosphate (3.6 mg / lit g water) for six hours

Exercise No. **Date :**

HYBRID SEED PRODUCTION IN PEARL MILLET

Botanical Name	:	*Pennisetum glaucum*
Chromosome number (2n)	:	14
Family	:	Poaceae
Inflorescence	:	panicle
Special feature for cross pollination	:	Protogynous
Pollination	:	Cross pollination
Spike Emergence	:	10 weeks after sowing
Style production	:	2-3 days after sowing
Flowering Pattern	:	Top to Bottom
Completion of flowering	:	24-48hrs (within panicle)
Stigma receptivity	:	12-24 hrs
Anther emergence	:	• Emerge after the styles are dry. • Emergence of anthers takes place in 2 distinct ways. The 1st way involves bisexual florets (upper floret) and 2nd way usually 2-3 days after first way from staminate flowers (lower floret) • Starts from middle of the spike and proceed upwards & downwards
Anthesis	:	• Throughout the day • Peak between 8.00 PM – 2.00 AM
Temperature for seed setting	:	37°C
Selfing	:	• Bagging (Two earheads of some plant increase seed set). • Single earhead yield will be less

Crossing Technique : Controlled crossing by bagging desired plants as male and female.

Breeding Technique for hybrid seed production : Cytoplasmic genetic male sterility system (CGMS)

History of cumbu hybrid

Seed production : The first report on CGMS line was made by Burton and his co workers at Tifton Georgia USA. The line is Tift 23A.

Popular hybrid :

Hybrid	Female	Male
X5	PT 1921	2111 A (Ludhiana)
X6	PT 3095	732A (CBE)
X7	L111A	PT 1890
KM1	MS514117	J104
KM2	MS5141A	K560D230

Commercial Hybrid Seed Production

Land Requirement :

- Select fertile land
- Avoid problematic soil
- Previous crop should not be the same crop variety / after variety.

Isolation : Foundation seed : 1000 m
Certified seed : 200 m

Season : Irrigated : March – April, June - July
January – February
Rainfed : October - November

Seeds :

- Must be from an authenticated source (SAU, NSC Department of Agriculture)
- Use proper stage for production (eg. Foundation seed for certified seed)

Pre sowing seed Treatment :

- Treat with metalaxyl @6 g kg^{-1} seed against downy mildew
- Treat with *Azospirillum* 600g kg^{-1} seed for fixation of atmospheric nitrogen.

- Soak the seed in 10% NaCl solution to remove sclerotial bodies and ergot diseased seeds
- Harden seeds with 2 % KH_2PO_4 for rainfed sowing.

Seed rate : A line : 6 kg ha^{-1}
B line : 2 kg ha^{-1}

Main field preparation : Ridges and furrows

Sowing

Seedling / hill : 1 seedling / hill

Planting ratio : Foundation Seed : 4 : 2
Certified Seed : 6 : 2

Pusa 23 - 8 : 2

Border rows : Foundation Seed : 8 (B line)
Certified Seed : 4 (R line)

Depth : 2-3 cm

Spacing : A line : 45 x 20 cm
B line : 45 x solid row.

Nursery : Seedling can also be raised in raised bed nursery and can transplanted to the main field at 20-25 days of aging.

Manures & Fertilizers

Nursery : 750 kg / 7.5 cents for transplanting in one ha.

Mainfield :
- Compost : 12.t ton/ha
- NPK 100:50:50 kg ha^{-1}

Basal : 50:50:50 kg ha^{-1}

Top : 50:0:0 kg ha^{-1} (At tillering phase)

Foliar spray : DAP 1% at peak flowering to enhance flowering and seed set.

Steps for synchronization of flowering :

- ❖ Withholding irrigation
- ❖ Application DAP 1%
- ❖ Staggered sowing
- ❖ Jerking

Jerking :

It is done 20-25 days after transplanting or 30-40 days after direct sowing. The early formed earheads of the first tillers are pulled out or removed which will result in uniform flowering of all the tillers.

Specialty with cumbu in synchronization :

- ❖ The synchronization problem is less in cumbu due to
- ❖ Tillering habit
- ❖ Supply of continuous pollen
- ❖ Lesser pollen weight
- ❖ Flight capacity of pollen
- ❖ Pollen viability & stigma receptivity are longer.

Irrigation :
- Immediately after sowing
- Life irrigation on 3rd day
- Once in 8-10 days

Critical stages :
- Primoidal initiation stage
- Flowering stage
- Seed filling stage
- Milky stage

Roguing : Done in both lines

- A line : seek for offtypes pollen shedder and partials
- R line : Seek for early flowering plants, rouges and diseased plants.

Character of offtypes : Variation in leaf colour, leaf waviness, grain colour earhead, shape, size, etc.

No. of field inspection : Three

- Seedling stage
- Tillering stage
- Grain formation stage.

Field standards :

Standards	Maximum permitted (%)	
	FS	CS
Offtypes	0.05	0.10
Pollen shedders	0.05	0.10
Downy mildew diseased plants	0.05	0.10
Earheads affected by ergot	0.02	0.04

Plant Protection

Aphids, Jassids : Monocrotophos, Rogor 2.5ml/lit

Ergot disease : Carbendazim @500 g/ac Mancozeb 1kg/ac (1^{st} at 5-10% flowering and the 2nd at 50% flowering)

Downy mildew : Spray of Metalaxyl @ 500 g ha^{-1} (or) Ridomil WP @2 kg ha^{-1} (or) Mancozeb 1 kg ha^{-1}

Harvesting

Physiological Maturation : 30-35 days after 50 flowering

Visual symptoms :
- Seed colour changes from green to straw yellow in colour
- Formation of dunken layer at the point of attachment to the panicle.

Moisture content : 30-35%

Harvesting Technique :
- Due to tillering habit, harvest the panicle / earhead in 2 picking (to avoid delayed harvest)
- Select 5-7 tillers for seed purpose.

Threshing :
- Dry in yard for 2-3 days
- Moisture content should be 15-18%
- Stick beating (manual) or mechanical thresher (LCT Thresher).

Processing : • Grade with 4/64" round perforated metal sieve as middle screen

• Use OSAW cleaner cum grader

Seed Treatment : Thiram / Bavistin @3g kg^{-1} seed

Seed storage : • Cloth bag for short term storage (12 months)

• 700 gauge polyethylene bag – long term storage (> 24 months)

Mid storage correction : HDH with Na_2PO_4 10^{-4}m for 4h.

Seed standards

Standards	**Permitted (%)**	
	FS	**CS**
Physical purity (Maximum)	98	98
Inert matter (Maximum)	2	2
Other crop seed (Maximum)	10 / kg	10 / kg
Weed seed (Maximum)	10 / kg	10 / kg
Ergot effected seeds (Maximum) by number	0.020 %	0.040%
Germination	75	75
Moisture content - Moisture pervious	12	12
Moisture impervious	5	5

Seed yield : 3200 - 3250 kg / ha

Exercise No. **Date :**

HYBRID SEED PRODUCTION IN MAIZE

Botanical name	:	*Zea mays*
Chromosome number [2n]	:	20
Family	:	Poaceae
Inflorescence	:	Panicle cob, as the crop is monoceious in nature
Type of flowers	:	Monoceious
		Female : Cob
		Male : Tassel
Location	:	Female flowers : Axillary in the middle portion of plants
		Male flowers : Terminal
Pollination	:	Cross pollination
Flowering pattern	:	Top to bottom (Tassel)
	:	Bottom to top (Cob)
Anthesis	:	Pollen shedding begins 1 to 3 days before the silk emerge from the cob.
Fertilization	:	Within 12 to 18 hrs after silk emergence The entire silk is receptive. Silk will be pinkish and sticky at the beginning (receptive) after fertilization it will be chocolate / brown colour.
No. of pollen in tassel	:	2,50,00,000
Pollen viability	:	12-18h
Male flower anthesis	:	6.00 am to 8.00 a.m
Duration of flowering	:	2-14 days

Selfing techniques

Crossing technique	:	Manual emasculation by detassling
Detasseling	:	Removal of male inflorescence from the monoecious crop

Time for detasseling : The time taken for shedding of pollen from the tassel in 1-2 days after emergence. Hence the tassel should be removed before the shedding of pollen.

Method

- Hold the stem below the boot leaf in left hand and the base of the basal in right hand and pull it oat in a single pull.
- No part should be left on the plant as it causes contamination.
- It should be uniform process done daily in the morning in a particular direction.
- Donot break the top leaves as the field may be reduced due to the earning of source material to accumulate in sink [seed] as removal of 1 leaf course 1.5% loss 2 leaves 5.9% loss and 3 leaves 14% loss in yield.
- Detassel only after the entire tassel has come out and immature detasseling may lead to reduced yield and contamination.
- Mark the male rows with marker to avoid mistake in detasseling
- Look out for shedders [shedding tassel] in female rows as the may cause contamination.
- After pulling out the tassel drop it there itself and bursy in soil. Otherwise late emerging pollen from detasseled tassel may cause contamination.
- Do not carry the tassel through the field as any fall of pollen may lead to contamination.
- Donot practice, improper, immature and incomplete detasseling.
- **Improper detasseling** : A portion of the tassel is remaining in the plant while detasseling.
- **Immature detasseling:** Carrying out detasseling work when the tassel is within the leaves.
- **Incomplete detasseling** : The tassel is remaining in lower or unseen or unaccounted in within the whole of leaves.
- There should not be any shedding tassel.
- **Shedding tassel** : Either full or part of tassel remain in female line after detasseling and shedding pollen which may contaminate the genetic purity of the crop.

System of Hybrid seed production

- Datasseling (Manual creation of male sterility)

Types of hybrids

- **Single cross hybrid Production :**

It is a cross between 2 genotypes A x B. A genotype will be detasseled and crossed with B genotypes.

Popular hybrids : COH1 : UMI 29 x UMI 59
COH2 : UMI 810 x UMI 90

Double cross hybrid Production :

- It is a cross between 2 hybrids (A x B) x (C x D) (A x B) single cross hybrid will be produced by detasseling A and by crossing with B (C x D) hybrid will be produced by detasseling C and crossing with D.
- Then (A x B) will be detasselled and crossed with (C x D) hybrid.

Popular hybrids : Ganga 2 : (CM 109 x CM 110) x (CM 202 x CM 111)
Ganga 101 : (CM 103 x CM 104) x (CM 201 x CM 206)
COH3 : (UMI 101 x UMI 130) x (UMI 90 x UMI 285)
Deccan hybrid (CM 104 x CM 105) x (CM 202 x CM 201)

Three way cross hybrid Production :

- It is a cross between a hybrid and a variety or inbred. (A x B) x C (Inbred / genotypes). A x B) single cross hybrid will be produced by detasseling A and crossing with C. (A x B) progeny is detasseled and crossing with C.

Popular hybrids	:	Ganga 5 (CM 202 x CM 111) x CM 500
		Ganga 4 (CM 402 x CM 300) x CM 602
		H1 starch (CM 400x CM 300) x CM 601
		Ganga safed of (CM 400 x CM 300) x CM 600
• Top cross	:	It is first generation resulting from the crossing of on approved inbred line and a certified open pollinated variety.
	:	(A x variety)
	:	A will be detasseled and allowed for crossing in the variety.
• Double top crosses	:	The first generation resulting from the controlled crossing of a certified single cross and a certified open pollinated variety.
	:	(A x B) x variety
	:	(Ax B) will be detasseled and crossed with a variety
Sequential development of hybrid	:	(Fig 1 2 and 3)

Hybrid seed production technique

Land selection	:	Field should be free from volunteer plants
	:	Well drainage system
	:	Well fertile land

Field standards for isolation

For inbred lines (Foundation seed)

a)	Some kernel colour	:	400 m
b)	Different kernel colour	:	600 m
c)	Some in bred not conforming to varietal purity	:	400 m

For (foundation single crosses and hybrid of certified class)

	Foundation stage	Certified stage
• Same kernal color	400	200
• Different kernal colour	600	300
• Field of single cross not confirming to varietal purity	400	200
• Single cross with same male parent confirming to varietal purity	5	5
• Single cross with other male parent not confirming to varietal purity	400	200

- ❖ 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 silk when more than 0.20% of the plants in the adjacent field within the prescribed isolation distance are having shedding pollen.
- ❖ In hybrid seed production (certified seed stage) alone the isolation distance (less than 200 meter) can be modified by increasing the border rows of male parent, if the kernal colour and texture of the contaminant are the same as that of the seed parent.

The number of border rows to be planted all around the seed field to modify isolation distance less than 200 m shell also be determined by the size of the field and its distance from the contaminant as shown below.

Area in ha.	Isolation distance (m)	Border rows
< 4 ha	200	1
< 4 ha	150	5
< 4 ha	100	9
< 4 ha	50	13
10-12 ha	180	1
10-12 ha	130	5
10-12 ha	80	9

10-12 ha	30	13
> 16 ha	165	1
> 16 ha	115	5
> 16 ha	65	9
> 16 ha	15	13

Seed production stages and production of parental lines / hybrids

Stage of seed	Single cross	Double cross	Three way cross	Double top cross	Top cross
Breeder seed	A, B	A, B, C, D	A, B, C	A, B, variety	A, variety
Foundation seed	A, B	(AxB) (CxD)	(AxB), C	(AxB) variety	A, variety
Certified seed	A X B	(AxB) x (CxD)	(AxB) xC	(AxB) x variety	Ax variety

Seed production in maize hybrids

Land preparation : Ridges and furrows

Season : Second week of June

: • Mid July

: • Jan. Feb.

: • Sep. Oct

Source of seed : Authenticated defined class of seed

Seed rate : Female : 7 kg ha^{-1}

: Male : 3 kg ha^{-1}

Spacing : Female : 60 x 20 to 75 x 30 depending on the area.

Male :45 x 30 cm

Depth of sowing **:** 5-6 cm

Planting ratio **:** Single cross : 4 : 2

Hybrids : 6 : 2

Border rows **:** • Can be modified based isolation requirement.

• Minimum of 4 is best

• Permanent structure can be used as border rows

Fertilizer

NPK kg / ha	:	200 : 100 : 100
Basal	:	100 : 100 : 50
1st Top	:	50 : 0 : 0 (20th days -vegetative phase)
2nd Top	:	50 : 0 : 50 (Boot leaf stage at 45 days)
Foliar	:	DAP 2% at 50% flowering
In Zn deficient soil	:	$ZnSO_4$ @ 25 kg ha^{-1}
Planting ratio	:	Single cross : 4.2
		Hybrids : 6:2

Irrigation

First	:	On the date of sowing
Life	:	3rd day
Regular	:	Once in 7-8 days
Critical stages	:	Boot leaf, tassel formation, flowering cob formation, silk emergence, milky and dough stage

Weed control

Pre-emergence herbicide	:	Atrazine @ 1 kg in 1000 lit/ha
Hand weeding	:	25 to 30 days after sowing
Caution	:	Do not enter into the field after boot leaf stage.

Field standards

Specific factors	Certified stage
Off types shedding pollen when 5 % or more of seed parent in receptive silk	0 .50 %
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 %
Off types in seed parent at final inspection	0 .5 %

Common factors

Off types	:	**Foundation stage**
		Inbreds 0.1%
		Certified stage
		Single : 0.1%
		Hybrid : 0.1%
		OPV : 1.0% Hybrid : 0.5%
		Inbred : Nil
Inseparable other crop	:	Nil (both stage)
Objectionable weed	:	Nil (both stage)
Designated diseases	:	Nil (both stage)
Number of inspection	:	Four
(Seed certification officers)	:	One : Before flowering
	:	Three : During flowering

Plant protection

Stem borer	:	Carbofuran / roger spray
Pink borer	:	Endosulfan
Aphids	:	Roger / monocrotophos
Downy mildew	:	Metelaxyl, spray
Leaf rust / smnt	:	Bavistin / dithane spray
Root rot	:	Bavistin drench
Seed maturation	:	•14-20 DAA milky stages (starch in fluid stage)
		• 35 DAA : Soft dough stage
		• 45 DAA : Glazad dough stage
		• 55 DAA : Ripe dough stage

Symptom of Physiological maturation :

- The funicular degeneration
- Formation of dunken layer
- Moisture content of seed 35%
- Cob sheath turn straw yellow colour

Harvest : Harvest when the moisture content falls to 20-25 %

Harvest male first and remove from the field and then harvest female

Seed yield : 2.5 - 3.6 t/ha

Post harvest operations

Cob sorting : Remove sheath and check for kernel colour, shank colour, diseased cobs, kernel arrangement etc.

Xenia : Effect of kernel colour due to foreign pollen on the some generation

Matezenia : Effect of kernel colour due to foreign pollen in next generation

Shelling : Moisture content 15%

: Mechanical (cob sheller)

: Manual (rubbing with stones)

Improper shelling leads to : 48% damage to kenel

: Growth of storage fungal

: Pericarp damag

Pericarp damage : Crack on pericarp

: Identified by $FeCl_3$ or Tz test

Processing : OSAW cleaner cum grader

: 18 /64 round perforated metal sieve.

Seed standard

Standards	**Seed certification stage**	
	Foundation	**Certified (hybrid)**
Pure seed (Maximum)	98	98
Inertmatter (Maximum)	2	2
Other crop seed (Minimum)	5 /Kg	10 /Kg

ODV (Minimum)	5 /Kg	10 /Kg
Weed seed (Minimum)	None	None
Germination (Minimum)	80	90

Rouging **:**

- Check for shedding tassel.
- Check for receptive silk.
- Check for Off types
- Check for Rogues
- Check for Diseased plants

Exercise No. **Date :**

HYBRID SEED PRODUCTION IN PIGEON PEA

Botanical Name	:	*Cajanus cajan*
Family	:	Fabaceae
Chromosome number (2n)	:	22
Inflorescence	:	Terminal racemes
Flowers	:	Papilionaceous, gamosepalous, polypetolous standard petal 1,wing petal 2,keel petal 2,Stamens (9 + 1) diadelphous didynomous, monocorpellery and superior ovary
Anthesis	:	8.00 am to 11.00 am
Time for pollination	:	7.00 am to 10.00 am
Duration of flowering	:	7-15 hours
Type of pollination	:	Often cross pollination
Extend of cross pollination	:	3-70%
Selfing technique (varietal production):		Flowers are bagged with brown paper cover prior to the day of opening
Crossing technique	:	Emasculation

The unopened selected buds of 7 mm long are emasculated on the previous day of pollination with the help of forceps and covered with a paper bag. There should not be any anthers left. The flowers from the male line are collected in the next day. Removing the standard and wing petals, the keel petals are pressed gently so that the pluff of anthers extrude out and they are pressed on the stigma of the emasculated flowers. The pollinated flowers are then bagged. Pollination is done between 7.00 am to 10.00 am

Technique for hybrid seed production : Genetic male sterility

Popular hybrids **:** COH1 : MST21 X ICPL87109 in 1994
COH2 : MSCO5 X ICPL 83027 in 1997

Stages of seed production **:** Breeder seed – foundation seed – certified seed

Production particular with stage of seed

Breeder seed	-	Multiplication of female and male line in isolation
Foundation seed	-	Multiplication of female and male line in isolation
Certified seed	-	Production of F_1 hybrid
Control of male sterility	-	Monogenic recessive gene are maintained in heterozygous form following the principle of test cross

No. of male sterility system reported : Two

MS_1 – Translucent white anthers
MS_2 - Dark brown, arrow head shaped anthers

MST21 : Developed at ICRISAT

MSCO5 : Developed at TNAU ,coimbatore

Hybrid seed production technique

Land requirement

- Fertile land with an irrigation source
- Previous crop should not be pigeon pea
- Isolation distance is 200 m on all side from any other variety / hybrid of pigeon pea.

Fertilizer

- Farmyard manure @ 20 cert loads ha^{-1}
- N P K @ 25:50:25 kg ha^{-1}
- DAP 25 kg as basal and 2% DAP spray at flowering and another after 15 days.

Seeds and Sowing

- The female and male parents are sown simultaneously.
- In CORH1, the pollen parent (ICPL 87109) should be sown one week after the sowing of female parent (MST 21)
- Planting ratio : 4:2 (Female to Male)
  If insect activities is more 6:2
- Border rows : Two (around the plots)
- For hybrid seed production a ratio of 4:2 or 6:2 or 4:1 of male sterile pollen parent is to be adopted depending on honey bee activity. If bee activity is normal a ratio of 4:1 can be adopted. If honey activity is very less a ratio of 4:1 can be adopted. If honey activity is very less a ratio of 4: 2 may be adopted. If honey activity is moderate adopt a ratio of 6: 2.
- Spacing : 60 x 20 cm
- Sowing depth : 2-3 cm
- Seed rate : Female parent : 40 kg ha^{-1}
  Male parent : 5 kg ha^{-1}
- Presowing seed treatment : Rhizobium @ 3 pocket/ha or n—
  $ZnSO_4$ socking in 1/3rd volume (100 ppm)
- Season of sowing : First fortnight of June
  First fortnight of December
- Supplementary pollination : To increase the activity of insects, the whole plot should be bordered with sunflower to increase bee activity to effect cross pollination. Bee hives may be placed @ 5.8 ha^{-1} for effective cross pollination.

Irrigation **:**

- First irrigation after sowing
- Life irrigation on 3 rd day.
- Subsequent irrigation depending on need once in 7-10 days
- Mulching helps in moisture conservation

Rouging

In male sterile line or female parent

- Remove the off type plant
- Remove the male fertile line by examining the color of the anthers at the time of first flower formation, i .e. one day before flower opening.
- Roguing should be completed in7-10 days time.
- Remove the late flowering plants.

In male fertile line or male line

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

Field standard

Standards	Maximum permitted (%)	
	FS	CS
Isolation distance	-	100 m
Off types	-	0.10
Pollen shedder	-	0.10
Other weed plants	-	-
Designated weeds	-	-

Weeding : Ensure weed free condition
Apply pre-emergence herbicide Basilin 1.5 litre /ha on 3rd day after sowing.

Harvesting

- Physiological maturation 27.30 days
- Symptom - Brown pods, tan colour of seed
- Collect the pods from the female parent which will be the hybrid seed.

Plant protection

Insects

- Common problem blister beetle.
- Try to minimise insecticidal spray as it may kill the honey bees and other insects responsible for pollination and seed set.
- Spray NPV at 500 lit/ha with 20% teepol against pod fly.
- Spray endosulfan 4% or carbaryl 5% @ 25 kg or monocrotophos @ 625 ml/ha against pod borer.
- Spray neem oil 5% spray during flowering and pod set stage followed by Tricophos 0.05 % spraying.

Diseases

Sterility mosaic virus

- Affected plant at young stage are removed.
- Spray monocrotophos @ 500 ml/ha as the symptoms are visible and continue with another spray after 15 days.

Wilt and root rot

- Around the roots of all plants either affected or not, apply carbendenzamin @ 0.5 g dissolved in 1 litre of water.

Grading

- Seed moisture content to be reduced to 16-14%
- Use 10/64" round perforated sieve irrespective of parental and hybrid seeds.
- Reduce the final moisture content between 8-10% for prolonged storage.

Seed treatment

- Treat seeds with Thiram/Bavistin @ 2g / kg^{-1} of seed along with carbaryl @ 200 mg kg^{-1} of seed.
- Treat the seed with halogen mixture @ 3g kg^{-1} of seed as ecofriendly treatment.
- Treat the seed with Turmeric rhizome power / chilli powder / neem leaf power @ 100 g kg^{-1} of seed for dual purpose seed storage.

Storage

- Use cloth bag for short term storage.
- Use sealed container or 700 gauge polythene bag for long term storage.

Seed standards

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Characters	Maximum (permitted)	
	FS	**CS**
Physical purity	98 %	98 %
Germination %	75 %	75 %
Moisture	9 %	9 %
Other crop seed	_	_
Other distinguishable variety	_	10 %

Yield

Cost of seed

Male parental line : Rs.50.00/kg

Female : Rs.300.00/kg

Hybrid : Rs.120.00/kg

Benefit ratio : 1:33.

Exercise No. **Date :**

Hybrid seed production in sunflower

Botanical Name	:	Helianthus annus
Chromosome number (2n)	:	34
Family	:	Asteraceae
Inflorescence	:	Head or capitulum
Type of florets	:	Ray and disc
Disc florets	:	Bisexual in disc florets
No of disc florets in Head	:	4000 – 10,000
Head size	:	4 – 50 cm
Flower opening	:	From periphery to center @ 2-4 circles in each day
Nature of flower	:	Protoandry
Darting blooming $^{-1}$ head	:	5-10 days
Pollen viability	:	12 hrs
Anther Dehiscence	:	6.30 - 11.00 depending on sunlight
Time of anthesis	:	5- 8.00 A.M.
Stigma emergence	:	9.00 A.M.
Stigma receptivity	:	2-3 days
System of self incompatibility	:	Protoandrous flowers
Insects for cross pollution	:	Bees
		Apis mellifera
		Apis dorseta
Type of pollination	:	often cross pollinated
Extend of cross pollination	:	17-62%
Selfing	:	By bagging
Crossing technique	:	Emasculation of removing united anther lob by forceps.

Chemical for male sterility (Gematicide) : GA3 100 ppm

Varietal renovation Technique : Pustovate model

Commercial Hybrid seed production technique : Cytoplasmic genetic mole sterility

Popular hybrids : BSH1 (CMS 234A x RHA 273)

KBSH1 (CMS 234A x RHA 274)

: TCSH1

Commercial Hybrid seed production technique

Land selection :
- Select fertile & well drained soil
- Avoid wilt / Charcoal rot infected field
- The previous crop should not be sunflower past 2 seasons
- Sunflower can tolerate high PH upto 8.5

Isolation :

- Isolate field from same variety or other varieties not confirming to certification stand all around the plot.
- The distance of foundation stage : 400m
- The distance of certified seed stage : 200m

Land Preparation : Deep ploughing

Season :
- April - August
- December - January
- There should not be rain at the time of flowering.

Spacing : 45 x 30 cm (Female)
45 x 30 cm or 45 cm line sowing (Male)

Fertilizer : N PK – 60 : 45 : 45 Kg ha^{-1}.
: FYM : 12.5 t / ha

Micronutrient deficiency : *Mn deficiency :* Basal 25 kg /ha (or)
0.5% $MnSO_4$ spray of 30, 40, 50 DAS

: *Zn deficiency* : ZnSo4 Basal 25kg / ha (or)
0.5% $ZnSO_4$ spray at 30 , 40 & 50 DAS.

Seeds and sowing :

- Get seed form authenticated source.
- Get appropriate seed based on class of seed production

(eg) Foundation seed - A & B line seeds

Certified seed - A and R line seeds.

- If dormant soak in 0.5% $KN0_3$ solution for 16 hrs.
- Treat with Thiram @ $2gKg^{-1}$ of seed.

• **Seed rate :** : A : 6 kg / ac

: R : 4 kg / ac

• Sowing depth : 2-3 cm : Row ratio : 3 :1
Border row : 4

Herbicides : Apply fluchloralin 2.0 l ha^{-1} before sowing or as pre-emergence spray.

: 3 days after sowing along with irrigation.

Irrigation : At the time of sowing
: Life irrigation (3rd day)
: Once in 8 – 10 days.

Critical stages : • Bud development
: • Seed development
: • Seed maturation

Rouging : • Based on stem hairyness,
• leaf blade, leaf colour
• Bract colour, find the off type and remove.
• Based on head shape
• Convex ,concave flower (disc floret colour, ray floret colour) off type are to be removed.
• Keep the florets upside down on around to avoid cross pollination by insects.
• Remove downy mildew effected plants

Supplementary pollination	:	• Use muslin cloth and rub on male 1st and then on female heads (morning hours 8.00 - 11.00 am)
		• Keep bee hives @ 5-7 / ha
Special problem	:	• Bird damage / parrot damage (Occur on milky stage seeds eaten away by birds)
	:	• Bird scaring 6.00 – 10 pm 3.00 – 7.00 pm. • Coloured ribbon are blown.
Physiological maturation	:	• Thalamus turns greenish yellow in colour.
Harvesting	:	• Remove male first, then female
	:	• Moisture content : 15%
	:	• Do not heap the heads
Threshing	:	• Dry and beat with sticks • Sunflower thresher (risky)
Grading	:	• Sieve grading with - 8/64 , 10/64" depending on parent hybrids • Specific gravity grading is best.
Storage	:	• Thiram treatment @ 2g kg^{-1} of seed • Seed moisture content : 8% • Cloth bag for short term storage • Polyethylene bag (700 gauge) at which 5-6 % seed moisture for long term storage

Exercise No. **Date :**

HYBRID SEED PRODUCTION IN CASTOR

Botanical Name	:	*Ricinus communis*
Family	:	Euphorbiaceae
Chromosome Number	:	2n = 20
Inflorescence	:	Candle or spike
Type of flower	:	Monoecious
Male	:	Bottom (40-50%)
Female	:	Top (50-60%)
Nature of flower	:	Slightly potently
Flower opening	:	❖ Male opens first ❖ Female one or two days later ❖ Flowers open early the morning 4.30-5.00 am 10-12 days for complete anthesis)
Anthesis	:	4-8 am
Pollen grains viable	:	66 hrs.
Stigma receptivity	:	1-2 days
Type of pollination	:	Highly cross pollinated
Selfing	:	By bagging
Crossing Technique	:	i) Emasculation by removing of male flowers. ii) Use of 100% pistilate line (Female) (No new for emasculation)
Hybrid Seed Production Technique	:	Use of 100% pistillate line. (Depending upon environment i.e. Temp. sensitive)

Commercial Hybrid seed production technique

Land requirement	:	Select fairly deep, fertile and well drained soil. Avoid alkalinity/salinity soils. (Problematic soil). Previous crop should not be castor.

ISOLATION

Isolation	Isolation distance recommended (m)	Statutory isolation limits (m)
Male Parents	1500	-
Nucleus shredder	1000	300
Foundation	600	150
Certified		
Female Parents	2000	-
Nucleus shredder	1500	300
Foundation	1000	150
Certified seed of common hybrid		
Land Preparation	Deep planting	2 to 3 harrowing
Stages of seed production	**Breeder seed - foundation seed - certified seed**	
Area/regions	Western and Northern state	Southern state
Season		
Male Parent	July first Fortnight (FN)	June 2nd FN
Female	July first FN	Jan first FN and May last week to June first week.
Certified (Hybrid)	August season FN	Sep second FN
Spacing	Initial (cm) 90 x 30	Final spacing to be adjusted at the time of second ranging (cm) 90 x 60
Seed rate (kg/ha)	10-12	
Sowing	4 to 5 cm deep	
Row ratios	4:2 or 3:1 (depending upon hybrid)	
Nutrient Management :		
Fertilizer	: N P K kg/ha 80 : 60 : 0	

Basal	:	40 : 60 : 0
After 45 to 60 days	:	20 : 0 : 0
After first picking	:	20 : 0 : 0
Herbicides	:	Plot should be weed free during first 45 days of crop growth.
	:	Spray Fluchloralin or Trifluralin @ 1 kg active ingredient / ha. 3-5 days prior to seeling.
Irrigation	:	Depending upon the soil and the crop season.
		Kharif 4-6
		Rabi 6-8
		Summer 15-20
		At an interval of 9-10 days.
Plant Protection	:	
Caster semilooper	:	Monocrotophos (0.05%) or quinolphos (0.05%) or dimethoate (0.05%) or endosulfan (0.05%) 10-15 days.
Tobacco caterpillar	:	Chlorphyriphos (0.05%)
Caster hairy cater pillar	:	Phosphomidon or quinolphos (0.05%) MCC or twice at 10 days interval.
Sex expression	:	Occurrence of staminate flower mostly related to seasonal variation and associated with the genotype and mean day temperature.
	:	Generally female tendency is highest in rabi and early summer.
	:	Plants tends to be mostly make when planted.
	:	In late summer and kharif.
Temp below 32°C	:	Mostly female.
above 32°C	:	Plant produces more male flowers. Besides temp. age of plant and level of nutrition and influence sex expression.

	:	Female tendency is in general highest in young plant with high level of nutrition. White reverse in the case with old and poorly nourished plants.
Roguing	:	Minimum 3 field inspection requires.

Crop growth stage		**Basis for identification**
i) At least 10 days prior to flowering in primary raceme	:	Stem colour, internode type, leaf shape and bloom.
ii) Flower initiation in primary raceme	:	Nodes upto primary raceme, internode type, sex expression, branching and spike characters.
iii) Flower initiation in secondary order raceme	:	In female parent spike and capsules character in primary raceme and reversion to monoceious in secondary order raceme.
iv) Flower initiation in Ternary order raceme	:	In female parent Reversion to monoecism in tertiary and quaternary order racemes.
Physiological Maturation	:	When capsules turn green to pate yellow – brown colour or 1 or 2 capsules dried.
Harvesting	:	First harvest female line (hybrid) capsules harvested sequenced order racemes. Generally to picking required starting from 90 to 120 days at an interval of 25-30 days.
Threshing	:	After harvesting capsules dried in sun for 3–7 days. Seeds may be separated from capsules either manually or mechanically. Keep picking seed lots separately.
Grading	:	Sieve grading with 18/64". Depending upon genotypes or hybrid.
Storage	:	Seed moisture content 8.00 cloth bag or polyethylene bag
Grow out test	:	The limits for rejection numbers are

	Genetic purity (%)	Reject number in 400 plants
Foundation	95.0	24
Certified	85.0	64

Seed standards

Factor	Foundation	Certified
Pure seed (minimum)	98.0	98.0
Inert matter (maximum)	2.0	2.0
Other crop seeds (maximum)	None	None
Weed seeds (maximum)	None	None
Other distinguishable varieties (maximum number per kg)	5	10
Moisture	8.0	8.0
For vapour proof containers	5.0	5.0

Exercise No. **Date :**

HYBRID SEED PRODUCTION IN COTTON

Botanical Name	:	*Gossypium spp.*
Chromosome number (2n)	:	26
Diploid cotton	:	*G. arboreum* (korungani cotton)
		G. herbaceum (uppom cotton)
Tetraploid cotton (2n)	:	52
		G. hirsutum (American cotton)
		G. barbadense (Egyptian cotton, sea island cotton)
Family	:	Malvaceae
Inflorescence	:	Raceme (axillary)
Flower	:	Solitary bisexual with monodelphous ovary
Anthesis	:	Asiatic cotton : 8-10 AM
		American cotton : Earlier
Specialty with flowering	:	Temperature affects the flower opening. After flowering cream yellow colour of corolla turns pink within a day of later turns to red.
Time of stigma receptivity	:	8-10 AM
Pollen viability (duration)	:	24 hours
Stigma receptivity (duration)	:	7 hours
Selfing	:	Selfing the flower bud by using thread, paper clips, wet clay or mud.

Crossing Technique : By removal of monodelphous staminal column and dusting with pollen.

Hybrid Seed Production Technique : Manual method / Emasculation and dusting.

Popular Hybrids

Varalakshmi	:	Lakshmi x SB 289 (*G.hirsutum*) x (*G. barbadense*)
CBS 156	:	Acala glandless x SB 1085 - 6
Jayalakshmi / DCH 32	:	DS 26 x SB 425
TCHB 213	:	TCH 1218 x TCB 209

Other breeding systems for hybrid seed production :

- ❖ Genetic male sterility (eq. Suguna)
- ❖ Cytoplasmic genetic male sterility.
- ❖ Emasculation

Commercial Hybrid Seed Production technique

Land Selection : Free of volunteer plants of cotton variety deep, well drained and fertile soil.

Land preparation : Fine tilth with giving ploughing followed by 2-3 harrowing.

Isolation :
- FS : 50 m
- CS : 30 m
- Between parental lines : 5 m

Seed rate :

Delinted :	Female :	1.5 kg/ha
	Male :	0.50 kg/ha
Fuzzy :	Female: :	2.00 kg/ha
	Male :	0.75 kg/ha

Spacing :

Female: :		4’ x 2’
Male :		3’ x 2’

Manures & Fertilizers : FYM : 25 tonnes/ha
NPK : 18 : 40 : 40 kg/ha

I dose at sowing & II dose at 30 DAS at : 16 : 40 : 40
II dose at 30 DAS at square formation : 32 : 0 : 0
III dose at 60 DAS at flowering : 32 : 0 : 0

Sowing : Female & male parents are sown separately side by side in the ratio 4:1 or 5:1. (Adopting block system)

Pre-sowing seed treatment : Thiram or Capton @2 .5 g/kg of seed.

Irrigation Stages : No. of irrigation - 9

Germination : 1. Immediately after sowing
2. Life irrigation on 5th day of sowing

Vegetation phase : 1. On 20th or 21st day of saving
2. On 35th or 36th day of sowing

Flowering stage : 1. 48th day of sowing
2. 60th day of sowing
3. 72nd day of sowing
4. 84th day of sowing
5. 96th day of sowing

Roguing : From flowering initiation and continued till flowering is completed.

Characters for rouging : Leaf colour, shape, leaf hairiness, flower colour, petal eyespot, boll shape.

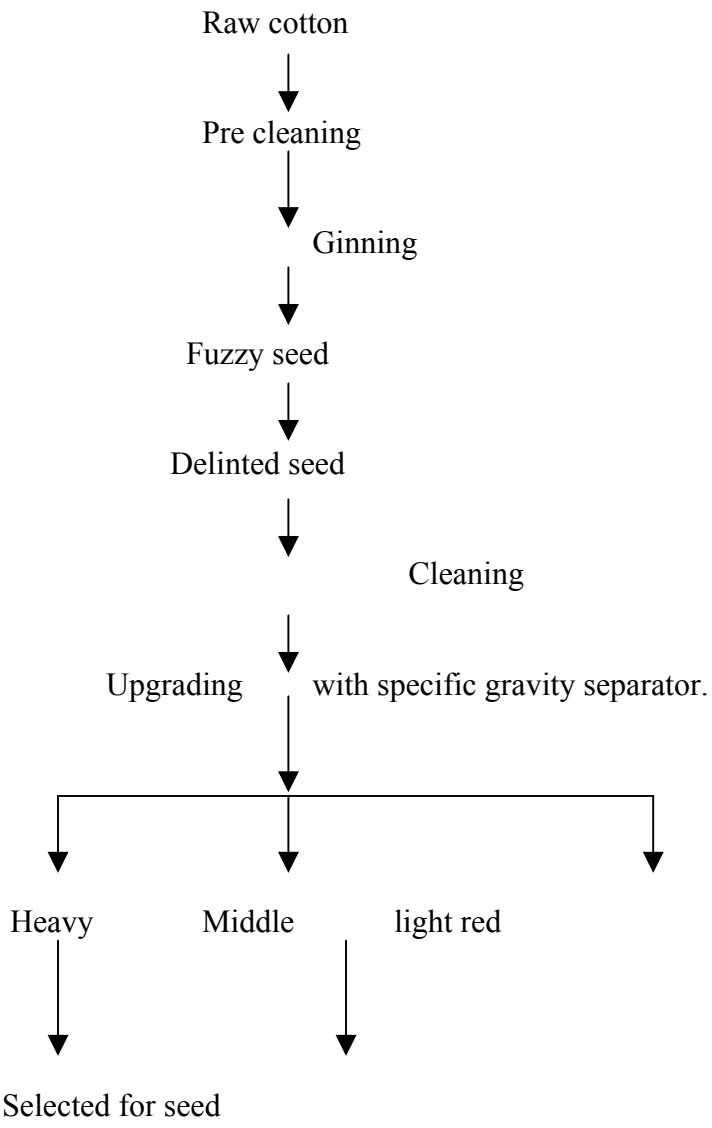
Field standards

Standards	**Maximum (permitted)**	
	FS	**CS**
Isolation distance	50	30
Off types	0.10	0.50
Pollen shedders	0.05	0.10
Other weed plants	-	-
Designated diseases	-	-

Picking : 30 to 40 percent boll bursting.
Generally 3 to 4 pickings are required.

Seed yield : kapas yield 15-20 q/ha
Cotton seed yield 7-10 q/ha

Seed processing : Flow chart for efficient processing of cotton seed



Delinting Methods

- Acid deliniting : Used concentrated H_2SO_4 (93 to 98%) @100 ml/kg of fuzzy seed for 3-4 minutes.

- Dry gas delinting : Dry HCl gas is injected in a revising drum containing fuzzy seed. The drum is heated. Temp. reaches 49°C

  Ammonia gas is used for neutralize the acid traces.

Seed storage : Seed is dried upto 8-9% moisture and stored in well dried cloth bag.

Seed standards

Standards	Maximum (permitted)	
	FS	**CS**
Physical purity (Maximum)	98	98
Germination % (Minimum)	65	65
Moisture (Minimum)	10	10
Other crop seeds (Minimum)	5	10
Other distinguishable variety (Minimum)	-	-

Exercise No. **Date :**

HYBRID SEED PRODUCTION IN BHENDI

Botanical Name	:	*Abelmosehus eseulentus* (L) Moenet
Chromosome Number	:	2n
Family	:	Malvaccae
Inflorescence	:	Solitary
Pollination	:	Often cross pollinated
Anthesis	:	8.00 Am
Pollen viability	:	
Srisme receptively	:	
Crossing Technique	:	Emasculation
Setting Technique	:	Bagging

Commercial hybrid seed production technique

System involved	:	Manual manipulation of sterility by emasculation & dusting
Popular hybrids	:	CO_2 (AE 180 x Puse sewami)
	:	Parbhani Kranti
	:	CO_3 (Parbharikranti MDUI)
Land requirement	:	Free from volunteer plants
	:	Free from Macrophomina infection
Isolation	:	Foundation seed : 400 m
	:	Certified seed : 200 m
Season	:	June-July Sep-Oct
Spacing	:	45 x 30 cm
Fertilizer	:	NPK @ 80 : 60 : 60 kg ha^{-1}

Seed rate	:	8 kg female kg ha^{-1}
		4 kg male kg ha^{-1}
Roguing	:	From Vegetative to Harvesting stage
Field inspections	:	3
	:	1st Before flowering
	:	2nd During peak flowering
	:	3rd Fruiting stage (matured fruit stage)

Field standards

Factor		**Maximum permitted (%)**	
		Foundation	**Certified**
Off types	:	0.10	0.20
Objectionable weed seed	:	None	None
Physiological maturation	:	30 days after anthesis	
Maturation Symptom	:	Hair line cracks in dried pair	
Harvesting	:	Picking (4.5)	
Problems in Harvesting	:	Sheltering	
Seed Grading	:	10/6” round perforated	
		Metal sieve	
		IDS method (Incubation drying & separation)	
Seed treatment	:	Bavistin @ 2 g kg^{-1} of seed	
Seed storage	:	Long-term storage (HDPE/700 sieve poly bags)	
Planting method	:	Block system	
Planting ratio	:	8:1	
Hybridization	:	Emasculation of female and dusting with male pollen	
Distance between male and female	:	5 m	

Seed standards

Factor	Standard	
	Foundation clan	**Certified clan**
Pure seed (Mini)	99%	99
Inert matter (Max)	1	1
Other crop seeds (Max)	None	5/kg
Total weed seed (Max)	None	None
Objectionable weed seed (Max)	None	None
ODV	10/kg	20/kg
Germination	65%	65%
Moisture	10%	10%
Vapour Proof Containers (Max)	8	8

Exercise No. **Date :**

TOMATO HYBRID SEED PRODUCTION

Botanical name	:	*Lycopersicum esculentum*
Family	:	Solanaceae
Inflorescence	:	Cluster
Hybrid seed production technique	:	Emasculation technique
Popular hybrids	:	COTH1 (CIHR 709 X LE8 (2)) Pusa hybrid,MTH1
Land and climate selection	:	• Dry season 21-30º C/ 15-20ºC temperature • Poor fruit set at > 30^{O}C& >60% LH. • Soil pH – 6.0 to 7.0 • Low pH (15.5)
Season	:	January-February, Oct-Nov.
Selection of Parents and sowing	:	Female-best seed yielder.
Planting ratio	:	1: 3 (Male: Female) adopting in block system, can be extended upto 4-5
Sowing	:	
Staggering	:	Male parent sown 3 week earlier.
Seed rate	:	Female -60-100 g/ha Male - 20-25g/ha
Nursery	:	Raised Bed.
Stages of seed production	:	Breeders, foundation seed ,certified seed Parental line multiplication, (BS & FS) hybrid production. (CS).
Isolation	:	• FS : 200 m • CS : 100 m • Between parental line : 5 m
Transplanting	:	20-25 days old plant
Spacing	:	Female - 50 cm Male - 40 cm

Stacking :

- Female –both for indeterminate & determine
- Easy emasculation
- Prevents rotting of fruits
- Male –only for indeterminate

Hybridization technique

Emasculation :

- 55-65% days after sowing
- Removal of stamens from flower buds of female line before they shed pollen.
- Select flower buds from second cluster which will open in next 2-3 days.
- Petals – slightly out of flower bud , but not opened.
- Corolla colour is slightly yellow or pale.
- Sterilize the forceps, scissors and gloves with 95% alcohol.
- Open the selected buds : split open the anther cone and remove.
- Calyx, corolla& pistil – intact.
- Cut few sepals.
- Preferably in the morning hours.

Pollen collection :

- Collect flowers from the male parent to extract pollen.
- Collect pollen early morning before pollen shed.
- Avoid pollen collection on rainy days
- Remove anther cones & put in glasshine envelopes.
- Dry under a 100w lamp for 24 hrs. (30^{O}C).
- Place the anther cones in a cup – cover with 200-300 mesh screen –cover with lid.
- Fresh pollen – good seed set.
- Store pollen in sealed container under freeze & refrigerated condition.

Pollination :

- 1-2 days after emasculation
- Corolla turns bright yellow
- Dip the stigma into a pool of pollen.
- Continue for 3 –5 weeks.
- Remove non-crossed flowers /fruits

Rouging :

- On the basis of plant type , leaf type ,fruit characters (shape ,size , color , shoulder)
- Diseased plants yellow mottling, curling, cupping
- Stunted plants

Designated / seed borne diseases : • Early blight (*Alternaria solani)*
• Leaf spot
• Tobacco mosaic virus (TMV)

Field standard

Standards	Permitted (Maximum %)
	Certified seed
Off types in seed parent	0.05 %
Off types in pollinator parent	0.05 %
Pollen shedder	0.1 %
Plant affected by seed borne disease	0.5 %

Harvesting :
- Ripening 50-60 days after pollination
- Be sure to check for clipped sepal.
- Use nylon net bags, plastic containers.

Seed extraction

Manual :
- Harvest the fruit in nylon bags.
- Crush the fruit by trampling with feet.
- Put into plastic containers for fermentation.
  For one day – if Temp is > 28^{O}C
  For 2-3 days – if Temp < 28^{O}C.
- Fill the container with water and stir well
- Remove the debris and wash the seeds.

Mechanical :
- Extract pulp – for crushing and separation of seeds and gel from pulp.
- Treat the seed gel mass with 7-10 ml HCI per kg of seed gel.
- Stir continuously for 40min/until the gel is dissolved fully.
- Wash thoroughly

Seed drying :
- Place the washed seeds in fine mesh bags
- Spin drying – for quick drying.
- Spread the seeds uniformly.
- Loosen the clumps of seed by hand.
- Dry the seeds in seed drier for 3- 4 days at 28 –30^{O}C. (6-8% M.C).

Seed packing and storage :
- Grading – 12 x12 BSSor 5/64 " size.
- Halogen mixture @ 3g/kg of seed
- Store in vapour proof /air tight containers (4-5yrs).
- Storage temp 20˚ C & 30% RH.

Seed standard (Certified Seed - Hybrid)

Pure seed (minimum)	:	98.0%
Inner matter (maximum)	:	2.0%
Other crop seeds (maximum)	:	10/kg.
Weed seeds (maximum)	:	None.
Germination (minimum)	:	70.0%
Moisture Content	:	8.0%
M.C. for V.P. container	:	6.0
Genetic purity during grow-out test	:	90.0%

Exercise No. **Date :**

HYBRID SEED PRODUCTION IN BRINJAL (*SOLANUM MELONGENA* L.)

Botanical name	:	*Solanum melongena* L.
Family	:	Solanaceae
Inflorescense	:	Four types of flowers in brinjal based length Of style *viz.* i. Long styled with big size ovary (25) ii. Medium styled with medium size ovary (107) iii. Pseudo short styled with rudimentary ovary (15%) and iv. Time short styled with rudimentary ovary (50%)
Flower	:	Solitary (or) in cluster of two (or) more highest % of fruitset is found where the stigma is above the stamens , bisexual flowers
Anthesis	:	7.30 am to 11.30 am
Peak time of anthesis	:	8.30 to 10.30 a.m.
Pollen dehiscence	:	9.30 to 10.00 a.m.
Stigma receptivity	:	At the time of flower opening more cross Pollination by itself
Pollen viability	:	8-10 days
Selfing	:	Bagging
Crossing technique	:	• Emasculation and dusting • Male sterility line also used

Commercial Hybrid seed production technique

: Manual method / emasculating and dusting

Popular hybrids :

I Long type : COBH 1 (TNAU)

II Round type : Pusa hybrid 6 (IARI)

III oval to oblong : Arka Navneet (IIHR)

IV small size fruits : Phule hybrid 2

ABH 1 and 2

Commercial Hybrid seed production technique

Land selection : Fertile, well, drained sandy (or) sandy loam soil

Disease free field is important one

Previous crop should not be brinjal for past 2 seasons

Isolation : The distance of Foundation stage : 200 m

Certified stage : 200 m

Land preparation : Deep ploughing

Season :

Sowing	:	Transplanting
July-July	:	July - August
Nov.-Dec.	:	Jan. - Feb.
Mar-Apr.	:	April-May

Spacing :

Female plant	:	100 x 75 cm.
Male plant	:	75 x 60 cm.

Fertilizer :

NPK	:	100:50:30 kg/ha
50 N basal		
I 25	:	25-30 DAT
II 25	:	45-50 DAT

Seeds & Sowing

- Get seed from Authenticated source
- Get appropriate seed based on seed production

Seed rate	:	430 g of female seeds.
	:	70 g male seeds.

Raising of seedling

Separate raised nursery bed for male and female parent.

Seed treatment	:	30 ppm IPA before sowing.
Sowing Depth	:	5-10 cm deep in rows of 5 cm apart.
		cover with fine layer of soil & compost.
Germination	:	12 to 18 days.
Transplanting	:	20-25 DAS.
		Should not mixed male and female parent.
Row ratio	:	5:1 (or) 6:1 Female & Male
Border row	:	-
Herbicide	:	Fluchloralin (Basalin) @ 2-3 litres/ha. (Pre-emergenc herbicide)
Irrigation	:	After transplanting light irrigation essential for survival.
Summer	:	Every 4^{th} (or) 5^{th} day whereas 10-12 days during in winter.

Roguing

(i) Before flowering	:	Already born flowers should be removed branch orientation, leaf colour, presence (or) absence of pubescence should be removed diseases and disorders should be removed.

(ii) At flowering and fruiting, late flowers, flower colour, flower orientation. At the time of fruiting stages - fruit colour, fruit shape are consider.

(iii) At maturing stage

Immature and overmatured fruits. Fruits for size, shape, colour and external feature.

Physiological maturing : Fully ripened seeds are used for seed extraction. Colour of the fruit is full yellow.

Harvesting : 50-55 DA Pollination depending on the maternal parent.

Seed extraction and drying : Fruits is peeled off.

The number of seeds are imbibed is cut into pieces or crushed electric pupler is allowed to soak in water for 12 hours washing in running water.

- HCl is added in pulp at 1:4 ratio (25 ml HCl/kg of pulp) stired for 25-30 minutes and then separated out washing and seiving.
- Poor quality seeds are shorted out. Recovery of seed is 5%.

Drying : Partial shade to bring down the moisture content 8%.

Seed yield : 50-60 kg/ha. 1000 seed weight is 4-5 g approximately.

Grading : 8/64" round perforated metal sieve.

Storage : Drug store beatle (*stegobium paniceum L.*) is a serious pest of brinjal seeds. Moisture 8% treated with Thiram 75 WP @ 2.5 g/kg (or) Malathion 5 D @ 3 g/kg of seed.

Field standard

Factors	Certified	Renames
Off types	0.20	Strict roughing for Phomosis blight and little leaf diseases.
Other types	-	
Objectionable weed plants	-	
Disease Plants	0.50	

Seed Standards

Standards	Certified
Pure seed (min)	98.0
Inert matter (max)	2.0
Other crop seed (max)	None
Total weed seed (max)	None
Objectionable weed seed (min)	None
Germination (min)	70
Moisture (max)	80

Exercise No. **Date :**

HYBRID SEED PRODUCTION IN CHILLIES

Botanical Name	:	*Capsicum annum*
Chromosome number (2n)	:	24
Family	:	Solanaceae
Inflorescence	:	Solitary.
Pollination	:	Often cross pollinated crop (16% out crossing)
Anthesis	:	5-6 a.m.
Anther dehiscence	:	8-11 a.m.
Ideal temperature for seed set	:	20-25˚C
Pollen viability	:	24 hours (At the day of anthesis)
Stigma receptivity	:	24 hours
Selfing technique	:	Bagging
Crossing technique	:	i) Emasculation and land pollination
		ii) Genetic male sterility
Popular hybrids	:	CH1, CH3, CH4 (Public Sector)
		Agni, Tejasvani, (Private Sector)
Soil pH	:	5-5-7.0
Environmental Problem	:	At 38°C fruit development will be affected.

Commercial Hybrid Seed Production technique

Land selection	:	* Free from volunteer plants * Free from Macrophomina infection * Same crop not to be raised in the previous two seasons.
Land Preparation	:	* Fine tilth * Ridges & Furrows
Isolation	:	FS – 400 m CS – 200 m

Season	:	June – July Feb – March
Seed Rate	:	Female – 500 g/ha Male – 100 g/ha
Seedling Production	:	By raising raised bed nursery
Nursery Preparation	:	1m breath with optimum length. Compost to be incorporated. Shade to be provided
Sowing	:	Line sowing at 5cm spacing
Seeding Protection	:	Drenching with 1% Bavistin, or Drenching with Blue Copper 1%

Main field

Age of transplanting	:	21 days
Fertilizer	:	FYM, NPK
Foliar spray	:	* NAA 50 ppm at full bloom stage against flower drop * Ethrel 400 ppm to enhance fruit set.
Hybridization		
Emasculation	:	Early in the morning or previous day afternoon before flower opening and the petals still covering the anthers and stigma.
Pollination	:	Late in the morning

Methodology

- Emasculation may be done either early in the morning or in the previous afternoon before opening of flower and petals still covering the anthers and stigma.
- The petals are removed carefully with the help of a pair of forceps and the anthers are removed separately.
- The emasculated flower buds are protected by thin cotton wad or bag or by thin cloth loosely wrapped around the branch, enclosing leaves and flowers and securely fastened.
- Pollen collection is normally done late in the morning.
- Pollen from the previously protected flowers are collected by a vibrator or after plucking the flowers from intended male parents, they are gently tapped by finger for the collection of pollen in petridish or watch glass.
- Best time of pollination in early morning or late afternoon of the following day of emasculation.

- Pollination in done by touching the freshly dehiscenced anthers to the stigma by forceps, by dusting pollens over the stigma or by transferring the pollens with brush or needle very carefully and the petals may be cut off to facilitate pollination.
- Bagging of the flowers should be done to prevent pollen contamination.

Field inspection : * 3 times
* Before flowering
* At flowering
* After flowering at fruiting stage.

Roguing : Done from vegetative to harvesting stage.

Field standards

Isolation

Contamination	**Minimum distance (M)**	
	Foundation	**Certified**
Field of other varieties	400	200
Field of same variety not conforming to varietal purity requirements for certification	400	200
Fields of capsicum from chilli and vice versa	400	200

Specific standards

Contamination	**Maximum permitted %**	
	Foundation	**Certified**
Off types	0.10	0.20
Plants affected by seed borne diseases (leaf blight ,Anthracnose)	0.10	0.50

Physiological Maturation : 35 DAA

Type of harvest : Picking

Number of pickings : 4-5 at weekly intervals

Seed extraction : Mechanically using chilliseed extractor

Seed grading : BSS 8 x 8

Seed treatment : Bavistin @ 2g/kg

Seed packing : * Long term storage – 700 guage polythene bag

* Short term storage – cloth bag

Seed yield : 50-60 kg/ha

Seed standards

Factor	Standards for each class	
	Foundation	**Certified**
Pure seed (%) (Max)	98	98
Inert matter (max)	2	2
Other crop seeds (Max)	5/kg	10/kg
Weed seeds (Max)	5/kg	10/kg
Germination (%) (Min.)	60	60
Moisture (%)	8	8
Vapour proof containers	6	6

Exercise No. **Date :**

HYBRID SEED PRODUCTION IN CUCURBITS (BITTER GOURD)

Botanical Name	**:**	*Memordica charantia*:
Inflorescence	:	Solitary, Monoceious
Types of flowers	:	* Staminate * Pistilate * Hermaphordite
Sex forms in cucurbits		
Trimonoecious	:	Musk melon, ridge gourd
Monoecious	:	Ash gourd, bottle gourd, bittergourd, cucumber, muskmelon, pumpkin, ridge ground, round melon, squash, watermelon
Androecious	:	Rare
Andromonoecious	:	Muskmelon
Gynoecious	:	Cucumber, muskmelon breeding lines
Gynomonecious	:	Water melon
Hermaphordite	:	Sponge gourd
Sex ratio	:	15:1 to 30:1 (E to Γ)
Anthesis	:	6-8 a.m.
Type of pollination	:	Cross pollination (60-80%)
Pollinating agents	:	Bees
Bee colonies required for seed set	:	1 bee colony/acre
Techniques for hybrid seed Production	:	Emasculation and open pollination.
Methodology	:	* The male and female lines are grown in alternate rows * Male flowers from female lines are pinched off, day before anthesis and pollination is enhanced by honey bees and other insects.

Planting ratio : 2:1 – 4:1 depending upon the crop.

If sown in blocks : 2:1-summer squash, 4:1 – musk melon
2 : 1 - Bitter gourd

Hand pollination can be Adopted : Crossing

Field inspections : 4 (Before flowering, during flowering, mature fruit stage)

Roguing : From vegetative to harvesting phase.

Field standards (Bittergourd, bottlegourd, cucumber

Isolation

Contamination	**Maximum permitted %**	
	Foundation	**Certified**
Field from other variety including commercial hybrid of the same variety	1500	1000
Field of the same hybrid not conforming to varietal purity requirements for certification and from bolsom apple (*Mokho* spp.)	1500	1000
Specific requirements		
Off types in seed parent	0.010	0.050
Off types in pollinator	-	0.050
Male flowers shedding pollens in seed parent	-	0.10
Objectionable weed plants (*Mokha balsammie*, *M. coeninehinensin*)	-	-

Physiological maturation : Yellowing – Bittergourd

Harvesting : Manual

Extraction : Wet extraction

Seed grading : 16/64"

Seed treatment : Bavistin @2g/kg

Seed storage : Long term storage – 700G polythene bag

Seed Standard

Factor	Standards for each class	
	Foundation	**Certified**
Pure seed (Mini)	98	98
Inert matter (max)	2	2
Other crop seeds (max)	None	None
Total weed seeds (max)	None	None
Objectionable weed seed (max)	None	None
Other distinguishable varieties (max)	5/14	10/14
Germination (min)	60	60
Moisture (max)	7%	7%
For vapour proof containers (max)	6%	6%

Exercise No. **Date :**

SEED PRODUCTION IN SEEDLESS WATERMELON

- In watermelon, a triploid hybrid is produced by crossing diploid and tetraploid. The fruits of the triploid hybrid are seedless.
- This triploid hybrid was invented by Khora (1951) of Japan.
- Steps involved are as follows.
- Colehcine 0.2% to 0.4% is sprayed on the growing points of young seedlings at 1 to 2 true leaf stage for 2 to 3 days successively to induce tetraploid (44 chromosome)
- The treatment is given under controlled conditions avoiding direct sunlight.
- The tetraploid plants are characterised by broad thick leaves and bigger pollen grain and at flowering pollen fertility and pollen size are tested.
- The seeds will be broad and bigger.
- Fermentation method of seed extraction is to be avoided and tetraploid should be soaked overnight before sowing.
- The maintenance of tetraploid lines at stable level is important and continuous selections for improvement of quality and vigour in tetraploid line has to be done for atleast 4-5 generations.
- The seeds of diploid are produced in isolation.

Exercise No. **Date :**

HYBRID CUCUMBER SEED PRODUCTION

Hybrid cucumber seed can be produced by hand-pollination. In the USA the gynomonoecious lines are being used for hybrid seed production. These lines produce two kinds of plants, gynoecious (in which all flowers are female) and monoecious (in which male and female flowers occur separately on the same plant). To produce hybrid seed the gynomonoecious line is used as a female parent and planted adjacent to a selected monoecious variety. At about the ten node stage all monoecious and intermediate plants are removed from the gynomonoecious line, leaving the gynoecious plants to bear hybrid seed.

Exercise No. **Date :**

HYBRID SEED PRODUCTION IN COLE CROPS (CABBAGE AND CAULIFLOWER)

Cole Crops : Cabbage, Cauliflower

Botanical Name : *Brassica oleraceae* var. *capitata*
Brassica

Chromosome No. : 2n =

Inflorescence : Umbel

Flowering period :

Type of pollination : Cross pollination (73%)

Anthesis :

Anther Dehiscence :

Pollen fertility :

Stigma receptivity : 2-3 days

Commercial seed production : Biennial, vegetative- bolting - seed.

Tool for hybrid seed production : Self and sib incompatibility and cross incompatibility

Commercial hybrid seed production technique

Types of hybrid produced

Single Cross : The first generation resulting from the controlled crossing of two approved self incompatible put cross compatible inbred lines it may be three types depending upon the procedure of seed production.

- Seeds of only female parent are harvested and certified.
- Seeds of both the parents are harvested separately and certified.
- Seeds of both the parents are harvested together, mixed and certified.

Double cross	:	The first generation resulting from the controlled crossing of two approved self incompatible but cross compatible single cross.
Three-way cross	:	The first generation resulting from controlled crossing of an approved inbred line and certified single cross being self-compatible individually put cross compatible to each other.
Popular hybrids	:	
Cabbage	:	Pusa hybrid -1
Cauliflower	:	Pusa hybrid-2, Pant Gobi 3
Land requirement	:	Shall be free of volunteer plants.

Production practices

Field Standards

Isolation

Seed crop	Contamination	Isolation distance (cm) (FS & CS)
Cabbage, cauliflower, Broccoli, knol khol, chinese cabbage	Other varieties / commercial hybrid of same variety / same variety not confirming to varietal purity	1600
Specific requirements		
Cabbage, cauliflower, Broccoli, knol khol, chinese cabbage	Off types of each parent and after flowering	0.050
	Plants affected by seed borne diseases at final inspection	0.50

No. of inspections	:	Three
1st inspection	:	Before flower stalk development To check isolation, off types out crosses, planting ratio and others.
2nd inspection	:	During flowering To check isolation, off types and other relevant factors.

3rd inspection : Before harvesting
* To check off types, seed borne diseases and other factors.

Seed standards

Factor	**Standard (FS/CS)**
Pure seed (mini)	98
Inert matter (maxi)	2
Other crop seed (maxi)	None
Weed seed (maxi)	None
Germination (mini)	70
Moisture (max)	7.0
Vapour proof containers	5.0

Exercise No. **Date :**

HYBRID SEED PRODUCTION IN ROOT CROPS

Root crops	:	Carrot (*Daucus carota*)
		Beetroot (*Beta vulgaris*)
		Radish (*Raphanus sativas*)
Family	:	Carrot / Beetroot : Umbelliferae
		Radish : Brassicaceae
Type of pollination	:	Cross pollination
Inflorescence	:	Umbel.

Commercial Hybrid seed production technique

System involved	:	Cytoplasmic generic male sterility system (carrot, beetroot, radish)
Season	:	Aug - Sep – Seed sowing Nov – Dec – Steckling transplanting
Isolation	:	Mother root FS & CS : 5 m
Carrot	:	Seed production FS : 1000 m Seed production CS : 800 m
Beetroot	:	Seed production FS : 1600 m Seed production CS : 1000 m
Raddish	:	Seed production FS : 1600 m Seed production CS : 1600 m

Spacing

Carrot	:	45 x 60cm
Beet root	:	60 x 25cm

Fertilizer	FYM : 10-25 ton/ha
Carrot	NPK : 65:40:40 kg ha^{-1}
Beetroot	NPK : 100:50:100 kg ha^{-1}
Raddish	NPK : 200:100:100 kg ha^{-1}

Field standards

Field inspection : Mother root production stage : 2
Seed production stage : 4

Isolation

	Mother root production (FS&CS)	**Seed production FS & CS**	
Carrot : Other varieties	5	1000	800
Fields of same hybrid / not confirming to varietal purity requirement	5	1000	800
Beetroot			
Fields of same hybrid / not confirming to varietal purity requirement	-	1600	1000
Radish			
Fields of same hybrid / not confirming to varietal purity requirement	-	1600	1600
Specific Requirements			
Carrot	**FS**	**CS**	
Root not confirming to varietal character is including forced roots (%)	0.010 (By number)	0.050 (By number)	
Offtypes in seed parent at and after planting.	0.010	0.050%	
Offtypes in pollinator at and after flowering	0.010	0.050%	
Plants of pollen shedding umbels in seed parent at flowering	0.050	0.10%	
Beet root			
Roots of other varieties	0.10% (By number)	0.20% (By number)	
Off types	0.10%	0.20%	
Radish			
Off types in each parent	0.050	0.050	
Plants affected by seed borne diseases	0.50	0.50	

Harvesting Change of seed colour in 2-3 harvests

Seed Standard

	Carrot		Beet root		Radish	
	FS	**CS**	**FS**	**CS**	**FS**	**CS**
Pure seed % (Maximum)	95	95	96	96	98	98
Inert matter % (Maximum)	5	5	4	4	2	2
Other crop seed (max)	5/14	10/14	5/14	10/14	None	Nil
Weed seed (max)	5/14	10/14	5/14	10/14	None	Nil
ODV (max)	5/14	10/14	-	-	-	-
Germination (%) (minimum)	60	60	60	60	70	70
Moisture (max)	8	8	9	9	6	6
For vapour proof containers (max)	7	7	8	8	5	5

INDEX

Exercise No	Date	Topic	Signature

Exercise No. **Date :**

POST HARVEST HANDLING IN HYBRID SEED PRODUCTION

A. Harvesting of seed

1. Advantages on correct method of harvesting :

- ❖ Seed yield will be protected without loss due to shattering.
- ❖ Processing loss will be reduced.
- ❖ Seed storability will be more.

2. Physiological maturation :

The correct stage of harvesting for seed crops is termed as physiological maturation. It can be represented both as duration and visible symptoms.

3. Harvestable maturation : (HM)

- ❖ This is for the population.
- ❖ This will be later to physiological maturation.
- ❖ At this stage, more than 80% of the population will attain physiological maturation hence without economic loss crop can be harvested.

4. Caution on harvesting seed crop :

Harvesting should be done after PM at HM.

5. Method of harvesting :

- ❖ Harvesting of crop can be done either mechanically or manually.
- ❖ Mechanical harvesting can be done only as single or once over harvest.
- ❖ Manual harvesting is done in two methods which is single harvest (or) periodical harvest.

6. Specialty with hybrid seed production in harvesting :

- ❖ Male should be harvested first and to be removed from the field before the harvest of female parent.
- ❖ Female should be harvested separately and brought to separate threshing floor.

B. Grading and upgrading of seeds

1. Seed grading :

- ❖ It is done after threshing and before seed treatment in any seed production cycle.
- ❖ Grading is homogenation of a seed lot based on any one of the morphological characters of seed. Morphological characters used for grading are size, weight, colour, shape and surface texture.

2. Size grading :

- ❖ The seeds are initially graded based on size to bring uniformity in seed lot. It is also termed as basic grading.
- ❖ For size grading different sieves of uniform role size are used.
- ❖ For size grading the seeds, two different systems are used *viz.,* American System (AST) and British System (BSS).

3. Grading based on weight :

- ❖ Based on weight also seeds are being graded.
- ❖ It can be done either using water (Based the efficiency of buoyancy of seed to float due to the difference in seed weight). Using machine known as specific gravity separator.

  Eg. 1. Paddy - upgrading technology

  2. Marigold, Casuarina, Mild organic solvents used for specific gravity grading. Eg. Acetone.

4. Grading based on colour :

- ❖ It can be done either manually or mechanically.
- ❖ The machine used for colour grading is electronic colour sorter.

5. Grading based on shape :

Based on seed shape it can be graded. Seed shape vary as oblong, rectangular, round, triangular, square, hexagond.

6. Grading based on surface texture :

In processing magnetic separator is used for separating lucerne seed from dodder seed with corrugated surface texture.

7. Upgrading of seeds :

Upgrading additional grading for further seed quality improvement.

8. Some of the machinaries used in processing unit :

- ❖ Specific gravity separator - For grading seeds based on weight
- ❖ Indented cylinder - For grading seeds based on shape
- ❖ Electronic colour sorter - For separation of seed based on colour
- ❖ Magnetic separator - For separation seeds based on surface texture

9. Other machines based on specificity :

Sl. No.	Machine	Usage	Crop
1	Pod grader	Grading based on size	Groundnut
2	Ginner	Removal of fuzz form seed	Cotton
3	Delinting	Removal of lint from seed	Cotton
4	Tomato pulper	Pulping of fruits	Tomato

10. Grading of seed in relation to hybrid seed production

Normally grading sieve size will not be vary with parental lines / hybrid. If it varies each genotypes should be graded with the specified sieves recommended.

C. Packing material for seeds

Packing materials classified into 3 based on their relation with moisture.

1. Moisture pervious container.
2. Moisture resistant container
3. Moisture vapour proof containers.

What is moisture transmission :

When a seed is kept in an atmosphere, since both are having moisture, the transmission of moisture from one to another will happen till they attain uniformity in

moisture which is known as moisture equilibrium status.

For long term storage seeds are to be stored in moisture vapour proof containers.

Short term storage moisture previous containers are used.

Packing material for hybrid seed

Seeds of parental lines of hybrid are highly costlier. Hence it is preferable to pack in moisture vapour proof containers and keep them under a cool condition (> 5^0C).

D. Storability of hybrid seed

The storability of hybrid seeds normally will vary with parental lines. The female parents are usually poor storers than the male parent. The male parents are good storers while the maintainer lines are medium in storability. Hence the caution should be given to store the female line in seed storage conditions.