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College of Horticulture, Dapoli

Practical Manual

Seed Production of Vegetable, Tuber and Spice Crops

Semester : VI (New) **Course No. : H/VS-367**

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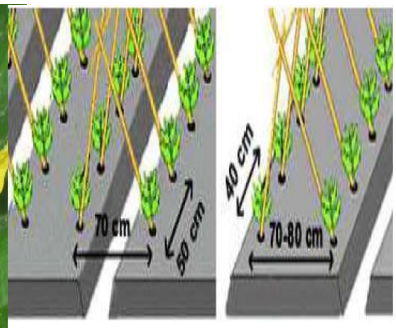
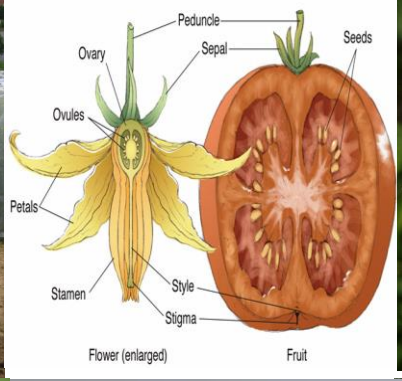
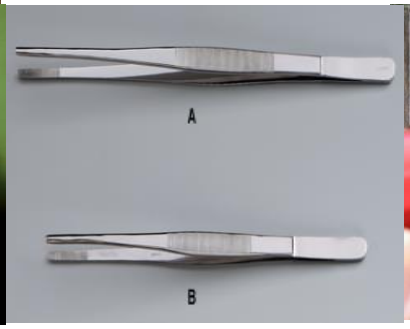






DR. BALASAHEB SAWANT KONKAN KRISHI VIDYAPEETH

COLLEGE OF HORTICULTURE, DAPOLI

PRACTICAL MANUAL

SEED PRODUCTION OF VEGETABLE, TUBER AND SPICE CROPS

COURSE NO:H/VS-367 **CREDITS: 2+1=3**

INDEX

CERTIFICATE

This is to certify that Mr./ Miss. _____, Registration No. _____ student of VIth(New) semester, has successfully completed the Practical exercises in the H/VS-367 "SEED PRODUCTION OF VEGETABLE, TUBER AND SPICE CROPS" during the academic year 2021-2022.

Place: Dapoli

Date: **Course Teacher**

EXERCISE NO : 1 **Date:**

STUDY OF SEED STRUCTURES, SIZE AND SHAPES

Seeds are the basic unit of identification of crop species and cultivars can be distinguished from one another either by morphological or physiological or biochemical characteristics and these characteristics are to be reproducible on repeated cultivation under normal agro climatic conditions for maintenance of seed quality in terms of genetic purity. Genetic purity is the trueness of the cultivar where it should be reproduced or resembles its mother in all characters. Botanically seed is defined as a ripened ovule containing an embryo in arrested state of development usually with a food reserve and a protective coat. In seed technological term, the part of a plant used for sowing to raise the crop or any propagative material is known as seed.

Morphological features of seed

The morphological features of seed are associated with physical characteristics and presence or absence of any appendages. Irrespective of seed/species, most common features useful in identification are shape, base of lemma, rachilla hairs, deviation of lateral/dorsal nerves, wrinkling of lemma and palea, shape and hairiness of lodicules etc., in monocots. In dicots, shape, surface texture, micropyle region, hilum, raphe and seed coat characteristics are highly useful in identification of species. In some crops certain special structures serve as identifying characters. But in all species, seed colour and shape serve as eminent characters of seed identification. Some prominent identifying characters in crop seeds/ varieties are as follows.

Seed size

Seeds can be identified based on the length, width and thickness.

Shape

It is one of the main diagnostic characters of seed. The seeds may be globose or sub-globose or oblong or round or flat or rectangular, square, elliptic, etc.,

Seed weight

Seed weight is indicated as the number of seeds per unit weight like gram or kilogram or weight of 1000 seeds. Seed weight often varies considerably within species because of genetic characters. But is should not be mistaken with the special variations due to the environmental conditions and fertility status of soil.

Surface texture

Seed surface varies from very smooth and glossy to rough and fibrous. Botanical terms applied to the seed surface are smooth, glabrous, wrinkled, ribbed, punctuate, reticulate, pulp, tomentose and hairy.

External structures

Seed coat

It is the outer covering of seed which gives protection. It is developed from the two integuments of ovule. The outer layer of seed coat which is smooth and rough is known as tests and it is formed from outer integument. The inner layer of seed coat is called as Tegmen and is formed from inner integument.

Pericarp

The body of a fruit developed from the ovary wall and enclosing the seed

Raphe

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

Micropyle

The point where the integuments meet at nuclear apex.

Hilum

It is the scar left on the seed where it was formerly attached to the funicle or placenta.

Caruncle

White spongy outgrowth of the micropyle seen near the hilum of seed. Eg. Castor, tapioca

Appendages

External attachments on the seed that favours dispersal of seeds or in identification of genotypes.

Aril

Coloured fleshy mass present on the outside of the seed

a. Awn: Thread like projection at the tip of seed. Eg. Paddy

b. Aril: Eg. Nutmeg

c. Caruncle: Eg. Castor, Tapioca

d. Hairs: Minute thread like appendages present on the surface of the seed. Eg. Cotton, Tomato

e. Wings: It is the papery structure attached to the side of the seed coat either to a specific side or to all sides. Eg. Moringa

Internal features

Embryo

It is a miniature plant consisting of plumule, radicle and cotyledon (embryonic axis + cotyledon). Plumule + radicle without cotyledon are known as primary axis.

Endosperm

Storage tissue of the seeds which are formed by fusion of pollen cell or sperm nuclei with polar nuclei. It is triploid in nature and non-viable.

Cotyledon

It is the storage tissue of dicots and is a part of the embryo. It is viable.

Scutellum

It is the cotyledon of monocot seeds. It is viable

Coleoptyle

It is the covering tissue of miniature plumule, the shoot portion in monocots.

Coleorhiza

It is the covering tissue of radicle, the root portion in monocots.

Plumule

It is a miniature part of shoot region seen both in docots and monocots.

Radicle

Miniature part of root region.

Hypocotyl

Part of seedling which is below the cotyledon and above the radicle.

Perisperm

It is an unutilized part of the nuclear region which is normally visible as a papery growth outside the endosperm and inside the seed coat.

Epicotyl

Part of seedling above the cotyledon and below the primary leaf of seed

Parts of seedling

a) Root- Part seen below the soil surface

b) Shoot- Part seen above the soil surface

c) Cotyledonary leaf- In dicots, it is the first leaf developing from the seed which gives food to the growing seedlings.

d) Primary leaves- First formed true leaves of plumule, seen in between two cotyledonary leaves. The seedling will be auto tropic after formation of leaves as photosynthesis starts after this stage.

EXERCISE NO : 2 **Date:**

OBJECTIVES AND PRACTICES OF FIELD INSPECTIONS

Field inspection

The primary objective of conducting field inspection is to verity the factors which can cause irreversible damage to seed quality by causing genetic and physical contamination.

The objective of field inspection is to verify the following factors:

1. Cropping history
2. Seed source
3. Unit of seed certification
4. Isolation distance
5. Genetic and physical contaminants
6. Border rows

1. Cropping history of seed field

The seeds left scattered in the field from the last crop may cause genetic or physical contamination of the seed crop by volunteer plants. Hence in the previous year or season the same crop of lower standard should not have been grown. The volunteer plants should be destroyed by irrigation and subsequent ploughing, just before sowing or planting.

2. Seed source

Source of seed of the seed crop should be approved and should satisfy the specific requirement of purity. It is verified by checking the certification tag of the source seed used for sowing

3. Unit of seed certification

One unit shall consist of 10 hectares of seed farm. However

i. Seed fields should be separated by not more than 50 meters

ii. Planting dates do not differ by more than 7 days

iii. Seed crop is of same variety and class

4. Isolation distance

It is distance provided to separate the seed crop from all possible sources of contamination during the growing period. Sources of contamination may be

- **i.** Cross pollination from different cultivars
- **ii.** Transmission of designated diseases or
- **iii.** Mechanical admixture from adjacent crop during harvest.

5. Genetic and physical contaminants

Proper rouging of physical and genetic contaminants must have been performed so as to confirm to the prescribed Minimum Seed Certification Standard (MSCS). Necessary guidance should be given to the farmers at each stage of field inspection.

6. Border rows

In hybrid seed production field, border rows are used to provide enough pollen and it absorbs foreign pollen thus avoiding contamination of main seed crop. Besides, the planting ratio between male and female parents is also confirmed. Rouging space should also be verified wherever applicable.

Stages and number of field inspection

The number of field inspections and the stages of crop growth at which the field inspection should be conducted vary from crop to crop. It depends upon duration, and nature of pollination of the seed crop. If the crop is grown for hybrid seed production, the no. of field inspections during the flowering stage should be more than in the case of self-pollinated / cross / often cross pollinated varieties. In the vegetatively or asexually propagated crops such as potato they are classified as sprouting seedlings, tuberization, tuber hardening, and haulm cutting stages. The root and bulb crops, inspection at lifting and replanting stage is essential. In cauliflower, the stages comprises are curd formation and bolting and in knol-khol, it is knob formation and bolting and in cabbage it is head formation and bolting. In cross – pollinated crops inspections during flowering are essential to verify free from genetic contamination. In self-pollinated crops inspection during flowering may help to distinguish off-types. Inspections of cross – pollinated crops at flowering stage must be made without prior intimation to the grower. For self- pollinated crops, vegetatively propagated crops and for lifting and replanting inspection in root and bulb crops advance intimation can help to reduce the number of inspections.

SN	Stage of crop	Key points to be observed at inspection
1.	Pre flowering	a. Verification of seed source b. Confirmation of acreage given in the report c. Land requirement to keep check on genetic as well physical contamination and spread of disease inoculum d. Planting ratio e. Border rows f. Isolation distance g. Guide the grower in identification of off-types, pollen shedder, diseased plants, shedding tassels, etc.

2.	Flowering stage (May be IInd and IIIrd inspections when 5% of plants begin to flower)	a. Confirm the observation of plants inspection were correct b. Confirm whether grower had continued thorough roughing after the previous inspection. c. Verify the removal and occurrence of off-types, pollen shedders, shedding tassels, objectionable weed plants and diseased plants.
3.	Inspection during post flowering and pre harvesting stage	a. Confirm the correctness of observations, made in earlier inspections b. Guide the grower on roughing based on pods, ear head, seed and chaff characters, colour, shape and size c. Explain to the grower when and how to harvest the crop and process
4.	Inspection during harvest (this is the last inspection conducted on a seed crops)	a. Verify that male parent rows have been harvested separately. b. Ensure complete removal of off-types, other crops, weeds and diseased plants etc. c. Seal properly by the certification agency of the threshed produce after initial cleaning & drying d. Instruct the seed growers for safe storage & transporation

Minimum number of field inspections and stages

Crop	**Min. no. of inspections**	**Stages of crop**
Tomato, brinjal, chilli, bhendi, cucurbits, watermelon, melons, cucumber, celery, variety	3	1st before flowering, 2nd during flowering and fruiting stage and 3rd during mature fruit stage and prior to harvesting
Tomato, brinjal, cucurbits, watermelon, cucumber, hybrids	4	1st before flowering, 2nd and 3rd during flowering and fruiting stage and 4th at mature fruit stage and prior to harvesting
Amaranth and fenugreek	2	1st before flowering and 2nd during flowering
Lettuce	3	1st before heads (heading type) before full grown stage (non-heading type), 2nd during heads formed stage and full grown stage and 3rd during flowering stage
Cabbage and cauliflower	3	1st before marketable stage, 2nd when heads have formed and 3rd at flowering stage
Knoll-kohl	3	1st before marketable stage of knobs, 2nd when

		knobs have formed and 3rd at flowering stage
Cabbage, cauliflower, knoll-kohl, single cross	3	1st before flower stalk development, 2nd during flowering and 3rd at maturity and prior to harvest
Onion var. and hybrids bulb production	2	1st after transplanting of seedlings, 2nd after bulb have been lifted
Seed production	4	1st before flowering, 2nd and 3rd during flowering, 4th at the stage of maturity
Carrot var. and hybrids Root production	2	1st after 20-30 days of the sowing and 2nd after mother root have been lifted.
Seed production	4	1st before flowering, 2nd and 3rd during flowering, 4th at the stag of maturity
Beet root		
Root production	2	1st after 20-30 days of the sowing and 2nd after roots have been lifted
Seed production	2	1st before flowering and 2nd during flowering
Radish and turnip		
Root production	2	1st after 20-30 days of the sowing and 2nd roots have been lifted
Seed production	1	1st during flowering
Radish & turnip – foundation single crosses and hybrids	3	1st before flowering, 2nd during flowering and 3rd at maturity and prior to harvesting
Potato – tuber	4	1st 45 days after planting in the hills and
production		35 days in the plains, 2nd 60-65 DAP for early var. and 70-75 DAP for late var., 3rd immediately after haulms cut / destruction and 4th 10 days after haulms cutting / destruction and before harvesting
True – tuber production	4	1st before flowering, 2nd and 3rd during flowering and 4th during harvesting

FIELD COUNTING PROCEDURES

Field counts

The purpose of field inspection is to find out the field standards of various factors in the seed form. It is impossible to examine all the plants in the seed farm. Hence, to assess the filed standards of various factors random counting is followed. Which in the field sampling of analyzing the genetic purity and health status of the crop. The number of counts taken and the method employed in taking counts vary from crop to crop. Five counts are taken for an area of up to 5 acres (2 ha) and an additional count is taken for every additional 5 acres (2 ha)

Double count

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

Number of plants for a count

Some plants are planted at a narrow or wide spacing. Thus the number of plants comprising a single count differs from crop to crop as given below

SN	No. of plants for a count Crop	No. of plants/heads per count
1.	Beans, cluster beans, cowpea, greengram, blackgram, Mustard, seasame, bengalgram, safflower, niger	500 plants
2.	Bhendi, brinjal, chilli, castor, cole crops, cotton, cucurbits, Groundnut, maize, potato, red gram, tomato and sunflower	100 plants

Points to be observed before counting

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

Contaminants to be observed

I. Physical contaminants

1. Inseparable other crop plants
2. Objectionable weed plants volunteer plants
3. Diseased plants

II. Genetic contaminants

1. Off-types
2. Pollen shedders / partials
3. Shedding tassels

a. Off-type

Off types are plants that differ in morphological characters from the rest of the population of a crop variety. Off-type may belong to same sp or different species of a given variety. Plants of a different variety are also included under off – types. Volunteer plants of same species and mutants are also off types

b. Volunteer plant

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

c. Pollen shedders

In hybrid seed production involving male sterility, the plants of 'B' line present in 'A' line are called pollen shedders. Sometimes 'A' tends to exhiit symptoms of fertile anthers in the ear heads of either on the main tiller or side tiller and these are called partials. These partials are also counted as pollen shedders.

d. Shedding tassels

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

e. Inseparable crop plants

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

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

f. Objectionable weed plants

These are weeds, whose seeds are difficult to be separated once mixed, poisonous, difficult to eradicate, separate and causes mechanical admixtures. The following are objectionable weed plants in vegetables.

Bhendi	: Wild okra
Bitter gourd var. hybrids	: Balsam apple
Cucumber	: Cucumsis hardwickii
Long melon	: Weed melong
Musk melon	: C. prophekarum
Snake gourd	: Trichosanthes palmate, T. Lobata
Water melon	: Wild water melon
Amaranth	: Wild amaranth
Fenugreek	: Senji

Lettuce : Wild lettuce

i. Designated diseases in vegetables

Seeds are known carriers of harmful pathogens internally or externally or by both causing diseases which make a seed lot unfit for use. During field inspection symptoms of these designated diseases should be observed and counted during vegetative, flowering and maturity stages as indicated in IMSCS. The list of designated diseases in vegetable crops is given below.

Tomato	: Early blight
Brinjal	: Phomopsis blight
Chillie	: Leaf blight, anthracnose ripe rot
Musk melon	: Cucumber mosaic virus
Multiple onion	: Bacterial brown rot (*Pseudomonas aerugnioba)* bacterial soft rot (*Erwinia carotovota),* basal rot (*Fusarium oxysporum)*
Potato (seed)	: Mild mosaic (3%), server mosaic, leaf roll and yellw (1%); brown rot (*Pseudomonas aerugnioba)* 3 plants ha-1
Celery	: Leaf blight (septoria appicola); root rot (Phoma apiicola)
Lettuce	: lettuce mosaic virus
Cabbage	: Black leg (*Leptosphaeria maculans)*
Cauliflower	: Black rot (*Erwinia carotovora)*
Know – khol	: Soft rot (*Erwinia carotovora)*
Radish	: Black leg, black rot
Potato	: Mild mosaic (1-3%); severe mosaic, leaf roll and yellows (0.5-1.0%); total virus (1-3%); brown rot (*Pseudomonas solanaceous)* seed tubers showing visible symptoms of late blight (*Phytophthora infestans),* dry rot (*Fusarium caeniteum)* or charcoal rot (*Macrophomnia phaseoli) (1%), wet rot (*Sclerotium rolfsii) nil; common scab (*Streptomyces scabies) – 3-5%; black scurf (*Rhizoctonia solani*) – 5%; total diseases – 5%.

EXERCISE NO : 3 **Date:**

OBJECTIVES AND PRACTICES IN ROUGING

Roguing

The existence of off type plant, i.e. plants differing in their characteristics from those of the seed variety is another potent source of genetic contamination. Adequate and timely rouging is extremely important in seed production. The number of roguing are necessary will vary with the crop, clean-ness of the plantings seed and stages of the multiplication of the seed crop. There are three sources.

1. Off types may arise due to presence of some recessive genes in heterozygous condition at time of release of varieties due to mutation.
2. Presence of volunteer plants arising from accidently planted seed or from seed produced by earlier crops.
3. Mechanical mixture

Off types individual plants should be rogued out of seed production fields at 3 different stages.

1. **Vegetative/pre-flowering /early**

As per morphological features of particular cultivars rouging is to be done. The rouging at vegetative stage in cross pollinated crops is extremely important to avoid genetic contamination.

2. **Flowering /mid late**

The rouging at flowering stage is equally important, perhaps even more important than vegetative stage the undesirable plants not distinguishable earlier, should be removed soon after the emergence of ear heads in order to avoid contamination. Here also rouging of particular cultivar is to be done at conversion stage from vegetative to reproductive phase.

3. **Maturity/late**

It is to be done from flowering to harvesting but before harvesting. In cucurbits, vine habit, fruit shape, fruit colour, flowers colour. In fruit vegetable as per shape, size colour of the fruit as per growth habit of plant. Flower colour, shape, shape of bulb, root types, core colour, pungency etc. in root and leafy vegetable crops rouging at harvest time for confirmation of fruit tuber/root characteristics is necessary.

Presence of other crop plants

Seed production plot should be under sole cropping. Some crop plant is designated as inseparable crop plant for specific crop.

Presence of objectionable weed

Weed plants designated as objectionable for associated crop should be removed from the seed plot before flowering.

Table 1: Presence of Objectionable Weed

Sr. no.	Crop	Weed	Foundation seed	Certified seed
1	Bitter gourd	Balsam apple, jangali karela	0.00	0.00
2	Cucumber	***C. hardwickii***	0.00	0.00
3	Muskmelon	*C. prophrtarum*, weed melon and other desert forms	0.00	0.00
4	Okra	wild okra	0.00	0.00
5	Fenugreek	Senji (*Melilotus spp*)	0.01	0.02
6	Watermelon	Wild water melon	0.00	0.00
7	Amaranthus	Wild amarathus	0.01	0.02

Presence of seed-borne diseases

Different crops have designated and specified seed borne diseases objectionable at fields level. Certification standard for infection of downy mildew in vegetable crops is verified at each inspection.

Table : Presence of seed-borne diseases

Sr. no.	Crops	Disease	Maximum inspection (%)	
			Foundation seed	Certified seed
1	Tomato	Early blight, leaf spot , tobacco mosaic, *stemphilium leaf blight*	0.1	0.5
2	Chilli	*Alterneria* leaf blight and anthracnose	0.1	0.5
3	Brinjal	Phomopsis fruits blights	0.1	0.5
4	Cowpea	*Macrophomia* ashy stem blight, mosaic and bacterial blight	0.1	0.2
5	Frenchbean	Anthracnose, ascochyte blight mosaic and bacterial blight	0.1	0.2
6	Cabbage, Cauliflower, Knol khol	Black leg, bacterial black and *Erwinia* soft rot	0.1	0.5
7	Lettuce	Lettuce mosaic	0.1	0.5
8	Muskmelon	Cucumber mosaic	0.1	0.2

9	Potato	Mild mosaic, leaf roll, brown rot	1.0	2.0

Presence of objectionable insect pest

Some crops plants have designated objectionable insect pest at field stage which should be verified during the field inspection at any stage.

Number of field inspection

Minimum 2 and maximum 4 field inspections are standardised for the certification. At least one minimum at flowering stage is recommended to observe off types, rogue out objectionable disease.

Table: Number of field inspection and stages of field inspection

Sr. no.	Crop	No. of field inspection	Stages of inspection
1	Radish and Turnip	1	During flowering
2	Cowpea	2	1st before flowering 2nd from flowering to harvest
3	Fenugreek, spinach and Amaranthus	2	Before and at the time of harvest
4	Pointed gourd and Little gourd	2	1st after transplanting 2nd before cutting of planting stock
5	Garlic	2	1st when plants are well developed 2nd when leaves begin to fall and before lifting of bulb
6	Brinjal, okra, tomato, chilli, capsicum, cucurbits and parsley.	3	1st before flowering 2nd during flowering 3rd at maturity prior to harvesting
7	Cole crops (Cabbage, cauliflower, Sprouting broccoli, Brussels sprout, Knol-knol)	3	1st before marketable stage 2nd at marketable stage 3rd at flowering
8	Sugar beet, Garden beet	2	1st after transplanting 2nd after lifting of beet
9	Potato	4	1st 35-45 days after planting 2nd 60-75 days after planting 3rd immediately after haulm cutting 4th 10 days after haulm cutting
10	Carrot and Onion	4	1st before flowering 2nd during flowering 3rd during flowering 4th at maturity
11	Asparagus	3	1st at crowning 2nd during flowering 3rd at maturity
12	Sweet Potato	2	1st at nursery 2nd shortly after transplanting

Isolation distance

To avoid cross pollination a minimum isolation distance between different cultivars of the same crop and cross compatible species should be maintained as seed certification standards.

Table: Isolation distance (Meter)

Sr. no.	Name of group or crops	Isolation distance (m)	
		Foundation seed	**Certified seed**
A. Cole crops			
1	Cabbage	1600	1000
2	Cauliflower	1600	1000
3	Chinese cabbage	1600	1000
4	Knol-knol	1600	1000
B. Fruit vegetables			
5	Brinjal	200	100
6	Capsicum or chili	400	200
7	Tomato	50	25
8	Okra	400	200
C. Bulbous vegetables			
9	Garlic	10	5
10	Onion	1000	500
D. Roots vegetables			
11	Beetroot	1600	800
12	Carrot	1000	800
13	Radish	1600	1000
14	Turnip	1600	1000
E. Tuber vegetables			
15	Sweet potato	10	5
16	Potato	10	5
F. Legume vegetable			
17	Cluster bean	50	25
18	Cowpea	50	25
19	French bean	50	25
20	Indian bean	50	25
21	Lima bean	50	25
22	Peas	10	5
G. Leafy vegetables			
23	Amaranths	400	200
24	Beet leaf	1600	1000
25	Coriander	800	400
26	Fenugreek	50	25
27	Lettuce	-	-
28	Spinach	1600	1000
29	Cucurbits (All crops)	1000	500

EXERCISE NO : 4 **Date:**

SEED SAMPLING TECHNIQUES AND TYPES OF SEED SAMPLES

Methods and Types of Sampling

Objectives :

1. Sampling is done to get a uniform and representative sample from a seed lot. The size of the submitted sample required for testing is small as compared to the size of the lot, therefore, care must be taken to ensure that the submitted sample represents the lot of the seed to be tested.

2. Hence it is essential that the samples be prepared in accordance to ISTA rules to ensure that the small size sample should represent truly and in the same proportion all constituents of seed lot.

Definition of samples :

The seed lots received by laboratory for analysis and testing are given an accession number of each variety for future reference.

A seed lot to be sampled must not be heterogeneous i.e. the primary samples drawn from the lot should be similar in constitution. If there is any evidence of heterogeneity test of the primary samples drawn, as defined by ISTA rules, further sampling and testing from the seed lot should not be continued.

Seed lot :

Seed lot is a specified quantity of the seed of one cultivar of known origin as physically identifiable.

Principles of sampling :

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

Methods of sampling -

a. Hand sampling :

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

b. Sampling with triers :

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

1. **Bin samplers :**

Used for drawing samples from the lots stored in the bins

2. **Nobbe trier :**

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

3. Sleeve type triers or stick triers

It is the most commonly used trier for sampling:

There are two types viz.,

1. With compartments
2. Without compartments.

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

This trier may be used horizontally or vertically. This is diagonally inserted at an angle of 30^0 in the closed position till it reaches the centre of the bag. Then the slots are opened by giving a half turn in clockwise direction and gently agitated with inward push and jerk, so that the seeds will fill each compartment through the openings from different layers of the bag, then it is again closed and with drawn and emptied in a plastic bucket. This trier is used for drawing seed samples from the seed lots packed in bags or in containers.

Types of samples

1. Primary sample

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

2. Composite sample

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

3. Submitted sample

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

4. Working sample

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

EXERCISE NO : 5 **Date :**

SEED TESTING TECHNIQUES FOR DETERMINATION OF PERCENT GERMINATION, VIABILITY, PURITY.

Germination is the awaking of the dormant embryo in mature angiospermic seeds. Embryo lies in the dormant stage. When physiological activities are ceased. As soon as favourable conditions are available dormancy is broken and germinating begins, thus it is resumption of active growth of the embryo after a period of dormancy.

Changes during germination:

1. Swelling of seed due to imbibition i.e. water is absorbed through cell wall by diffusion and osmosis,
2. Bursting of seed coat due to swelling.
3. Dilution of stored food material within seed.
4. Initiation and activation of physiological activities such as respiration & secretion of enzymes,
5. Digestion of complex insoluble food reserves to soluble forms by enzymatic activities.
6. Assimilation of these soluble food material at meristemic area to provide energy for cellular activity & growth.
7. Emergence of radicle and plumule through seed coat.
8. Growth of seedling by process of cell division, enlargement & differentiation at growing point.

When seed placed in soil gets favourable conditions, radicle grow vigorously and comes out through micropyle and fixes seed in the soil. Then either hypocotyl or epicotyl beings to grow.

Essential structure of seedling -

1. The root :

The first root of germinating seedling mostly in dicotyledons is primary root. It is commonly white, slender & elongates rapidly. Later on, numerous root hairs are usually produced to this primary root. At later stage, secondary roots are produced as either lateral from the primary root itself or as adventitious roots emerging from other parts (i.e. hypocotyls) of seedling. In monocotyledons, the primary root does not survive long and replaced by secondary roots or seminal roots e.g. *Gramineae* and does not produce lateral roots. Main function of root systems are to anchor the plant in soil, to absorb water and dissolved salts and to conduct these to cotyledons and the shoot.

2. Cotyledon :

Cotyledons from the part of embryo within seed. They act as photosynthetic organs in epigeal germination. Mostly they provide nutrients (which were either stored or photosynthesized

by them) to seedling. In monocotyledons, it is divided into two isolated parts with different functions such as the shield shaped scutellum for the absorption of stored food and the sheath like coleoptile which protects the shoot apex (while emerging through soil) and coleorhiza which protects root apex (while growing into soil).

3**. Hypocotyl :**

The part of seedling axis immediately above the primary root & up to the point of attachment of cotyledons is called hypocotyl. In epigeal germination, the hypocotyls elongates & bring cotyledons above the soil.

4. Epicotyl:

The part of seedling axis between point of attachment of cotyledons and that of first foliage leaf (or pair of leaves) is known as epicotyl. In hypogeal germination, it elongates & brings the shoot with 1st foliage leaves into the light above the soil surface.

5. Shoot apex:

The upper end of seedling axis is called the shoot apex. This main shoot growing point consists apical meristem and leaf initials. The developing leaves envelop it and from terminal bud.

Types of Germination -

1. **Hypogeal germination** :

When cotyledons remain below soil surface due to rapid elongation of epicotyl (portion of embryo above cotyledons) then it is termed as hypogeal germination. It occurs with the majority of monocotyledons (e.g. *Gramineae*), some large seeded legumes (eg. Pea, Bean, gram) and some trees like Mango, Jack fruit, Coconut & Arecanut.

2. Epigeal germination :

When cotyledons pushed above soil surface due to rapid elongation of hypocotyls (portion of embryo below cotyledons), then it is termed as epigeal germination. It is mostly observed in horticultural & woody plant species eg. Cotton, Cucumber, Castor, Sunflower, Groundnut, Guar, Gourds andFrench bean.

3. Vivipary :

Germination of seed inside the fruit attached to the mother plant (which also nourishes the seedling at intial stages just after germination) is known as 'Vivipary and it is observed in many plants which grows along sea coasts e.g. Mangrooves and also in agaves (e.g. bubils). When radicle of such seedling elongates, swells in lower part and gets stouter, it separates from parent plant also due to increase in weight and falls on ground vertically in such a way that the radicle goes into soft mud and the plumule remain above the soil level.

Pre-harvest sprouting:

sprouting of seed due to high moisture on the matured plants standing on the field is known as pre harvest sprouting and it is different than vivipary. e.g. Groundnut, Bajra.

Hypo-epigeal germination: A dicot species leaves one cotyledon beneath the soil as hypogeal germination while the other cotyledon comes out above soil as epigeal germination, e.g. *Paperomia peruviana*.

Factors affecting germination -

Following factors are essential for normal germination of seed.

A) External -

1. Water (Moisture) : It enables the resumption of physiological activities, swelling of seed, due to absorption of moisture and causes bursting of seed coat and softening the tissue due to which embryo awake and resumes its growth.

2. Temperature : A suitable temperature is necessary for proper germination. Germination of seed does not take place beyond certain minimum and maximum temperature i.e. 0°C and above 50°C, optimum temperature range for satisfactory germination of seed is 25 to 30°C.

3. Oxygen : It is essential during germination for respiration and other physiological activities which are vigorous during the processes.

4. Light : It is not considered as essential for germination and it takes place without light. The seedling grow more vigorously during darkness rather in light. However, for survival of germinating seedling, light is quite essential Germination of *Nicotiana tabacum*, *Sorghum helapense*, *Cynadon dactylon* and *Chloris gayana* need light but it is essential for lettuce, while jowar. Bajra, pea and bean are neutral in the requirement of jowar for germination.

5. Substratum : Substratum is the medium used for germinating seeds in the laboratory. It may be absorbant paper (blotting paper, towel paper, tissue paper) soil and sand, Substratum should be free from toxic substances. It should not act as a medium for growth of micro organism.

B) Internal -

1. Food and auxin : Embryo feeds on the stored food material until young seedling prepare its own food. Auxins are the growth promoters hence quite essential during the germination.

2. Viability : All seeds remain viable for certain definite period of time and thereafter embryo becomes dead. It depends on maturity of seed, storage conditions vigour and presents and type of species. Generally, it is for 3 to 5 years and they remain for more than 200 years also as in lotus.

3. Dormancy : It is failure of mature viable seed to germinate under favourable conditions of moisture. Many seeds do not germinate immediately after their harvest, they require rest period for certain physiological activities.

Experiment :

Objects: To show the effect of external factors on germination of seed.

Materials:Bean seeds, wooden rod/piece glass beaker water bins etc.

Procedure: 1. Take three dry bean seeds and fix them on wooden rod.

2. Keep the wooden rod in a beaker in slanting position and fill the beaker with water till it touches the middle seed.

3. Keep the beaker in a warm place and observe the germination of seeds after 5 to 6 days.

Observations: 1. The seed touching the water only germinate.

2. The seed in air and water fail to germinate.

Conclusion: 1.The seed receiving sufficient moisture, air and temperature germinates.

2. Others do not germinate due to lack of air, moisture or temperature.

Home work:

1. Draw neat diagram, of Parts of seedling

2. Draw figures of types of seed germination

GERMINATION TEST-DIFFERENT METHODS OF GERMINATION

Germination in laboratory test is the emergence and development from the seed embryo of these essential structures which for the kind of seed being tested indicate ability to develop into a normal plant under favourable conditions in the soil.

Objectives:

1) To provide information on field planting value of seed lot from working seed sample, i.e. to evaluate capability of emergence and development of seed embryo into essential structures of normal seedling i.e radicle, plumule, cotyledons, epicotyl, hypocotyls, shoot apex.

2) To compare per cent value of normal seedlings with prescribed germination percentages of ISTA.

Materials:

1) Working seed sample (400 pure seeds separated during physical purity test).

2) Seed counter.

3) Germination papers such as filter / towel /-blotting/crape kraft papers Or sand / soil to be used as substratum for germination as per methods.

4) Germinators with thermometers: For germination of seeds under controlled (temperature, light, relative humidity and oxygen) conditions within specified period.

5) Other materials such as petriplates with lids & cotton wool, germination boxes with sand/silica, wax paper & rubber bands as per germination methods.

6) Red pencil, forceps, magnifying lens.

Methods of Germination Testing: At least four hundred seeds should be tested for germination. Seed selected for germination should be from submitted sample and should be counted without discrimination as to size or appearance, by hand, counting board or by vacuum seed counter

1. Top of Paper (T.P.) Method: In this method seeds are germinated on top of one or more layers of paper which are placed either in enclosed transparent petridishes or boxes and are kept in Jacobson type germinators. In Jacobson apparatus, each replication is covered with bell jar having opening in the top for ventilation. Moisture is continuously supplied to paper by wick, lower part of which rests in water. In room type germinators relative humidity must be maintained to the saturation. Moistened porous paper or absorbant cotton can be used as a base for paper or even as an immediate substratum.

2. Between Paper Method (B.P.): The seeds are germinated between two layers of germination paper which are placed directly on germination trays in cabinet or room type germinator or in metal, plastic or glass boxes, In former method relative humidity in the cabinet or room should be maintained to the saturation. The paper can be folded or rolled and placed in flat or an upright position metal glass or plastic frames can be inserted between papers to ensure ventilation.

Moistened porous paper or absorbant cotton can be used as base for the paper or even immediate substratum.However, paper should not be too wet to form water film if pressed with finger.

3. Germination in sand: Seeds are either planted in uniform layer of moist sand and then covered with loose sand 1 to 3 cm deep or seeds are pressed into the surface of the sand. Amount of water to be added depends on type of sand e.g. cereals except maize may be germinated to 50 per cent of its water holding capacity while large seeded legumes and others to 60 per cent.

4. Germination in soil: Soil or artificial compost is used instead of sand. This method is used to confirm the evaluation of seedlings, in doubtful cases and testing samples

which produce seedlings with phototoxic symptoms when germimited on per or sand Soil should be kept wet

Procedure for germination Test:

I. Germination of Towel Paper:

1 Take rectangular germination paper (Crape craft paper) and soak it in water remove excess water

2. Put it an polythene paper slightly bigger than germination paper

3. Place seeds of given sample on germination paper with the help of counting board in four replications of 100 seeds each,

4. Cover the seeds with another moist germination paper and roll along with polythene paper and tie both ends of roll by rubber bands.

5. Keep such rolls in germinator having appropriate constant temperature.

6. Take the count of seedlings on the prescribed day and report the percentage of normal, abnormal, dead, hard and fresh ungerminated seeds.

II. Germination in Petri-dish

1. Take germination paper (blotting) and prepare round pieces as per inner diameter of dishes.

2. Place cotton wool at the bottom of dish and cover the piece of blotting paper, add water till paper becomes wet and remove excess water from the dish.

3. Put either 100, 50 or 25 seeds in each dish on moist paper at proper distance.

4. Cover petri-dish with lid and put it in germinator/incubator maintain at appropriate constant temperature.

5. Take the germination count and calculate the germination percentage.

III Germination in sand and soil:

1.Take cathern or plastic pots filled with sand or soil.

2. Add water to retain sufficient moisture in soil/sand.

3. Put the seeds of variety to be tested at appropriate depth with proper spacing

4 Cover the seeds with soil or sand and give water if necessary and put them in germinator at appropriate constant temperature.

5. Take count and report the germination percentage.

Observe the following from the germinated seeds and report the results.

1. Normal seedling: Seedlings which show the capacity for continued development into normal plants when grown in good quality soil and under favourable conditions of water supply, temperature and light. Following seedlings may be treated as normal

a) Seedlings with well developed system of root with primary root intact

seedlings.hypocotyl/epicotyl and a normal plumule and cotyledons.

b) A well developed primary leaf within or emerging through the coleoptile in monocotyledons.

2. Abnormal seedlings: Which do not show the capacity, for continued development into normal plants when grown in good quality soil under favourable conditions of water supply, temperature and light.

Following seedlings may be treated as abnormal:

a) Seedlings without cotyledons, constrictions, splits, cracks and lesions.

b) Seedlings without primary root

c) Seedling with damaged and stunted root and plumule, coleoptile without primary leaves.

d) Seedlings with decayed essential structure and discoloration

3. Hard seed: The seeds belonging n leguminous and malavacene family which remain hard at the end of prescribed period of test Because they have not absorbed water due to impermeable seed coat are called hard seed.

4. Fresh ungerminated seeds: Seeds other than hard seeds, which remain firm and

viable even after appropriate treatment for breaking dormancy, are classified as fresh! ungerminated seeds.

5. Dead seeds: Seeds, at the end of test period are neither hard nor fresh and have not produced seedlings are classified as dead seeds.

Table : permissible substrate, temperature and duration for germination test

Labotatoru preparation for

Crops	Scientific	Substrata	Temp.	Final counts (days)	Final counts (days)	Recommendations breaking seed dormancy
Cereals:						
Maize	Zea mays	BP.S	20-30-25	4	7	
Sorghum	Sorghum bicolour	BP.TP	20-30-25	4	10	Prechill
Pearl miller	Pennisetum	BP.TP	20-30	3	7	0.2% KNO3 (2.3 hrs)
Wheat	Triticum aestivum	S:BP:TP	20	4	8	
Paddy	Oryza sativa	BP, TP,S	20-30-25	5	14	Per heat (50˚C)soak in water GA_3(560ppm)
Barley	Hordeum	BP,S	20	4	7	Pre heat pre chill

						GA_3
Oilseeds:						
Groundnut	Arachis Hypogaea	BP,S	20-30-25	5	10	Pre heat 40˚C
Rapeaseed & mustard	Brassica spp.	TP	20-20-30	5	7	
Castor	Ricinus Communis	BP,S	20-30	7	14	
Soyabean	Glycine max	BP,S	20-30-25	5	8	
Til	Seasamum Indicum	TP	20-30	3	6	
Sunflower	Helianthus	BP,S	20-30-25,20	4	10	Ethrel (25ppm 48hrs)
Linseed	Linum Usitatssimum	TP,BP	20-30,25,20	3	7	
Pulses:						
Redgram	Cajanus cajan	BP,S	30	4	6	
Greengram	Vigna radiate	BP,S	20-30,25	5	8	
Blackgram	Vigna radiata	S,BP	20-30,25	4	7	
Chickpea	Cicer arietinum	BP,S	20-30,25	5	8	
Cowpea	Vigna unguiculata	BP,S	20-30,25	5	8	
Lentil	Lens cullinaris	BP,S	20	5	10	
Peas	Pisum sativum	BP,S	20	5	8	
Fibre						
Cotton	Gossypium spp.	BP,S	20-30,25	4	12	Hot water
Jute	Corchorus spp.	TP,BP	30	3	5	
Fodder crops:						
Oats	Avena sativa	SP,TP	20	5	10	Pre heat
Berseem	Trifolium spp.	BP,TP	20	3	7	Pre chill
Luceme	Medicaho sativa	TP,BP	20	4	10	Pre chill
Teosinte	Euchlaena Maxicana	SP,S	20-30	-	7	-
Guar	Cyamosis tetragonolobus	BP	20-30,25	5	14	P
Senji	Melliotus indica	TP,BP	20	4	7	Prechill KNO_3
Vegetable crops						
Bhindi	Abelmoschus esculantus	BP,S	20-30,25	4	21	
Brinjal	Solanum melongena	TP,BP	20-30,25	7	14	
Carrot	Dacus carota	TP,BP	20-30,25-20	7	14	
Chillies	Capsicum spp.	TP, BP	20-30,25	6	14	KNO_3
Cucumber	Cucunis	BP,TP,S	20-30,25	4	8	

	sativus					
Onion	Allium cepa.	BP,TP	20-15	6	12	Prechill
Palak	Spinacia spo.	BP	15,10	7	21	Prechill
Radish	Raphanus sativus	TP,BP,S	20-30,20	4	0	prechill

Practical Experience:

Students will carry seed germination test by different methods and calculate germination percentage

SEED VIABILITY AND SEED VIGOUR TEST

I. Seed viability: The capability of plant structure (seed, cutting etc.) to show living properties like germination and growth. The long period is required to conduct germination tests and due to which seed processing and marketing is delayed. Hence, a rapid method is used for estimating or predicting the germination behaviour of seed. Following two tests are employed.

1.Topographical Tetrazoli urn Test or TZ. Test: In this test, the indicator TZ' a colourless solution of tetrazolium salt is used which shows red coloured living parts of seed while colourless is dead ones. Sometimes, partial colouration is also seen.

Procedure

i) Sample of 50 to 100 seeds is sufficient However, two hundred seeds in replicate of 100 may be used.

ii) Soak the seeds in warm water (30 °C) or folded moist blotting paper over night at room temperature.

iii) Soaked seeds are then longitudinally (maize, wheat) or laterally (small seeded grasses) cut to exposés the embryo while seed coats of dicot seeds (gram) should be removed to facilitate quick penetration, of tetrazolium.

iv) The prepared seeds should be soaked in 1% TZ' solution of Ph 6 to 7 and kept in dark at about 30° C for 3-4 hours but not above 45°C.

v) When the colour has developed drain the excess TZ' solution and the treated seeds are rinsed 2-3 times with water and evaluated on the same day or may be kept in arefrigerator in water for 1-2 days.

vi) Estimate the seed viability percentage.

II. Seed vigour : The germination test evaluates the viability of seed lots. However, in fields many varying results are observed in regard to field stand. This is due to favourable artificial conditions available in laboratory.

Hence, the tests are used which reliably predict stand potential of seed lots, which are referred to as 'Vigour test'. It is the sum total of all seed attributes that favour stand establishment

under varying field conditions. This test provides means of detecting differences under specific environmental conditions. Which is difficult in an ordinary laboratory, germination test. The vigour tests are -

1.Direct Tests: These tests simultaneously evaluate all the factors affecting seed vigour however difficult to standardize.

2.Indirect Tests: These tests measure certain physiological attributes of seeds. In these tests, variables can be precisely controlled. These tests require less time, simple and require less equipments but they do not evaluate simultaneously all facters including injuries and morphological abnormalities.

1.Direct Tests:

a**) Brick gravel test:** A porous brick gravel of 2 to 3 mm size is used. About 30 mm layer of moist gravel is placed above the seed. This layer impedes the emergence of weak, partially diseased seedlings as well as coleoptile injured seedlings. Vigorous seedling are these emerged from layer of brick gravel.

b)Paper Piercing Test: This test involves the use of sand plus a special paper disk through which seedlings penetrate. It is used for cereal crops in which seeds are placed on top with 1.25 cm moist sand and covered with special paper and kept for eight days.

2.Indirect tests:

a) Measurement of seedling growth rate It is measured by dry matter production, speed of germination and measurement of seedling length.

i) Dry weight of seedlings. e.g grasses Seedlings grown in green house for 5 to 6 weeks are cut off at ground level and dried at 100 °C for 24 hours and weighed. The weight per seedling is determined

ii) Speed of germination: Preliminary germination counts are taken at standard time before completion of germination. The seed lot producing largest number of germinated seedlings at preliminary count will produce fastest growing seedlings and establishment.. iii)Seedling length Seeds are planted in a single row in desirable medium (towel or blotting paper roll) and placed in germinators at 45 angle. After 5 days, the length of root and sheets is measure with ruler and the average length is worked out.

Tetrazolium Test: This test is used as a viability test. In which seed samples, to be tested for vigour test are washed to remove any traces of fungicides and then soaked for 16 to 20 hours in water at 30 C. The seeds are then cut longitudinally from distal end towards base leaving two halves at base in joined condition Shallow cuts are made through the pericarp of the seed half. Such seeds are soaked in 1% solution of at 30 C. Sometimes, antibiotic compounds TZ salt for 24 hours (streptomycin/penicillin) may be added at low concentration to prevent microbial infection.

However this test differfrom viability test in evaluation pattern. In viability tests, seeds are evaluated into two categories viz. viable and non viable. However, here they are evaluated in several categories. The aleurone cells become red where as dead cells remain unstained. Seeds are classified into

A. 100-75 per cent of total aleurone surface stained- High

B. 75-25 per cent of total aleurone surface stained - Medium to low vigour.

C. Less than 25 per cent total aleurone surface stained - Poor vigour.

Factors affecting seed vigour:

1.Seed Size: Bolder seeds produce vigorous seedlings

2. Seed endosperm - Well developed endospermic seeds show more vigour.

3. Seed coat: Papery seed coat shows greater vigour than thick seed coat.

4. Genetical factors: Hybrid seed produce much vigorous seedlings than parental seeds.

5. Seed age: Fresh seed having proper dormancy show more vigour than old.

6. Germination condition :Under favourable conditions of germination, seeds shows better vigour.

Practical Experience:

Students will carry practically different seed viability and draw figures of it.

GENETIC PURIETY TEST-GROW-OUT TEST

I. Object: To determine the genetic purity of a given seedlot of a released cultivar and the extent to which the submitted sample conforms to the prescribed standards

II .Sampling: The samples for grow out test are to be drawn simultaneously with the samples for other quality tests and the standard procedure shall be followed.

Thesize of the submitted sample will be as follows:

1,000 gm - For maize, cotton, groundnut, soybean and species of other genera with seeds of similar size. 500 gm - For sorghum, wheat, paddy and species of other genera with seeds of similarsize. 250 gm Beta and species of other genera with seeds of similar size. 100 gm - For bajra, jute and species of all other general,250 tubers/planting stalkers/ roots/forms,potato, sweet potato and other vegetatively propagating crops.

III. Procedure: While raising the desired population, standard and recommended Agronomic/ cultural practices (e.g. field preparation, size of the plot, row length. distance between rows, distance between plants, irrigation, fertilization etc.) in respect of individual crops to be followed both the for unknown sample and its control. The possibility to prove the genuiness of a cultivar by growout test is based on hereditary characteristics of the plants. Usually the cultivar differences are more distinct if growth conditions are favourable. Crop should be so grown that the genetical difference express themselves as clearly as possible. In self fertilizing species the individual of a cultivar may be theoretically identical whereas the individual of a cultivar in cross fertilizing

species may not be genetically similar, but comprise a number of types. Therefore, it is easier to determine the cultivar purity in self fertilizing species than in cross fertilizing species where the examination for greater part are based in the mutual comparison between the samples to be tested and the standard sample Hence, it is essential to sow the various samples of the same cultivar in succession and standard sample are sown at suitable intervals (for example one standard sample for every ten samples to be tested). The size of plots, row length etc. will differ crop to crop. However, the specifications for certification agency may change the specification if considered necessary.

Sr.no.	Crops	Row length (meter)	Plant to plant dist. (Cm)	Space between rows (cm)	Space between plots	No. of replication
1	Wheat, barley oat	6	2	25	50	2
2	Pea.cowpea	6	10	45	90	2
3	Chickpea, green gram,black gram	6	10	30	60	2
4	Maize	10	25	60	90	2
5	Hybrid cotton	5	10	45	45	2
6	Paddy: a)very early to medium	6	15	20	45	2
	b)Late and very late	6	25	30	60	2
7	Pearl millet	6	10	60	90	2
8	Sorghum	6	10	45	90	2

The seed rate may be adjusted depending on the germination percentage of samples and the sowing may be done by dibbling Subsequent thinning is not recommended The test crop could be raised along with the control either to the areas recommended the variety or in off-season nurseries. The authentic control sample from the originating plant breeder/breeding institute is to be maintained by the testing station/agency following standard procedures: A minimum of two hundred plants from control sample would be raised along with the test crop.

IV. Observations

a) All plants are to be studied keeping in view the different distinguishing characters described for the cultivar both in the test crop as well as the control. Necessary corrections may be incorporated if the control is found to be heterogeneous.

b) Observations are made during the full growing period or for a period specified ongination breeding institute and deviations from the standard sample of the same variety and recorded. At suitable development stage the plots are examined carefully. and plants which are obviously of other cultivar are counted and recorded. The specification of the field plot, row length etc. may be determined from the information given in paft III above. And on the basis of the number of plants required for taking observations is dependent on maximum permissible offtypes (minimum genetic purity) which are as follows:

Maximum permissible off type (%)	Minimum genetic purity (%)	Number of plants required for sample for observation
0.10	99.9	4,000
0.20	99.8	2,000
0.30	99.7	1,350
0.50	99.5	800
1.00 and above	99.0	400

V. Calculation, interpretation and reporting of the result:

Percentage of other cultivars, other species or inherent found maybe calculated upto first place of decimal while interpreting the result, use of tolerance may be applied by using the reject table given below at serial No.VIII.

VI.Analysis for grow-out test : The analysis employed for conducting grow-out test should possess the basic qualification as identified under seeds Rules, 1968.

VII. Reject number of or prescribed standards and sample sizes.

Standards	Reject number for sample sizes of	
	800	400
99.5 (1 to 200) 99.0 (1 to 100)	8 16 48 128	*
95.0 (5 to 100) 85.0(15 to 100)		8 24 64

- Indicated that the sample size is too small for a valid test.

Practical experience :

Students will visit seed plot and calculate genetic puriety by above methods

PHYSICAL PURITY TEST

The purity test is done with the objectives.

1. To determine the composition of sample by dividing each sample into 4 components namely pure seeds, other crop seed, weed and inert matter and to judge the quality of seed sample on the basis of proportion of pure seed and other components as per prescribed norms of SCA.

2. To identify objectionable weed seeds and other crop seeds found in sample and to give them botanical names.

3. To determine eligibility of seed sample for seed certification.

4. To get the pure seed for further seed tests like germination.

Material:

1. Working seed sample.

2. Analytical balance (Range of weight 0.1 mg to 1 kg) and precision balance (accuracy 10 mg & capacity 1 kg).

3. Physical purity board with magnifying lens (for identification & separation of component).

4. Small hand sieves with different sizes of perforations.

5. Seed blower (to separate different light weight components-especially in grasses and also for rapid purity separation)

6. Other equipments - Forceps, needles, spoon, spatula, shallow trays, watch glasses,

weight box.

Procedure:

1. Draw and weigh the working sample as prescribed earlier.
2. 2 Use seed blower, if seed sample is chaffy or grass species after adjusting air flow.
3. 3. Place the working sample on a board or glass plate and with the help of Forceps needles and magnifiers, separate out the seed sample into following components.

i) Pure seed

ii) Other crop seed

iii) Weed seed

iv) Inert matter

v) Objectionable weed seeds.

Vi) Objectionable infected seeds

Components of working seed sample for physical purity analysis

i) **Pure seed:** Pure seed refers to the seed of species which is stated by sender or found to be dominant in the seed lot. Such seeds are immature, undersized, shriveled, achenes or similar fruits, diseased seeds, germinated seeds, intact seed unit or diseased seed unless transformed into fungal sclerotia, smut balls or nematode galls be regarded as pure seed provided they can be identified as that species, of pure seed. Note: Piece of seed unit longer than half of original size should be considered as pure seed (provided it can be authentically be identified as of that crop).

ii) **Other crops seed:** This refers to any kind of seed or seed like structures of any plant species other than pure seed. The distinguishable characteristics set out for pure seed should be applicable to other crop seed except certain weed species which are classified separately.

iii) **Weed seed**: Seeds, bulblets or tubers of plants recognized as weed seed by laws or official regulations or by general use shall be recognized as weed seeds.

iv) **Inert matter:** Inert matter includes such seed like structures as pieces of broken or damage seed, empty glumes or any other extraneous matter such as soil & sand particles, glumes, pieces of stems, leaves, bark, flowers, chaff, nematode galls, fungal bodies, insect larvae etc.

v) **Objectionable weed seeds**: Seeds of weed plants which are difficult to separate once mixed with crop seed and which are poisonous or injurious or have smothering effect on main crop are known as objectionable weed seeds it seed level

vi) **Objectionable infected seeds:** Seeds which are affected by designated seed bome diseases are known as objectionable infected seeds at seed level. 4. After complete separation of components of sample, retain the pure seed on purity work board for re-checking. After re-checking the pure seed separate other seeds and inert matter.

5. Take separate weight of each component of seed sample as mentioned below -

Wt. of working sample (g)	the number of places of decimals upto which each component needs to be weighed
Less than 1 gm	4
1 to 9.999 gms (but less than 1o gms)	3
10 to 99.99 gms (but less than 100 gms)	2
100 gms to 999.9 gms	1
Greater than 1000 gms	0

(Note : After weighting each component, they should be properly marked & retained for future reference. Only pure seed component (minimus 400 number of seeds should be used for germination test.))

6. calculate the percentage value of each component on the basic of total of sum of weights of all components and not on the basis of the original sample.

$$\text{i) pure seed (\%)} = \frac{\text{Wt. of pure seed}}{\text{Total wt. of all seed components}} \times 100$$

$$\text{ii) inert matter(\%)} = \frac{\text{Wt. of inert matter}}{\text{total wt. of all seed components}} \times 100$$

$$\text{Iii) other crop seed (\%)} = \frac{\text{Wt. of other crop seed}}{\text{Total wt. of all seed components}} \times 100$$

$$\text{Iv) weed seed (\%)} = \frac{\text{Wt. of weed seed}}{\text{Total wt. of all}} \times 100$$

Note: i) The summation of percentage of all components must be 100.

ii) If component occurs in less than 0.05%, it can be reported as 'trace', while that of 0.05 to 0.1% shall be recorded as 0.1%.

iii) There should not be more than 1% variation between the weight of original sample and the total weight of four components. If the gain or loss is greater than this amount, another test should be made.

7. If percentage of seed of any other crop species or weeds together is more than 0.1 per cent or if the number of seeds is more than 20, separate out all seeds of the species from working sample as well as submitted sample.

8. The number of weed seeds & other crop seeds need to be counted and calculate the number of seeds per kg as per requirement.

$$\text{Number of weed seed/kg} = \frac{\text{No. of weed seeds}}{\text{Wt. of all seed components (g)}} \times 100$$

$$\text{Number of other crop seeds /kg} = \frac{\text{Number of other crop seeds}}{\text{Wt. of all seed components}} \times 1000$$

9**. Reporting results**:

a) Results of purity analysis is to be given in one decimal place

b) If percentage components is less than 0.05 per cent, then it is to be reported as trace

c) The total of percentage of all components must be 100.

d) The percentage of each components is shown in the analysis sheet at proper space.

e) If the results are nil, it is to be shown as 0.00 per cent

f) Latin names of pure, weed and other seeds must be reported

10. Source of errors in purity analysis:

1)Moisture: The working sample should not be left on table for longer time before analysis and make analysis as quickly as possible, otherwise variation in weight may occur during analysis due to moisture regain or loss from seeds if the laboratory is not dehumidified.

2) Computing error: Weights of all components should be taken carefully upto required decimal places to avoid error in calculation.

Laboratory work: Find out various components of working sample given to you and calculate the percentage of each and give your opinion about the sample.

Physical purity analysis report

1.Test number _____ 2. Kind /class of seed _____

3.Crop with variety _____

4. Lot No. _____ 5. Sample No._____

Table : composition of working seed sample for physical purity analysis.

Sr. no.	Observations	Purity fractions/components						Total
		Pure seeds	Inert matter	Other crops seeds	Weed seed	Objectionable		
						Weed seeds	Infected seeds	
1.	Weight of components (…gms)							
2.	No. of seeds							
3.	Percent values							
4.	No. of seeds per kg.							
5.	Prescribed standard values of SCA:							
	a) Percent values							
	b) No.of seeds/kg							
6.	Component wise liability forcertification							

Conclusion: The given seed sample is lible /not liable for certification because

Place: (Signature)

Date : Seed Testing Officer

Note : Quote scientific names of each components of physical purity analysis.

EXERCISE NO : 6 **Date:**

SEED CLASSES OR TYPES ON THE BASIS OF PHYSICAL AND GENETICALLY PURITY

A) Physical purity test :

The seed sample of requisite quantity is spread on work table with a view to separate non-seed elements and to identified and isolates those seeds individually in the lot which have different shapes, size, color and surface texture. After separation, the seed sample spitted into three categories as follows-

I. The true seed belonging to the kind declared.
II. Other seed including weed seed and those not belonging to the variety or kind.
III. The inert matter or particles.

After separation, each of the component part shall be weighted accurately and the percentage are calculated.

B) Genetically/ varietal purity test :

1) Use of chemicals :

Characteristic colour reaction of some genotypes to specific chemicals do form the basis for diagnosis of genuineness of variety.

a) Phenol colour reaction :

It is recommended test for Identification wheat cultivars. Grains are soaked in distilled water for 24 hours at 20° C. The soaked seeds are transferred on filter paper soaked in 1% aqueous solution of phenol in petri dish. The dish is covered and kept for about 43 hours at 30°C. The ventral side of the grains should face downwards on filter paper. The intensity of colour developed is evaluated on 0-9 scale (0 is negative or no change of colour and gradual intensification of colour from light brown to deep black graded from 1-9). The lower glumes may also give specific colour with phenol. The intensity of colour depends on the extent of tyrosinase activity generated in the grain in presence of phenol as a substrate. This test also be used on dehulled oat seed and on certain herbage seed.

b) Peroxidase reaction:

Soybean varieties can be differentiated on the basis of difference in peroxidase reaction shown by the seed coats treated with 0.1 % hydrogen peroxide solution.

c) Sodium hydroxide :

When the red or white grain colour of wheat is not distinguishable easily due to weather damage or seed treatment, the seeds are dipped in 10% sodium hydroxide solution for 15-20 minutes. After drying the red wheat grains would show clear red colour while white wheat grains would turn yellowish white. Sodium hydroxide solution can also be used to distinguish between garden pea and fodder pea seeds.

d) Potassium dichromate :

The 1% solution of potassium dichromate may be used to identified garden pea and fodder pea seeds from their differential reactions.

e) Potassium hydroxide and bleaching powder mixture :

The mixture of potassium hydroxide and bleaching powder in the proportion of 1:5 on weight basis can be used to differentiate between the varieties of sorghum. Seeds are soaked for 5- 10 min. in the solution. Seeds with tannic acid in the testae turn dart whereas seeds without tannic acid remain light coloured

f) Iodine solution :

After removal of the flowering glumes, mille grains mixed with weedy form treated with 5% iodine solution alcohol, grains of weedy forms turn dark brown in 5-7 min, while cultivated forms remain unchanged or slightly pink.

2) Chromosome count:

Varieties at different ploidy levels (grass, beat, wheat) can be easily differentiated by counting number of chromosomes from the root tips by germinating the seeds. In case of sugarbeet, the submitted sample is first sieved to prepare representative working sample sets of different seed sizes. Then the chromosome number of 50 seeds from the different sets are counted.

3) Grow out test:

The main aim of grow-out test is to determine the genetic purity of the variety of the given sample. In grow-out test plant characters that are less influenced by the environment and which are highly heritable are observed by growing the plants in the field. The variety, which is to be tested for genetic purity, should be grown in the area for which it has been released so that the characters of that variety are fully expressed. Each sample should be sown with proper spacing by adopting the recommended cultural practices so that the differences between the varieties are fully expressed.

Sampling :

The sample for grow out test are to be drawn simultaneously with the samples for other quality tests and the standard procedure shall be followed. The size of the submit sample shall be as follows:

1000 g for maize, cotton, groundnut, soybean and specie other genera with seeds of similar size. For sorghum, wheat, paddy and species of other genera with seeds of similar size – 500g.

For bajra, jute, and species of all other genera – 100g.

For potato and other vegetatively propagated crops tubers /cuttings / roots.

Procedure :

Before sowing the seed in the field the seed should be examined on the diaphanoscope to identify the seeds of other variety. The seeds of other variety should be separated and the percentage should be noted. One may also separate the doubtful seeds, which may be sown separately for thorough examination. The various samples of the same cultivar are sown in adjacent plots with standard samples at regular intervals. In case of self pollinated crops the characters are fixed and it is easy to identify the plants of other cultivars. In cross pollinated crops where the variability for characters is more it is essential to sow the authentic samples at regular intervals for comparison between the samples to be tested and the standard sample. The sample plots should be regularly observed during the entire growing period of the crop as some of the characters are expressed at seedling stage while the others are expressed at flowering or at maturity stage. The size of plots, row length etc. will differ from crop to crop.

4. CLASSES OF SEED

i. Breeder Seed:

Breeder seed is seed or vegetative propagating material directly controlled by the originating or sponsoring plant breeder of the breeding programme or institution and/or seed, whose production is personally supervised by a qualified plant breeder and which provides the source for the initial and recurring increase of foundation seed.

ii. Certified Seed:

Certified seed shall be the seed certified by the certification agency notified under Section 8 of the seeds Act 1966 and shall consist of two classes, namely, foundation seed and certified seed, and each class shall conform to the following description:

1. Foundation seed shall be the progeny of breeder seed or be propagated from foundation seed which can be clearly traced to breeder seed. Production shall be supervised and approved by the certification and be so handled as to maintain specific genetic identity and purity, and shall be required to conform to certification standards specified for the crop being certified.

2. Certified seed shall be the progeny of foundation seed and its production shall be so handled as to maintain specific genetic identity and purity according to standards specified for the crop being certified.

   Certified seed may be the progeny of certified seed, provided this reproduction does not exceed two generations beyond foundation seed and provided further that it is determined by the certification agency that is genetic identity and purity will not be significantly altered. However, in the case of highly self- pollinated vegetable crops, certification of one further generation may be permitted. Certified seed produced from certified seed shall not be eligible for further seed increase under certification except in case of highly self-pollinated vegetable crops where certification of one further generation may be permitted. Certification tags, for such production which are not eligible for further seed increase under certification shall carry the words 'Not eligible for further seed increase under certification.

3. The colour of the certified tag shall be white for foundation seed, and a shade of blue to be prescribed by the Central Certification Board for certified seed.

EXERCISE NO : 7 **Date :**

HARVESTING, EXTRACTION, PROCESSING, DRYING OF SEEDS

In general, the crop harvested at harvestable maturity will have the greater seed yield. In crops the maturation will not be always be uniform but there will be mingling of matured, immatured and over matured based on the time of anthesis and fertilization.

Hence optimum time of harvest for a given seed crop is necessary as beyond the point losses will be greater than the potential seed yield. Hot dry weather conditions greatly accelerate the rate of natural seed drying on the plant. Seed moisture can form the most important indication of a crop's fitness for harvesting. Vegetable seed crops are divided in to three groups-depending on the state of seed at harvest time.

a. Dry seed

The seed is usually dried on the plant before harvesting e.g. Okra, Brassicas, Lettuce, Peas, Beans, Beet and Onions.

b. Fleshy fruits

The ripened fruits are picked from the plants and dried first. The dried fruits are then opened later to remove the dried seeds. e.g. Chillies, Ribbed gourds and Bottle gourd.

c. Wet fleshy fruits

In fruits containing a high level of moisture, the seed has a gelatinous or mucilaginous coating adhering to it. This has to be removed after seed. Extraction by fermentation process or treatment with dilute acids. Such fruits are harvested when they mature and ripen e.g. tomato, brinjal, cucumbers and pumpkins.

Method of Harvesting

The harvesting of seed or fruits is done manually or mechanically, depending upon the scale of production, cost and availability of skilled labour and or of suitable harvesting machines.

1. Hand picking

Seeds of some crops such as solanaceous fruits (brinjal, pepper, tomato), cucurbits and sweet corn are conveniently harvested by picking fruits by hand. The small seeded fruits or seed heads of vegetable crops like onion, carrot, okra or chilli can be cut with a knife or secatures. Often it is preferable to cut off the whole plant with sickle, as in the case of lettuce, chicory, brassicas, radish and peas. The legumes are, however, usually harvested by pulling up the whole plant and then threshed to recover the seed (e.g. peas and beans). Although hand harvesting methods are labour intensive, they allow plants to be harvested individually or even at several stages of crop growth.

Manual harvesting provides more protection and the maximum potential seed yield per unit area, when compared with the mechanical harvesting. In plants requiring after ripening, the larger the plant part are cut and removed with the ripening seed results in higher seed yield. e.g. the small seeded vegetable crops like lettuce and brassicas.

2. Mechanical harvesting

Vegetable seed crop may be harvested by employing a suitable mechanical harvester, especially in the large scale commercial seed producing farms where the manual labour is costly. In the mechanical harvesting, cutting and threshing operations may be carried out by two separate machines or both the operations may be performed by a single combined machine. The cutting operations can be mechanized, using mowing-windrowing machines, which are most conveniently used for crops like peas, beans, spinach, carrot and brassicas.

Seed extraction

The selected fruits are harvested for seed in the same way that is picked for the market. The seeds extraction from wet/flash fruits can be done by the following methods.

1. Manual method
2. Fermentation method
3. Mechanical method
4. Chemical method
5. Juice and seed extraction method

1. Manual Method-

(a) Maceration e.g., watermelon,

(b) Crushing e.g., brinjal,

(c) Scraping e.g., cucumber:

(d) Separated e.g., muskmelon.

(e) Scooping e.g., pumpkins and

(f) Extraction e.g., squashes.

1.1. Dry Extraction

Dry extraction is done either manually or mechanically. Manual extraction is by beating with pliable bamboo stick or by beating against a hard surface.

1.2. Wet Extraction

It is normally practiced in fleshy fruits of vegetables like tomato, brinjal, bittergourd, snakegourd and ashgourd. Among these, extraction is easier in brinjal and ashgourd as the fleshy pulp's interference is less. Seeds are separated with pulp and are washed with adequate water and for removing the sliminess; seeds are washed with 0.1% HCl for 2-3 minutes. In chillies, dry extraction using curry powder grinder is preferable than soaking in water and squeezing off the fruit

rind. In tomato seed extraction is done either by fermentation method or acid method. Alkali method (Na2CO3) and citric acid method are also available but are not practiced widely

Drying

Removal or elimination of moisture from the seed to the required level is called drying.

Seed drying should reduce the seed moisture content to safe moisture limits to maintain its viability and vigour during storage, which may otherwise deteriorate quickly owing to mold growth, heating and enhanced microbial activity.

Methods of drying

1. Physical drying (or) natural drying (or) traditional sun drying II. Mechanical (or) artificial drying

a) Drying with forced natural air

b) Drying with forced artificially heated air

c) Drying with desiccants

d) Drying with infrared rays

1. Physical drying (or) natural drying (or) traditional sun drying

• Drying of the harvested crop is carried out in the field or threshing floor by the radiant energy of the sun.

• This does not involve any expenditure.

• To achieve uniform drying, the seed should be spread in thin layer.

• High moisture content seed with a moisture content of more than 17% should be dried first under shade/ light to reduce the moisture content less than 17% and then dried under heavy sun i.e. noon drying.

• Sun dried seeds should not be allowed to remain open in the floor during night, since seed will absorb moisture from air.

• 2-4 days are needed to reduce the moisture content to 10-12%.

• Direct sunlight also can adversely affect seed germinability owing to high temperature and ultraviolet radiation, especially if the moisture content of the seed is high.

Advantages

1. Easy and cheap
2. Does not require any expenditure or fuel.

Disadvantages

1. The rate of drying is slow
2. Loss due to attack by insects, birds and animals
3. Large floor area is required
4. Involves extra labour for collecting and exposing during the day

II. Mechanical drying or artificial drying or Forced air drying

• In forced air drying, natural air or air supplemented with heat is blown through a layer of seed until drying is completed. - Generally ordinary seed godowns are provided with two types of ventilators for free movement of air circulation.

• In modern godowns, provisions are to be made for forcible circulation of air with the help of an electronic blower.

• The outside air which is comparatively dry is circulated in the godown and thereby the seed get dried up in this process. This is possible only in dry months.

Processing

Seed processing is a vital part of the seed productionneeded to move the improved genetic materials of theplant breeder into commercial channels for feeding therapidly expanding world population. The farmer mustget the quality seed that is free from all undesiredmaterials because farmers entire crop depends on it.

Steps involve in seed processing

- Step 1- Pre-conditioning and pre-cleaning
- Step 2- Cleaning
- Step 3-Cleaning and Grading

Step-1-Pre conditioning and pre cleaning

• Pre conditioning : Isolation of seed from plant parts with which it was harvested. ziion
c.g. Shelling

• Pre cleaning :- Removal of external materials like trash, stones, clods which are either in larger size or lighter in weight. No pre eleaning is required for hand harvested and winnowed seeds.

Step-2-Cleaning

• The second stage of cleaning is carried out with air blasts and vibrating screens and is applicable to all kinds of seeds. It is essentially the same as scalping but more refined. It is performed mostly by one machine known as air-screen cleaner.

Step-3-Cleaning and Grading

• To obtain quality seed, it is necessary to clean the seed obtained from the farm to get rid of inert materials, weed seeds, other crop seeds, other variety seeds.seeds can be separated when they differ in one or more physical characteristics. Physical characteristics normally used to separate seeds are size, shape, length. weight, colour. surface texture, affinity to liquids, electrical conductivity, etc. The problem lies in identifying the most important property and use the machine that separates seed using the identified property.

Advantages

• Make possible more uniform planting rates by proper sizing • Improve seed marketing by improving seed qualityS

• Prevent spread of weed seed

• Prevent crops from disease by applying chemical protectants • Reduces seed losses by drying

• Facilitate uniform marketing by providing storage from harvest time until the seed is needed for planting.

EXERCISE NO : 8 **Date:**

PACKAGING, LABELLING AND STORAGE OF SEEDS

Packaging

Seed packaging is the process of filling, weighing and sewing of bags with seed. An ideal storage facility should satisfy the following requirements. It should provide maximum possible protection from ground moisture, rain, insect pests, moulds, rodents, birds, fore etc., It should provide the necessary facility for inspection, disinfection, loading, unloading, cleaning and reconditioning. It should protect grain from excessive moisture and temperature favourable to both insect and mould development, it should be economical and suitable for a particular situation.

The factors to be considered while selecting the packaging materials are,

• Kind of seeds to be packed.

• Quantity of seed

• Value of seed

• Cost of packaging material

• Storage environment in which the packed materials will be held.

• Period of storage.

• Transport of seed

The packaging refers to all those activities related to designing, evaluating and producing the container for a product. Simply, the box-like container, wherein the product is stored to protect it from any physical damage and at the same time attracting the customer through its appeal is called as packaging.

It is important to package seed in dry containers for proper storage. For small quantities of seed, these containers may be tin cans, jars, or pots that are glazed on the inside; even reinforced boxes or bags can be suitable. Metal or plastic jerricans, or drums are often used to package large quantities of seed. Regardless of the type of container employed, it should be of standard size and shape, if possible, so that when one is filled with seed of a known purity percentage, the approximate number of seeds it contains can be estimated. Also, containers of standard sizes and shapes are easier to handle.

For subsequent identification, each package of seed, or each aggregation of packages representing a given seed collection, should be labelled. The information recorded for the collection of Prosopis fruit from which the seed was extracted should be repeated(see p.15), plus the following:

Quantity :	Number of seeds(estimated)
Extraction :	Date
	Technique of extraction
Fumigation :	Date (if undertaken)
	Method of fumigation, imcluding chemicals

Drying :	Date
	Method
	Moisture content
Quality :	Purity percentage
	Number of seeds per unit weight(estimated)
	Germination test

Once again, this information should be recorded in a notebook or ledger, with duplicate labels attached outside and placed inside the packaging container.

Labeling of seed

"Shall mean the use of any labels, and other written, printed, or graphic representations, in any form whatsoever, accompanying or associated with any lot of seed whether in bulk or in containers, and includes any representations on the invoices"

IDENTIFICATION

- Name & address of seller
- Kind and/or variety name
- Lot Number
- Origin
- Treated Seed Info

CONTAMINATION

- Pure Seed%
- Other Crop Seed%
- Inert Matter %
- Noxious weed seeds

VIABILITY

- Germination %
- Hard seed%
- Germination test date

About Labelling

The information reported on the product label and the seed certification label must comply with seed laws and the truth in marketing requirements of trade practice laws. The legal requirements vary from one country to another and, in some countries, among states or provinces. Typically, the label information includes the seed lot number, which enables tracking of the seed through the distribution chain and back to the seed producer, the kind/species, cultivar name, and origin of production; percentages of germination, pure seed, inert matter, other crop seed, and weed seed; percentage of noxious weed seeds if found; test date of seed, year of production, expiration date of valid certification, details of treatments applied to seed, and relevant safety warnings to users; the name and address of the wholesaler, manufacturer, or seed producer, and details and limitations of guarantees, and arbitration proceedings.

In the case of forage tall fescue seed containing a nontoxic endophyte, the label also may contain information about the minimum percentage of seeds infected with the nontoxic endophyte, and a recommended date before when the seed product should be planted.

In addition, the package may record several guidelines for users:

(i) Site selection, choice of ground and soils suitable for forage tall fescue
(ii) Use of a soil test to determine recommended fertilizer applications
(iii) Operations to remove existing vegetation and prepare ground for planting forage tall fescue seed
(iv) Seeding rates for planting in both cultivated and no-till operations
(v) Recommended companion species, namely legumes
(vi) Recommended planting date sand
(vii) Operations to manage seedling and mature forage tall fescue plants.

If the package label does not include the above information, purchasers are advised to request the missing information from their seed supplier or extension adviser

Seed Storage

Seed storage is preservation of seed with initial quality until it is needed for planting. The ability of seed to tolerate moisture loss allows the seed to maintain the viability in dry state. Storage starts in the mother plant itself when it attains physiological maturity. After harvesting the seeds are either stored in ware houses or in transit or in retail shops. During the old age days, the farmers were used farm saved seeds in little quantity, but introduction of high yielding varieties and hybrids and modernization of agriculture necessitated the development of storage techniques to preserve the seeds.

The practice of storing the seeds starts from the ancient days itself, following simple and cheap techniques e.g. Placing the seeds in salt, red earth treatment to red gram etc. But the same practices are not hold good for the present day agriculture, because

- large quantity to be stored
- exchange of varieties and species
- exchange of genes

The type of material to be stored decides the techniques to be followed for safe storage. Now a day storage technique changed from ordinary godown storage to cryogenic tank storage and even gene storage.

Stages of Seed Storage

- The seeds are considered to be in storage from the moment they reach physiological maturity until they germinate or until they are thrown away because they are dead or otherwise worthless.
- The entire storage period can be conveniently divided into following stages.
- Storage on plants(physiological maturity until harvest).
- Harvest, until processed and stored in a warehouse.
- In - storage (ware houses).
- In transit (Railway wagons, trucks, carts, railway sheds etc.).
- In retail stores.

Purpose of seed storage

Storage is needed to maintain the seed in good physical and physiological condition from the time they are harvested until the time they are planted.

Objective of seed storage

To maintain initial seed quality viz., germination, physical purity, vigour etc., all along the storage period by providing suitable or even better conditions

Types of storage

1. **Storage at ambient temperature and humidity.**

   Seeds can be stored in piles, single layers, sacks or open containers, under shelter against rain, well ventilated and protected from rodents and store at least for several months.

2. **Dry storage with control of moisture content but not temperature**

   Orthodox seeds will retain viability longer, when dried to low moisture content (48%) and then stored in a sealed container or in a room in which humidity is controlled, than when stored in equilibrium with ambient air humidity. Cool condition is especially favourable.

3. **Dry storage with control of both moisture content and temperature**.

   This is recommended for many orthodox species which have periodicity of seeding but which are planted annually in large scale afforestation projects. A combination of 4-8% moisture content and 0 to 5° temperature will maintain viability for 5 years or more.

4. **Dry storage for long-term gene conservation**

   Long-term conservation of gene resources of orthodox agricultural seeds is -18°C temperature and 5+11% moisture content

5. **Moist storage without control of moisture content of temperature**

   Suitable for storage of recalcitrant seeds, for a few months over winter. Seeds may be stored in heaps on the ground, in shallow pits, in well drained soils or in layers in well ventilated sheds, often covered or mixed with leaves, moist sand, peat or other porous materials. The aim is to maintain moist and cool conditions, with good aeration to avoid overheating which may result from the relatively high rates of respiration associated with moist storage. This may be accomplished by regular turning of heaps.

6. **Moist cold storage, with control of temperature**

   This method implies controlled low temperature just above freezing or less commonly, just below freezing. Moisture can be controlled within approximate limits by adding moist media e.g., sand, peat or a mixture of both to the seed, in proportions of one part media to 1 part seed by volume, and re-moistening periodically or more accurately by controlling the relative humidity of the store. This method is much applicable to temperate recalcitrant genera.

7. **Cryopreservation**

   It is also called as cryogenic storage. Seeds are placed in liquid nitrogen at 196°C. Seeds are actually placed into the gaseous phase of the liquid nitrogen -150°C for easy handling and safety. Metabolic reactions come to a virtual standstill at the temperature of liquid nitrogen and the cells will remain in an unaltered state until the tissues are removed from the

liquid nitrogen and defrosted. Therefore, little detrimental physiological activity takes place at these temperatures, which prolongs the storage life of seeds. It is not practical for commercial seed storage, but is useful to store the valuable germplasm.

Factors influencing seed storage

1. **Biotic**

2. A biotic

1. Biotic factors

a. Factors related to seed

- Genetic makeup of seed
- Initial seed quality
- Provenance
- Seed moisture content

b. Other biotic

- Insects
- Fungi
- Rodents
- Mishandling during sampling, testing

2. Abiotic factors

- Temperature
- Relative humidity
- Seed store sanitation
- Gaseous atmosphere
- Packaging material
- Seed treatment

EXERCISE NO : 9 **Date:**

METHODS OF SEED PRODUCTION OF COLE CROPS

Cabbage (*Brassica oleracea* var. Capitata)

Botany

Cabbage is highly cross-pollinated crop and pollination is entomophilous. Pollen fertility is maximum on the day of anthesis. Stigma is receptive 2-3 days before to the day of anthesis. Anthesis occurs 8.00 -10.00 hr.

Method of seed production

Cabbage requires two seasons to produce seeds. In the first season the heads are produced and in the following season seed production follows. Two methods are followed.

1. *In-situ* method - for certified seed production

(Seed to seed method)

2. Transplanting method - for nucleus seed production

(Head to seed method)

In-situ method

In this method, the crop is allowed to over-winter and produce seeds in their original position, where they are first planted.

Transplanting method

In this method the matured plants are uprooted and the outer whorls removed. Then the plants are replanted in a well prepared new field. In cabbage, during seed production, three methods have been followed to facilitate flowering and seed production.

1. **Stump method**

When the crop in the first season is fully matured, the heads are examined for true to type. The plants with off type heads are removed. Then the heads are cut just below the base by means of a sharp knife, keeping the stem with outer whorl of leaves intact. The deheaded portion of the plant is called 'stump'. The stumps are either left in-situ or replanted in the second season. After over wintering (dormancy breaking), the buds sprouts from the axis of all the leaves and leaf scars.

Advantage

Gives extra income by way of sale of heads

Crop matures 12-15 days earlier

Seed yield is slightly high

Disadvantage

Flower stalks are decumbent and requires very heavy staking

2. **Stump with central core intact method**

When the crop is fully matured in first season, off type plants are removed and rejected. Then the heads are chopped on all sides with downward perpendicular cuts in such a way that the central core is not damaged. When the head start bursting after over wintering, two vertical cross cuts are given to the head, taking care that the central growing point is not injured. In the absence of such cuts, the heads burst out irregularly and sometimes the growing tip is broken.

Advantages

Shoots arising from main stem are not decumbent; hence very heavy staking is not required.

Seed yield is high.

Disadvantages

The chopped heads cannot be marketed

3. **Head intact method**

In this method, when the crop is fully mature in first season, the heads are examined for true to type. The plants with off type heads are removed from the field and rejected. The head is kept intact and only a cross cut is given to facilitate the emergence of stalk.

Advantages

Saves time and labour

Very heavy staking is not required

Disadvantages

Seed yield is slightly low as compared to other methods

Stages of seed production: Breeder seed --- Foundation seed --- Certified seed

Varieties/ Hybrids

Early: Golden Acre, Pusa Mukta, Chaubatia Early

Mid: Pride of India, Pusa Drum Head, Aru Glory, Green Express

Late: Large Late Drum Head, September, Green Challanger, BSS-50, BSS-32, BSS-44, BSS115, Sri Ganesh Gol

Red cabbage: Red Acre

Season: Early varieties (Golden acre) second fortnight of July -10th, 25th July

Medium varieties second fortnight of June – 1st – 15th June

Late varieties first fortnight of June -15th – 30th June

Land requirement

In the hills, select field on which the same kind of crop or any other cole crop was not grown in the previous two years, unless the crop within the previous two years, was field inspected by the certification agency and found not to contain seed borne diseases infection beyond the maximum permissible limit.

Isolation requirement

The seed field must be separated from fields of other varieties at least" by 1600 m for foundation class and 1000 m for certified class seed production.

Seed rate: Early varieties - 600 g/ha

Late varieties - 400 g/ha

Seed treatment

Some seed borne pathogens such as black rot, black leg and alternaria leaf spot start invading the seedlings blight from germination of seed. Pre-drying of seeds at 40 0C for 24 hr followed by an air treatment at 75 0C for 5-7 days is an effective method to disinfect cabbage seeds infected by black rot without any seed damage. Hot water treatment to seeds at 500c for 30 minutes is done to prevent seed-borne pathogens. Immediately after the treatment, the seeds should be used for sowing within 24 hr. After hot water treatment seed can be treated with a fungicide like Captan before sowing to protect the seedlings from damping – off and downy mildew respectively.

Nursery

Seeds may be sown on raised nursery beds 15 - 20 cm height in rows with 10 cm spacing. Twenty five nursery beds of 2m x 1m size are enough for one hectare. Thin sowing should be done to avoid damping - off.

Transplanting:

Three to four weeks old seedling (25-30 days old) are transplanted, preferably in the evening with a spacing of 60 x 60 cm for late varieties, 60 x 40 cm for medium varieties and 45 x 45 cm for early varieties. Transplanting at 2nd fortnight of August for early varieties and 1st week of August for both medium and late varieties are advisable.

Main field Manuring

The field should be prepared to fine tilth by deep ploughing, three to four harrowing followed by levelling. Cabbage crop requires heavy manuring. At the time of land preparation, 50-60 t of FYM/ha should be applied. 200-300kg Super phosphate and 90 kg of potash should be applied before transplanting of seedlings. Two doses of 75-100 kg Ammonium sulphate at intervals of 2-3 weeks after transplanting the seedlings should be applied. Another dose of 200-250 kg Ammonium sulphate as surface application at the time of seed stalk emergence.

Staking

After the flower stalks are sufficiently developed, staking is necessary to keep the plants in an upright position.

Foliar spray

50 ppm NAA sprayed twice after two and four weeks of transplanting the cabbage seedlings in the field has beneficial effect on better growth and yield of cabbage varieties. The favourable temperature range for flowering and seed setting is 12.5 – 18.5^{0}c.

Rouging

The first rouging is done at the time of handling the mature heads. All off type plants, diseased or undesirable types are removed at this stage. Second rouging is done before the heads start bursting the loose-leaves poorly heading plants and those having a long stem and heavy frame, most by rogued out at this stage, subsequent rouging for off types, diseased plants affected by phyllody, black-leg, black rot, soft rot or leaf spot should be done from time to time as required.

Field Standards

Factors	**Foundation stage**	**Certified stage**	**Remarks**
Off-type	1.00	0.50	
Other crop plants	-	-	
Objectionable weed Plants	-	-	
Diseased plants	0.10 *	0.50* *	At and after flowering and maturity stage

Harvesting and processing

The harvesting may be done in two lots. Generally the early matured plants are harvested first, when the pods turn into brown colour. After harvesting it is piled up for curing. After 4 to 5 days it is turned up-side down and allowed for further curing for 4 to 5 days. Then the pods are threshed with pliable sticks and shifted with hand sifters. Then the seeds are dried to 7% moisture content, cleaned and treated with Bavistin @ 2 g/ Kg of seed.

Designated diseases

Black leg, Black rot and Soft rot.

Seed Yield

The average seed yield varies from 500 to 650 kgs per hectare.

Seed standards

Factors	**Foundation**	**Certified**
Pure seed (minimum)	98%	98%
Inert matter (maximum)	2%	2%
Other crop seed (maximum) (no./kg)	5/kg	10/kg
Total weed seed (maximum) (no./kg)	5/kg	10/kg
Germination(minimum)	70%	70%
Moisture (maximum) (normal container)	7%	7%

Cauliflower (*Brassica oleracea* var. Botrytis)

Botany

Cauliflower is highly cross-pollinated crop due to self-incompatibility. Flower is protogynous in nature. Stigma remains receptive 5 days before and 4 days after opening of the flower. The time taken from pollination to fertilization is 24-48 hours depending upon the temperature. The optimum temperature for fertilization and seed development is 12°C - 18°C. Bees are the major pollinators.

Method of seed production:

There are two methods of seed production

1. In situ method (seed to seed method)
2. Transplanting method (Head to seed method)

For seed production, seed to seed method is recommended since the head to seed method in India has not been very successful. In seed to seed method (In situ method) the crop is allowed to over winter and produce seed in the original position, where they are first planted in the seedling stage.

Stages of seed production: Breeder seed---- Foundation seed ---- Certified seed

Varieties

Early: Early Kunwari, Pusa Katki, Early Patna, Pusa Deepali, Pusa Early Synthetic, Pant Gobhi3, Improved Japanese.

Mid-season: Pant Shubhra, Pusa Synthetic, Pusa Shubhra, Pusa Aghani, Selection 235S, Hisar No.1, Pusa Himjyoti.

Late: Snowball-16, Pusa Snow ball-1, Pusa Snowball-2, PSK-1, Pusa hybrid -2

Hybrids: Pusa synthetic, Pusa hybrid 1 and 2

Season

In the hills, the last week of August is the optimum sowing time. The seed is sown in a nursery and transplanting should be completed by the end of September. For early varieties (in plains) best season for sowing is the last week of May and transplanting should be completed during first week of July. In hills, sowing should be adjusted that the plants put up the maximum leafy growth by 15th December when the temperature goes down and plants become dormant for which last week of August is optimum and transplanting should be completed by the end of September. The mean temperature of 6.5 to 11°C during February to March is very conducive to curd formation.

Land requirement

In the hills, select field on which the same kind of crop or any other cole crop was not grown in the previous two years, unless the crop within the previous two years, was field inspected by the certification agency and found not to contain seed borne diseases infection beyond the maximum permissible limit.

Isolation requirement

Cauliflower is mainly a cross pollinated crop. Pollination is chiefly done by bees.

The seed field must be separated from fields of other varieties at least by 1600 m forfoundation class and 1000 m for certified class seed production.

Seed rate

375 to 400 g /ha.

Nursery

Seeds may be sown on raised nursery beds 15-20 cm height in rows with 10 cm spacing. Twenty five nursery beds of 2 to 2.65 m x 1 to 1.25 m size are enough for one hectare. Thin sowing should be done to avoid damping - off. Three tonnes of FYM should be applied to nursery bed. DAP spray at 10 to 15 days after germination is important. Apply lime @ 5 t/ha before one month to nursery field and apply Borax and Sodium molybdate @ 4 kg/ha before sowing.

Transplanting

Transplant the seedlings at 35-40 days old preferably at evening time with the spacing of 60 x 45 cm (for early varieties in plains) or 90 x 60 cm for late variety and irrigate immediately after transplanting.

Main field manuring

The field should be prepared to fine tilth by deep ploughing and three to four harrowing followed by levelling. Cauliflower crop requires heavy manuring. Apply 50-60 tons of FYM/ha at the time of land preparation.

Foliar application

NAA @ 40 ppm sprayed at 30 days after curd initiation was superior in increasing the yield and quality of seed.

Rouging

Minimum of four inspections are required viz., pre-marketable stage, initiation of curd stage, curd formed stage and flowering stage. Rouging should be done based on the curd size, shape and colour, when fully developed. Off type plants with poor curd formation and plants affect by designated diseases like black leg, black rot, soft rot, leaf spot and phyllody should be removed during rouging. First rouging is done after curd formation. Plants forming loose ricey, fuzzy and buttons are rejected. Blind, deformed and diseased plants are also rejected. Second rouging is done after bolting but before flowering, plants with peripheral and uniform bolting are kept for seed production. Early and late bolters are also rejected.

Field standard

Factors	Foundation stage	Certified stage	Remarks
Off-type	1.00	0.50	
Other crop plants	-	-	
Objectionable weed Plants	-	-	
Diseased plants	0.10 *	0.50* *	At and after flowering & maturity

Scooping

Scooping central portion of curd when it is fully formed helps in the early emergence of flower stalks in hills. Scooping is normally not required for seed production in plains. Scooping curd pruning and half curd removal were effective in increasing the seed yield. However, scooping of curd was best compared to other methods.

Harvesting and processing:

The ripened fruit is called siliqua. Harvesting may be done in two lots. Heavy bearing may topple the plants, hence staking may be done wherever necessary. Wind belts can also be erected if needed. Generally the early matured plants are harvested first, when the siliqua turn in to brown colour. Delayed harvest results into seed shattering and bird damage. Hence, 2-3 harvestings are required. About 50 days are needed for pod maturity after fertilization. Seeds of early types are ready for harvesting in December - January and in February- March for North Indian Plains. However, snowball types are ready for harvesting by June. As harvesting is done when bottom siliqua turn brown followed by yellowing of the top siliqua, curing is necessary for ripening the late maturing siliqua. After harvesting, plants are piled up for curing. After 4 to 5 days it is turned upside down and for further curing for 4 to 5 days. The siliqua are threshed with pliable sticks and cleaned. Then the seeds are dried to 7% moisture content, cleaned and treated with Bavistin @ 2 g/Kg of seed.

Seed yield of Indian cauliflower may very between 500-600 kg/ha and snowball from 300- 500 kg/ha.

Seed standards

Factors	Foundation	Certified
Pure seed (minimum)	98%	98%
Inert matter (maximum)	2%	2%
Other crop seed (maximum) (no./kg)	5/kg	10/kg
Total weed seed (maximum) (no./kg)	5/kg	10/kg
Germination(minimum)	65%	65%
Moisture (maximum) (normal container)	7%	7%

EXERCISE NO : 10 Date:

METHODS OF SEED PRODUCTION OF ROOT VEGETABLES

Carrot (*Dauccus carota* L.)

Botany

Cross pollination is due to protandrous flowers. Anthesis takes place in the morning hours. The stigma becomes receptive on the fifth day after flower open and remains active for 8 days, but better fruit sets are from pollination on 6 to 11 days after flower opening. The inflorescence is a compound umbel.

Flowering

The individual carrot flowers, in common with most other species in *Umbelliferae*, are borne on terminal branches in compound umbels. There is a distinct order of flowering, which relates to umbel position. The first umbel to flower is the primary (sometimes referred to as the 'king' umbel) that is terminal to the main stalk. Branches from the main stalk from secondary umbels, and subsequent branches from these form tertiary umbels. Quaternary branches and umbels may also be formed.

Pollination and Pollinating Insects

Individual carrot flowers are normally protandrous and much crosspollination occurs between plants in a seed crop. However because of the extended flowering period resulting from several successive umbels per plant and the succession of flowers on individual umbels, the possibility of self-pollination always remains. Occurrence of pollinating honeybees, efficient pollinators are frequently scarce on carrot crops because other crops species were flowering in the vicinity at the same time. Several insect genera in *Dymenoptera, Diptera* & *Coleoptera* are extremely important pollinators of carrot seed crops, in the absence of bees. An adequate presence of pollinating insects improves both seed yield and seed quality. Where natural insect pollinator populations are low placing honeybee colonies would be advantageous.

Seed production

The seed production is taken in the hills for European types and in the plains for Asiatic types. European types require high chilling of 4-7° C for a period of about 2 months. The summer and low rainfall of hills especially during flowering and seed setting stages are beneficial.

Method of seed production

1. Seed to seed (In situ method)
2. Root to seed (Transplanting of cut root)

Stages of seed production: Breeder seed ---- Foundation seed ---- Certified seed

Varieties

Ooty 1, Pusa kesar, Zeno, Panvers, American beauty, Imperator

Hybrids

Pusa hybrid-1

Season

The ideal season for sowing to take up seed production is July-August

Land requirement

There are no specific requirements, but the land should be free of volunteer plants.

Isolation requirement

The minimum isolation distance required for carrot seed production is at least
1000 m for foundation and 800 m for certified seed production. Because of the high possibility of cross pollination, isolation distances for commercial seed crops should be 1000 m. For nucleus seed the distance should be at least 1600 m. In areas that specialize in carrot seed production the different cultivars within the same type can be zoned; this minimizes cross pollination between the different types. Cultivated carrots cross pollinate very readily with the wild carrot and this must be taken into account when choosing sites for seed production. Contamination of seed crops by wild carrot pollen is a major reason for genetic deterioration of seed stocks in some areas.

Seed production methods

There are two methods of seed production.

Seed to seed method:

The crop is sown as per climatic conditions of the area. For temperate varieties in Himachal Pradesh sowing is done in the month of October and November. Crop is left in the field for flowering and seedling. The roots cannot be inspected (or) rogued.

Seed rate

2-3 kg/ha. Row spacing of 50-90 cm are used with a sowing rate of 2-3 kg per hectare. Soaking seeds in water for 72 h with a change of water every 24 h leached off the inhibitors will improve germination.

Root to seed method

This system is similar to raising carrot crop for fresh roots as far as timings are concerned but the plants (steckling) are raised in beds and transplanted in the spring. Depending on local customs and winter conditions and stecklings are either left in situ during winter or lifted in the late autumn and stored until replanting in the spring. The transplanted steckling rows are 75 cm apart with 30 cm between plants. The seed raising stecklings that are later transplanted from their beds offer the opportunity for rouging plants with undesirable root or foliage characters while lifting and planting.

Rouging

Minimum of 3 field inspections should be done at 20-30 days after sowing, when roots are lifted and replanted and flowering stages. Rouging should be done based on the root colour, shape, skin colour, and flesh colour of the root and bolting characters and removed.

Field standards

Contaminants	**Minimum distance (meters)**			
	Mother root production stage foundation certified		**Seed production stage Foundation certified**	
Field of other varieties	5	5	1000	800
Fields of the same variety not conforming to varietal purity requirements for certification	5	5	1000	800

Seed to seed production

Very little if any rouging can be done when the crop is grown on without lifting. But plants bolting early and those with a typical foliage characters should be removed. If the crop is lifted and replanted it is rogued as described below for root to seed, but very little confirmation of root type can be done.

Root to seed production

During the first year growing season. a) Remove plants displaying typical foliage, remove plants bolting in the root development stage. b) After the roots have been lifted inspect for trueness to type, according to root shape, colour and size, discard roots showing poor colour, green shoulder, incorrect colour, off coloured shoulders (purple, green), split or fanged roots or those with rough surfaces.

Hybrid seed production in carrot

The production of hybrid seed by hand emasculation and pollination is not possible commercially as the flowers are very small and single pollination gives only one or two seeds. In carrot, the inflorescence is compound umbel. Sufficient buds in the female parent at peak stage of flowering are emasculated and the remaining young ones are removed. Then a cloth / paper bag is placed over the umbel of male parent and shaken to dislodge the pollen onto the sides of the bag. This bag is then used to enclose the emasculated umbel of the female parent. Apart from this, daily for a few days in the morning, the male umbel is gently rubbed over the female to ensure cross pollination. Sometimes when the pollen parent possesses some dominant marker gene with the help of which the hybrids can be distinguished in the seedling stage, it is not necessary to emasculate the flowers.

Hybrid seed production

In the heterosis breeding programme 3 lines are used, namely the male sterile line (A), male fertile sister line (B) and the pollinator line (C) that is male fertile has a good combining ability with the male sterile line. The male sterile and pollinator lines are grown in alternate rows of 4:1 or 8:2 and the hybrid seed is harvested from female line only.

Manuring

First season: A light does of 20-25 tons of FYM per ha should be applied before field preparation.

Nitrogen - 75 kg/ha (35 kg basal + 35 kg top dressing)

Phosphorus - 50 kg/ha (basal)

Potash - 50 kg/ha (basal)

Second season (During transplanting)

Farm yard manure -10 to 15 tons /ha

Nitrogen - 50 kg (25 kg at pre-bolting + 25 kg before flowering)

Phosphorus - 50 kg (basal)

Supplementary pollination

Since the honey bees are important pollinating agents. It is advisable to place beehives in the large seed fields or near by the field to increase the pollination. It is necessary when the temperature is below 15°C. Spraying of 150 ppm NAA at bolting stage also improved the seed setting percentage.

Harvesting and processing

The crop matures unevenly. Seeds are harvested when the secondary umbels (heads) are fully matured (brown) and the tertiary umbels are beginning to turn brown.

Hence 2 to 3 picking may often be necessary. After drying seed heads are threshed, cleaned and rubbed by hand to remove the bristles. The seeds are dried to 8% moisture content and treated with Bavistin @ 2 g per kg of seed. Size grading of seeds with BSS 12 wire mesh sieve or density grading at 0.5 inches of water pressure found to be optimum to upgrade carrot seeds.

Seed standards: (Variety & Hybrid)

Factors	**Foundation**	**Certified**
Pure seed (minimum)	95%	95%
Inert matter (maximum)	5%	5%
Other crop seed (maximum) (no./kg)	5/kg	10/kg
Total weed seed (maximum) (no./kg)	5/kg	10/kg
Germination(minimum)	60%	60%
Moisture (maximum) (normal container)	8%	87%

Radish *(Raphanus sativus*)

Botany

Radish is cross pollinated crop. Anthesis occurs during 9.00-10.00 hr. Anther dehiscence is between 9.00 and 10 hr. Pollen fertility is maximum on the day of anthesis. Stigma is receptive at the time of anthesis and lasts till 4 days after anthesis.

Method of seed production

1. Seed to seed method - for varieties which do not stand transplanting (In-situ method) 2. Root to seed method (Transplanting method)

Stages of seed production

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

Varieties: CO- 1

Temperate varieties (Chinese type)

Produce seed in the hills by over wintering. These varieties flower very late in the plains

Temperate varieties

White icicle, Rapid red, Woods, Long frame, French breakfast, which produce seed in the plains also, but behave just like winter varieties for seed production in plains.

Tropical varieties

Pusa Reshmi, Pusa Chetki, Japanese white, these produce seed freely in the plains.

Season

For hills - September-October and Plains - April-June.

Seed production systems

Both "root to seed" & "seed to seed" systems are used. The 'root to seed' is used for the biennial types especially in Europe and temperate regions. The roots are lifted in the late autumn, the tops taken off and the radishes are stored, usually in clamps, during the winter. It is also the method used for stock seed production of the annual types but in this case the material is replanted immediately after selection. In some areas of the world, especially in Asia, up to half of each steckling's root is removed before replanting. In seed production of the Japanese White cultivar steckling planting results in a higher seed yield.

The 'seed to seed' system is used for final multiplication stages where inspections of the mature root are not considered necessary and is normally used only spring sown seed crops unless the cultivars has a verbalization requirement.

Rouging stages (seed to seed method)

1. At market maturity stage of radish, **root:** relative size, shape, coloured, proportions of each colour on bi-coloured cultivars, solidity.

2. At stem elongation, removed early bolting plants and off types according to stem colour. Remove wild radish types. Check that the remaining plants are true to type for foliage and stem characters.

3. At flower bud and very early at start of anthesis flower colour. Plants with off colour flowers are rogued.

Land requirement

Select seed fields on which the same kind of crop was not grown within previous two years, unless the crop with in the previous two years were field inspected by the certification agency and found not to contain any seed borne diseases beyond the maximum permissible levels.

Isolation requirement

Radish is cross pollinated crop by insects. Hence, seed fields must be isolated from other varieties of radish field at least by 1600 m for foundation and 1000 m for certified seed production.

Seed rate

4 to 6 kg per hectare. The roots are produced in one hectare is sufficient for transplanting in 2.5 hectares.

Sowing

It is advisable to sow the seeds on ridges formed at 45 cm apart, in lines as thin sowing. This helps in better root development and drainage. When the seedlings are 10 to 15 days old, thin out the seedlings to a distance of 7 to 8 cm with in the rows.

Manuring

First season

A light does of 20-25 tons of FYM per ha should be applied before field preparation.

Nitrogen - 75 kg/ha (35 kg basal + 35 kg top dressing)

Phosphorus - 50 kg/ha (basal)

Potash - 50 kg/ha (basal)

Second season (During transplanting)

Farm yard manure -10 to 15 tons /ha

Nitrogen - 50 kg (25 kg at pre-bolting + 25 kg before flowering)

Phosphorus - 50 kg (basal)

Supplementary pollination

Since the honey bees are important pollinating agents. It is advisable to place beehives in the large seed fields or near by the field to increase the pollination. It is necessary when the temperature is below 15°C. Spraying of 150 ppm NAA at bolting stage in Japanese white radish recorded the highest seed yield per hectare (Sharma, 1995).

Rouging

Minimum of three field inspections should be done at 20-30 days after sowing, when roots are lifted and replanted and during flowering stages. Rouging should be done based on root character, flower character and the undesirable and diseased plants are to be removed.

Field standards

Factors	**Maximum permitted**	
	Foundation	**Certified**
Off types	0.10	0.50
Plants affected by seed borne disease	0.10	0.5
Roots not confirming to varietal characteristics	0.10	0.20

Harvesting and processing

The entire plants are cut when the plants are fully matured and the siliqua turns brown colour. Thorough drying of siliqua is must for easy separation of seeds. The seeds are separated by beating with pliable sticks. The seeds should be dried to 6% moisture content, cleaned and treated with Bavistin @ 2g per kg of seed.

Seed standards

Factor Foundation Certified

Factors	**Foundation**	**Certified**
Pure seed (minimum)	98%	98%
Inert matter (maximum)	2%	2%
Other crop seed (maximum) (no./kg)	5/kg	10/kg
Total weed seed (maximum) (no./kg)	5/kg	10/kg
Germination(minimum)	70%	70%
Moisture (maximum) (normal container)	6%	6%

EXERCISE NO:11 Date:

METHODS OF SEED PRODUCTION OF BULB CROPS

BULB CROP

Onion (*Allium cepa*)

Botany

Onion is the biennial crop and takes two full seasons to produce seeds. In the first year bulbs are formed and in the second year stalks are developed and produced seeds. It is a long-day plant. The day length influences bulb onion, but has little effect on induction of seeding. It appears to be day-neutral for seed production. It requires cool conditions during early development of the bulb crop and during early growth of seed stalk. Varieties bolt readily between 10 to15° C. In the early stages of growth, a good supply of moisture is required and temperatures should be fairly cool. During bulbing, harvesting and curing of seed, fairly high temperatures and low humidity is desirable.

Seed production is widely adapted to temperate and sub-tropical regions.

Onion flower and Seeds

Stages of seed production: Breeder seed _ Foundation seed _ certified seed

Varieties

Bellary Red, Rampur local, Pusa white, Kalyanpur, Red Round Punja 48, Pusa Red, Pusa Madhvi, Arka Niketan, Arka Kalyani

Season

The optimum sowing season is middle of June to Middle of July in the plains.

Isolation Requirements

Onion is largely cross-pollinated crop with up to 93 per cent natural crossing but some self-pollination does occur. It is chiefly pollinated by honey-bees. For pure seed production, the seed fields must be isolated from fields of other varieties of onion and fields of the same variety not conforming to varietal purity requirements for certification at least by 1000 meters for foundation seed production and 500 meters for certified seed production.

Method of Seed Production

There are two methods of seed production

1. Seed to seed method

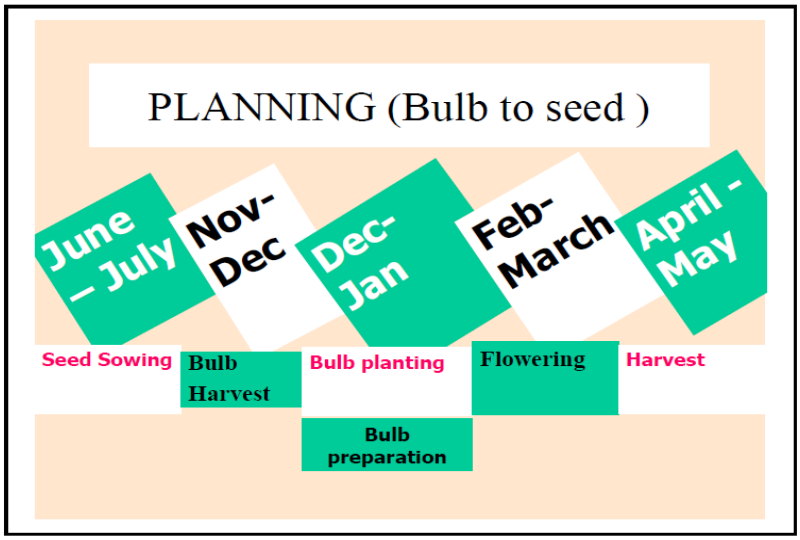
In this method, the first season bulb crop is left to over-winter in the field so as to produce seed in the following season.

2. Bulb to seed method

The bulbs produced in the previous season are lifted, selected, stored and replanted to produce seed in the second year. Mostly the bulb to seed method is used for seed production because of the following advantages over the seed to seed method.

a) It permits selections of "true-to-type" and healthy bulbs for seed production.

b) Seed yields are comparatively very high. The seed to seed method, however, can be practiced for varieties having a poor keeping quality.



Bulbs to Seed Method

Production and storage of bulbs (first year)

Sowing time (nursery)

Middle of October to middle of November in the plains and April to June in the hills. 1/20 hectare nursery is sufficient for raising seedlings for one hectare.

Seed rate

Eight to ten kg per hectare.

Seed treatment

Soaking of bellary onion (cv. Rampur Local) seeds with 100 ppm GA3 for 3 hrs increased the germination (from 50 to 90 per cent) and vigour.

Fertilization

Add 20 tonnes of well-rotted farmyard manure at the time of land preparation and 250 kg super phosphate (single) and 45 kg potassium sulphate at the time of planting. 250 to 375 kg of ammonium sulphate or CAN may be applied as top-dressing in two to three doses during the growing period.

Transplanting

Eight to ten weeks old seedlings are planted in small beds in well-prepared fields.

Spacing

Spacing depends upon variety and bulb size and varies from 10 to 15 cm.

Irrigation

Fortnightly irrigation during winter weekly irrigation during hot weather. Irrigate sparly during maturity.

Intercultural

Keep field free from weeds. Frequent inter culture is essential for good bulb development. For controlling weeds, post-emergence application of tenoran at 2 kg per hectare in 800 liters of water, two to three weeks after transplanting is recommended. Oxadiazon one kg active ingredient per hectare has also given for effective control of weeds.

Harvesting and curing of bulbs

Well-matured bulbs should be harvested. Maturity is indicated by the tops drooping just above the bulb, while the leaves are still green. After harvesting, the bulbs should be topped leaving a half inch neck. Before storage, a thorough selection and curing of bulbs should be done. The length of time required for curing depends largely on weather conditions and may take three to four weeks.

Storage

The essentials of successful storage are

a. The bulbs should be well-matured, dried and cured before storage.

b. Storage should be well-ventilated.

c. Storage should be done in shallow trays with perforated bottoms.

d. Storage temperatures should range 0 to 4.5° C until three to four weeks prior to planting, when the temperature should be increased to around 10° C.

Planting of bulbs and seed production (second year)

Time of planting bulbs

The best time for planting bulbs is the second fortnight of October.

Preparation of land

Prepare the field to good tilth. One deep ploughing followed by three to four harrowings and land levelling are enough.

Seed rate

The seed yield is affected by the size of the bulb. The bigger the bulb size, the higher is the seed yield. However, very large sized bulbs, if used, will need very high seed rate. If bulb size of 2.5 to 3.0 cm diameter is used for planting, approximately 15 quintals of bulbs per hectare are required.

Fertilization

Same as described for first year.

Method of planting and spacing

Selected bulbs are planted 8 to 10 cm deep in the soil at a distance of 45 x30 cm. The size of beds depends upon the source of irrigation. The sprouted bulbs are planted as such. In unsprouted bulbs,

the upper half portion should be removed, leaving the disc-like stem and roots intact. The removal of the upper tops hastens sprouting.

Foliar application

Foliar application of GA3 (100 ppm) (or) IAA (100 ppm) increase the seed setting per centage.

Rouging

First year: It is desirable to begin rouging in the field before bulbs are harvested, since it is then possible to detect any plants having a different foliage colour or plant type or late maturing bulbs. After harvesting, the bulbs should be carefully rogued for colour and such off-types as thick-necks, doubles, bottlenecks, as well as any other types which do not conform to varietal type.

Second year: plant only selected true-to type bulbs and remove plants not conforming to varietal characters before flowering.

Specific field standard

Field standard	
Other variety bulbs (max.)	0.2%
Off types (max.)	0.2%

Harvesting and processing

The maturity of seed ready for harvest is indicated when (April-May). On full maturity, the seeds turn into black colour. The matured seed bunches are harvested before shattering and dried .under shade. Normally two to three harvest are required depends up on the maturity of the seed. Harvest the seeds at intervals by cutting the seed head with 10-15 cm of stem attached. The harvested umbels are heaped for a few days for drying before threshing. This helps in proper curing of seed then the seeds are separated from the capsules by hand threshing or using pliable sticks. The seeds are cleaned, graded by using 10 x 10 BSS sieve, dried to 6-8 % moisture content and treated with Bavistin / Thiram @ 2-3g/kg of seed.

Seed Yield

The average seed yield varies from 850 to 1000 kg per hectare.

Seed standards: (Variety & Hybrid)

Factors	**Foundation**	**Certified**
Pure seed (minimum)	98%	98%
Inert matter (maximum)	2%	2%
Other crop seed (maximum) (no./kg)	5/kg	10/kg
Total weed seed (maximum) (no./kg)	5/kg	10/kg
Germination(minimum)	70%	70%
Moisture (maximum) (normal container)	8%	8%

EXERCISE NO : 12 Date:

METHODS OF SEED PRODUCTION OF SOLANACEOUS CROPS

Varietal and hybrids seed production in Solanaceous vegetables

1. TOMATO (*Solanum lycoperricum L.*)

Botany

Tomato is self-pollinated crop. Self-fertilization is favoured by the position of receptive stigma within the cone anthers and the normal pendant position of the flower. Anthesis starts at 6.30 a.m. and continues up-to 11.00a.m. Anther dehiscence occurs 1-2 days after opening of corolla. Tomato is a typical day neutral plant. It requires temperature of 15-20° C for fruit setting.

Method of seed production: Seed to Seed.

Stages of seed production

Tomato is a self-pollinated crop; hence either three or four generation model could be adopted as below

Varieties

Breeder seed ----- Foundation Seed ---- Certified Seed

Breeder seed ---- Foundation Seed I ---- Foundation Seed II ---- Certified Seed

Hybrids

Breeder seed ---- Foundation Seed ---- (Multiplication of parental lines) ---- Certified Seed (Production of F1 hybrids)

Varieties

Indeterminate varieties

Pusa Ruby, Solan Gola, Yaswant (A-2), Sioux, Marglobe, Naveen, Ptom-9301, Shalimar- 1, Shalimar-2. Angurlata, Solan Bajr, Solan Sagun, Arka Vikas and Arka Saurbh.

Determinate varieties

Roma (EC-13513), Rupali, MTH-15, Ptom-18, VL-1, VL-2, HS 101, HS 102, HS 110, Pusa Early Dwarf, Pusa Sheetal, Floradade, Arka Meghli, CO.1, CO.2, CO.3 (Marutham), PKM.1, Py1,

Hybrids

COTH-1, 2 and 3 Pant, Hybrid-2, Pant Hybrid-10, Kt-4. Pusa Hybrid-l-4, Arka Shreshta, Arka Vardan, Arka Abhijit, Navell 1 &2 (Sandoz), Rupali, Sonali, MTH 6

Season

It is highly suitable both for kharif (May – June) and rabi season (November - December).

Land requirement

Selection of suitable land for tomato seed production is important where the previous crop should not be the same variety to avoid the contamination due to volunteer plants.

Isolation requirement

For Seed production of tomato, varieties require minimum of 50 M for foundation seed and 25 M for certified seed. For hybrid seed production, it requires minimum of 200 M for foundation (parental line increase) and 100 M for certified hybrid seeds.

Seed rate:

i) Varietal seed production– 300 to 400 g/ha

ii) F1 hybrid seed production - Male parent 25 g/ha; Female parent 100 g/ha.

Seed Treatment

The seed required for one hectare are to be inoculated with *Azosprillum.* For this, the seeds should be first mixed with the required quantity of rice gruel and then with 150g of *Azosprillum* after shade drying it can be used for sowing.

Nursery

Sow the seeds in raised nursery bed of 20 cm height, in rows of 5 cm gap and covered with sand. Eight and ten nursery beds will be sufficient to transplant in one acre. Apply 2 kg of DAP 10days before pulling out of seedling.

Transplanting

Transplanting should be done with the seedlings are 20-25 days old, preferably at evening time.

Spacing

It varies with varieties from 60 x 30cm to 60 x 45 cm. and in hybrid seed production 90 x 60 cm for female parent and 60 x 45 cm for male parent.

Planting ratio

For hybrid seed production, the female and male parents are normally planted in the ratio of 12:1 or 12:2.

Manuring

After thorough preparation of a field to fine tilth, apply 25 tons of FYM per ha. Apply 100: 100: 100 Kg of NPK/ha of which, 50% of the N is applied as basal dressing and remaining 50% of N as top dressing in two split doses at just before flowering and fruit formation stages.

Rouging

The rouging should be done based on the plant characters (determinate / indeterminate), leaf, branching and spreading characters and also based on fruit size, shape and colour. The plants affected by early blight, leaf spot and mosaic (TMV) diseases should be removed from the seed production field.

Specific field requirements

Factors	Maximum permitted	
	Foundation	Certified
Off types variety (max)	0.10	0.20
Off types hybrid (max)	0.01	0.05
Plants affected by seed borne disease (max)	0.10	0.50

Harvesting and seed extraction

The fruits are harvested after full maturity of the fruit when turn in to red colour fruits from first and last one or two harvests should not be used for seed extraction. The fruits from in between 6-7 harvest should be used for seed extraction. The seed viability is depends on the method on which the seeds were extracted and hence, it is more important to choose proper methods of seed extraction. Before seed extraction, the fruits are to be graded for true to type and selection of medium to large size fruits for getting higher recovery of quality seeds. The acid method of seed extraction is the best method for tomato seed extraction. In this method, the fruits are to be crushed into pulp and taken in a plastic containers (or) cement tank. And then add 30 ml of commercial Hydrochloric acid per kg of pulp, stir well and allow it for ½ hour. In between this duration the pulp may be stirred well for one or two times. This facilitates the separation of seed and pulp. After ½ hour, the seeds will settle down at the bottom and then the floating fraction is to be removed. The collected seeds should be washed with water for three or four times.

Table 1. Comparison of different seed extraction methods

	Fermentation	Acid	Alkali
Method	Mix fruit pulp with water - 24 - 48 h	HCl @10ml / Kg of pulp - 20-30 minutes	Washing soda @ 900mg/4 l of water- equal volume – overnight soak
Salient features	▪ Low cost. ▪ Unskilled labour. ▪ More time taken. ▪ Low seed recovery (0.5 to 0.6 %) ▪ Dull seed colour. ▪ Seed borne pathogens	▪ Cost is more. ▪ Skilled labour. ▪ Lesser time. ▪ High seed recovery (0.8 to 1 %). ▪ Bright colour market value higher. ▪ Seed borne pathogen removed ▪ Improper washing leads to injury to seeds	▪ Recovery 0.7 to 0.8 per cent. ▪ Luster of the seeds will be lost. ▪ Improper washing leads to injury to seeds

While following acid method we must use only plastic or stainless steel containers or cement tank. Care must be taken to avoid the usage of iron or zinc containers, which will affect the viability potential of the seeds and as well, damage to the containers due to chemical reaction with acid.

For large scale seed extraction we can use the tomato seed extractor developed. The seeds extracted by this machine may again be treated with commercial Hydrochloric acid @ 2-3 ml/kg seed with

equal volume of water for 3-5 minutes with constant stirring. And then seed should be washed with water for three to four times.

It is easy to dry the seeds extracted by acid method and also remove the fungus growth over the seed coat, thus seeds possess golden yellow colour and high vigour. The seed extracted by fermentation method possess poor vigour and off colour due to fungal activity.

Seed cleaning and processing

After proper drying, the seed processing is essential. This will be helpful for maintaining high vigour and viability by way of removing immature and small seeds. In processing, we have to remove broken, immature and diseased seeds, other crop and weed seeds, mud and other inert matters. For processing tomato seeds, BSS 10 x 10 wire mesh sieve should be used.

Storage of unprocessed seeds results in poor viability. In processing, the sieves must be cleaned while changing to other variety otherwise it leads to physical admixture results in genetic contamination. Hence, utmost care must be taken during processing of seeds to maintain quality.

Seed treatment

The seeds may be treated with captan or Thiram @ 4g/kg of seeds. The seeds can also be treated with halogen mixture @ 5g/kg of seed and it is a eco-friendly seed treatment.

Storage containers

Seeds could able to absorb moisture from atmosphere. Hence for storing seeds in the coastal region (or) river sides we should use moisture vapour proof containers i.e. 700 gauge polyethylene bags. For seed storage every time new containers must be used.

Seed Yield: 100-120 Kg/ha

Seed Standards (variety and hybrid)

Factors	**Foundation**	**Certified**
Pure seed (mini)	98%	98%
Inert matter (maxi)	2%	2%
Other crop seeds (maxi) no/kg	5/kg	10/kg
Weed seeds (maxi)	None	None
Germination (mini)	70%	70%
Moisture (maxi)	8%	8%

BRIJAL (*Solanum melongena* L.)

Botany

Brinjal is often cross pollinated crop. Brinjal flower opens mainly in morning.

Anthesis starts at 5.53 a.m. and continues up to 7.35 a.m. with peak at 6.05 a.m. The dehiscences of anthers begin 30 minutes after anthesis. The stigma is receptive from 2 days before anthesis and up to 8 days. Brinjal produces 4 types of flowers with different style length. (Long style, short style, medium style and pseudo short style). For seed production and better yield, the long and medium style is desirable. To increase the production of long and medium style application of more nitrogen or spraying of growth regulators during pre-flowering and flowering stages may be followed.

Method of seed production: Seed to Seed.

Stages of seed production

Breeder seed ---- Foundation Seed I ---- Foundation Seed II ---- Certified Seed.

Varieties

CO.1, CO.2. MDU 1, PKM.1, KKM.1, PLR. 1. AU1, Pusa Purple Long, Arka Nidhi, Pant Samrat, Arka Neelkanth, Arka Shrish.

Hybrids

COBH1, Arka Navneet (IIHR 22-1 x Supreme), Pusa H-5, Pusa H-6, MHB 10, MHB 39 (Mahyco), Azad Hybrid.

Season

The brinjal seed production can be taken up in the following two seasons. May-June and December- January

Land requirement

The land should be free of volunteer plants.

Isolation

For varieties, 200 M and 100 M of isolation distance is required for foundation and certified seed, respectively. For hybrid seed production minimum of 200 M isolation distance should be maintained.

Seed rate

Varieties - 400 - 500 g/ha

Hybrids - 200 g/ha (Female)

- 50 g/ha (Male)

Seed treatment

Seed treatment with *Trichoderma viride* @ 4g kg-1 before sowing can be practiced against the incidence of damping off disease. Drenching of copper oxy chloride at 0.1% at weekly interval minimize this disease.

Nursery

Sow the seeds in raised nursery bed of 20 cm height, in rows of 5 cm gap and covered with sand. Eight and ten nursery beds will be sufficient to transplant one acre. Apply 2 kg of DAP 10days before pulling out of seedling.

Transplanting

Seedlings are transplanted when they are 30-35 days old (12-15 cm height) preferably in the evening time. Spacing of 75 x 60 cm (non-spreading) and 90 x 60 cm (spreading) varieties, 90 x 60 cm for female parent and 60 x 45 cm for male parent of hybrids.

Manuring

The field should be thoroughly ploughed for fine tilth and apply 25 tons of FYM/ha. The other fertilizer requirement for brinjal variety and hybrid are same as followed for tomato seed production.

Rouging

The rouging should be done based on the plant characters, leaf, branching and spreading characters and also based on fruit size, shape and colour. The plants affected by phomopsis blight, leaf spot and little leaf virus disease should be removed from the seed production field.

Specific Field Standards

Factors	**Foundation**	**Certified**
Off types – Variety (max)	0.1%	0.2%
Hybrid (max)	0.01%	0.05%
Designated diseased plant (max)	0.1%	0.5%

The designated diseases in brinjal are Phomopsis blight caused by *Phomopsis vexans* and little leaf caused by Datura virus -2.

Harvesting and processing

Harvesting is done when fruits are fully ripe (when the fruits turn into yellow colour) *i.e.*, 45 days after flowering. The harvested fruits are to be graded for true to type and off type and fruit borer infested fruits are discarded. The graded fruits are cut in 2-3 pieces or whole fruits will be put in a cement tank with water and crushed manually and then allow it for fermentation for 1-2 days. Then the floating pulp portions are to be removed, the seeds settled at the bottom should be collected and washed with water and then the seeds are treated with commercial Hydrochloric acid @ 3-5 ml/kg of seed. The mixture is kept for 10-15 minutes with frequent stirring. Then the treated seeds are to be washed with water for 3-4 times. Afterwards seeds are dried under shade for 2-3 days over a tarpaulin and followed by sun drying for 1-2 days to reduce the seed moisture content to 8 per cent. Then the seeds are cleaned and graded with BSS 12 sieve. The processed seeds are treated with fungicides or Halogen mixture @ 5g/kg of seed. To upgrade the seed lot water floatation technique

and specific gravity grading are commonly used. Seeds can be stored in aluminium foil pouches by which the viability can be maintained up to 18 months under ambient condition, by dressing the seeds with 2 g of thiram / kg of seed.

Seed treatment

Seeds must be treated with fungicides before storage. The seeds may be treated with Captan or Thiram @ 4g/kg of seeds. The seeds can also be treated with halogen mixture @ 5g/kg of seed and it is an eco-friendly seed treatment.

Storage containers

Seeds could absorb moisture from atmosphere. Hence storing seeds in the coastal region (or) river sides we should use moisture vapour proof containers *i.e.*, 700 gauge polyethylene bags. For seed storage every time new containers must be used.

Seed Yield: 100-200 Kg/ha

Seed Standards (Variety & Hybrid)

Factors	**Foundation**	**Certified**
Pure seed (mini)	98%	98%
Inert matter (maxi)	2%	2%
Other crop seeds (maxi) no/kg	None	None
Weed seeds (maxi)	None	None
Germination (mini)	70%	70%
Moisture (maxi)	8%	8%
Genetic purity required for tomato & brinjal hybrids	90%	90%

CHILLI (*Capsicum annuum*)

Botany

Cross pollinated vegetable. The flower is protogynous. Flowers open in the morning between 5.00 a.m and 6.00 a.m Anther normally dehisces between 8.00 a.m and 11.00 a.m. Pollens are fertile on the day of anthesis and stigma is receptive for about 24 hours after flower opening.

Method of seed production: Seed to seed

Stages of seed production

Breeder seed ---- Foundation seed ---- Certified seed.

Varieties

Samba Varieties: K1, CO1, Pusa Jwala, PKM1, CO3, K2, Pant C1, G4 Gundu Varieties: CO2, G5 (Andhra Jyoti), PMK1, PLR1, CO4

Notified Varieties: G5, Chanchal, CO1, CO2, Hot Portugal, Jawhar mirch 218, Jwala, K1, K2, MDU1, Pant C1, Panjab lal , PKM1, Sanauri, Sindhur

Hybrids

KT.1, (Pusa Deepti), Solar Hybrid 1, Solar Hybrid 2. Early Bounty, Indira, Lario, Hira, Bharat.

Season

June-July, February-March, September- October.

Land requirement

There is no land requirement as of previous crops, but the land should be free from volunteer plants. Generally areas affected by wilt or root rot may be avoided. Crop rotation must be followed to avoid endemic Solanaceous pests.

Isolation requirement

Minimum isolation distance of 400 M for foundation and hybrid seed and 200 M for certified seed production are necessary.

Seed rate

Seed required for one hectare is 500 g to 1 kg for variety; for hybrids - Female - 200 g and male - 50 g.

Seed Treatment

Seeds should be treated with captan @ 2g/kg or *Trichoderma viride* @ 4g /kg of seed and also seed treatment with *Azospirillium* @ 0.1 % improved the seedling vigour in chilli.

Nursery

Sowing the seeds in raised nursery bed of 20 cm height, in rows of 5 cm gap and covered with sand. Eight and ten nursery beds will be sufficient to transplant one acre. Application of 2 kg of DAP 10 days before pulling out of seedlings.

Transplanting

The seedlings of 30-35 days old are ready for transplanting. Transplanting may be done on the ridges in the evening.

Foliar spray

To arrest the flower drop, NAA (Planofix) can be sprayed @ 4ml/litre of water.

Very light irrigation is also done to arrest the flower drop.

Manuring

Application of 50 tonnes of FYM/ha for irrigated crop. Basal 100:70:70 kg of NPK and 50 kg of N at 15 days after transplanting and 50 kg N at 45th days after transplanting.

Rouging

Field inspection and roughing should be done both for varieties and hybrid at different stages based on the plant height and its stature, flower colour and pod characters. The plants affected with leaf blight, anthracnose and viral diseases should be removed from the seed field.

Specific Field Standards:

Factors	Foundation	Certified
Off types (max)	0.1%	0.2%
Designated diseased plant (max)	0.1%	0.5%

The designated diseases are caused by *Collertotictum capsici* and leaf blight caused by *Alternaria solani.*

Harvesting and processing

Harvesting should be done in different pickings. First and last two pickings can be harvested for vegetable purpose. The well ripened fruits with deep, red colour alone should be collected in each picking. After harvest, fruit rot infected fruits are to be discarded. The harvested pods are to be dried under shade for one (or) two days and then under sun for another 2 or 3 days. Before drying pods are to be selected for true to type and graded for seed extraction. The seed are extracted from graded dried pods. The pods are taken in gunny bag and beaten with pliable bamboo sticks. The seeds are cleaned by winnowing and dried to 10% moisture content over tarpaulin. Then seeds are processed with BSS 8 wiremesh screens.

Seed storage

Seeds obtained from the first picking stored well for a longer time than those obtained from fifth and sixth pickings. The rate of deterioration was also faster in seed obtained from the later pickings. The seeds stored in PAFP pouches recorded higher germination for thirty months after storage as compared those in cloth bags.

Seed Yield: 100 to 200 kg/ha.

Seed Standards (Variety & Hybrid)

Factors	Foundation	Certified
Pure seed (mini)	98%	98%
Inert matter (maxi)	2%	2%
Other crop seeds (maxi) no/kg	5/kg	10/kg
Weed seeds (maxi) no/kg	5/kg	10/kg
Germination (mini)	60%	60%
Moisture (maxi)	8%	8%

EXERCISE NO: 13 **Date:**

METHODS OF SEED PRODUCTION OF CUCURBITACEOUS CROPS

Land Requirements: There are no land requirements as to previous crop, but the land should be free of volunteer plants. Generally the soil should be well drained and aerated.

Isolation Requirements: Most of the cucurbits are monoecious in character and a few are dioecious. A number of hermaphrodite and andromonoecious cultivars are also available in some crops. Pollination is largely done by insects. For pure seed production and isolation distance all around seed field is necessary to separate it from fields of other varieties, fields of the same variety not conforming to varietal purity requirements for certification, from wild cucurbit species, and to separate musk melon from long melon and vice versa, and pumpkin from summer and winter squashes and vice versa as follows

Seed production details in Cucurbitaceous vegetables

Particulars	Bittergourd	Snakegourd	Ridgegourd	Ashgourd
Isolation distance	Foundation seed 1000 m & Certified seed 500 m			
Season	June - July and Feb – March			
Seed rate	2.5 kg	2.5 kg	2.5 kg	2.5 kg
Spacing	Take pits of size 45x45x45 cm at 2.5x2.0 m distance			
Female flowers increased by	Spraying of Ethrel 200 - 250 ppm at two true leaf stage and after a week of 1st spray			
Physiological maturity	Change of fruit colour in any part or 1/3 of fruit tip to yellow to red		Complete drying of fruits	Change of fruit colour to orange brown in pumpkin and ashy coating and metallic sound in ashgourd
Seed yield (kg/ha)	120-150	220-250	200-250	120-150

Seed Standards

Factors	**Foundation**	**Certified**
Pure seed (mini)	98%	95%
Inert matter (maxi)	2%	5%
Other crop seeds (maxi) no/kg	None	None
Weed seeds (maxi) no/kg	None	None
Germination (mini)	60%	60%
Moisture (maxi)	7%	7%

Techniques of Hybrid Seed Production in cucurbits

i. Hand emasculation and hand pollination

This technique is frequently used for melon seed production. In this species, andromonoecious lines are common and they must be emasculated and hand pollinated if used as the female parent for producing hybrid seed. This method has also been used for some watermelon and cucumber hybrids. This technique is applicable for limited scale production, since lot of trained labour are required in pinching, pollen collection and hand pollination.

ii. Hand emasculation and pollination by insect

The male flowers from female lines are pinched off day before of anthesis regularly, which honeybees and other insects (voluntary) uses as a pollinating agents. The male and female are grown in alternate rows. The fruit set on female lines are of hybrid and harvested for seed extraction. The planting ratio varies within the crops e.g. summer squash 3:1 and 4:1 in muskmelon and cucumber but depend upon the population of bees in plot. This technique is also used in bottle gourd, pumpkin, muskmelon, cucumber, summer squash and bitter gourd for hybrid seed production.

iii. Use of genetic male sterility system

Genetic male sterility system has been utilized for commercial hybrid production in muskmelon. The genetic male sterility in muskmelon is controlled by

single recessive gene (msms). For hybrid seen production, the male sterile line is used as female parent. Since genetic male sterile line is maintained in heterozygous forms, 50% fertile plants are to be removed at flowering. The other 50% having non-dehiscent empty anther are retained in female rows. The female and male are grown in 4:1 ratio. However, to maintain the good plant population in female rows it is suggested that seed parent should be sown with double seed rate. It is also advised that female line seedling should be raised in polythene bags and transplanted at flower appearance in order to avoid the fertile plants in female rows. The pollination is done by honey bees and 1 to 2 medium sizes hives are good enough to ensure the good pollination and fruit set at female row.

The male sterile line is maintained in heterozygous form by crossing with maintainer line under adequate isolation distance or under cover.

iv. Use of gynoecious sex form

The gynoecious sex form has been commercially exploited in hybrid seed production of cucumber. For hybrid seed production female and male rows are planted in 4:1 ratio. The female (seed parent) bear only female flowers and pollination in done by insect (honeybee). To ensure the good fruit and seed recovery, the sufficient population of honeybee 1 to 1½ colony of medium size has to be kept at the boundary of seed production plot to boost the amount of crossing. The parental lines i.e. male parent maintained by selfing (mixed pollination) and rouge out undesirable plants before

contamination take place. The female lines i.e. gynoecious lines maintained by inducing the staminate flower through the sprays of silver nitrate 200 ppm at two to four true leaf stage and then selfing is carried out. It was observed that 10-11 male flowers appear per 100 nodes.

The performance of gynoecious lines is unstable under high temperature and long photo period conditions because of their thermo-specific responses for gynoecious stability. That is why the gynoecious cucumber did not receive much attention in the tropical countries. However, few true breeding tropical gynoecious lines in cucumber and muskmelon have been developed at IARI. As a result of development of true breeding line, muskmelon hybrid Pusa Rasraj was developed.

These homozygous gynoecious lines are maintained by using GA_3, 1500ppm or silver nitrate 200-300 ppm or sodium thio sulphate 400 ppm to induce staminate flowers at two and four true leaf stage. Homozygous lines are planted in strict field isolation. The gynoecious lines are crossed with monoecious male parent to produce F1 hybrid.

v. Hybrid seed production through chemical sex expression

The hybrid seed can also be produce in cucurbits by the application of chemicals for attaining the sex of cucurbits. Specific chemicals are known to induce femaleness and maleness as desired. The spraying of ethrel (2-choloro-ethyl-phosphonic acid) 200-300 ppm at two and four true leaf stage and another at flowering is useful for inducing the pistilate flower successively in first few nodes on the female in bottle gourd, pumpkin and squash for F_1 seed production. The row of male parent is grown side by the side of female and natural cross pollination is allowed. In the absence of insect, hand pollination is possible when two sexes are separate. Four to five fruit set at initial nodes are sufficient for hybrid seed. The complete suppression of male flowers in squash can be achieved by applying ethrel at higher concentration (400-500 ppm) twice. The other chemicals like GA_3, (10-25 ppm) in cucumber, MH-(100 ppm), ethephon (600 ppm) in squash induces female flowers.

EXERCISE NO: 14 **Date:**

METHODS OF SEED PRODUCTION OF LEAFY VEGETABLES

Coriander (*Coriandrum sativum)*

Botany

The inflorescence is compound umbel. Flowering starts with the primary umbel.

In every umbel the peripheral umbellets and in every umbellet the peripheral flowers are the first ones to flower. Flowers are protandrous, small, white or pink in compound terminal umbels, fruits-schizocarp, globular, yellow-brown, ribbed, 2 seeds, ripe seeds are aromatic. Time of anthesis is 5.30-7.00 h. Duration of pollen fertility up to 14 h after anthesis stigma receptivity is 12 h before to 6-7 h after anthesis.

Stages of seed production: Breeder seed ---- Foundation seed ---- Certified seed

Varieties: CO1, CO2, CO3, Gujarat Coriander -1, Gujarat Coriander-2, Rajendra Swati, Rcr- 47, Swathi, Sadhana.

Season: In Tamil Nadu, as an irrigated crop, coriander is raised in June-July and September-October. In the first season, it matures early before the end of August- September. In the second season the crop matures late with an extended growth phase during January- February. The growth and the yield of second season crop are found to be better than the first season crop.

Land requirement: Land to be used for seed production of coriander should be free from volunteer plants.

Isolation requirement: Foundation seed – 200 m; certified seed – 100m

Seed rate: Irrigated condition - 10-15 kg/ha

Rainfed condition - 25-30 kg/ha

Seed treatment: Coriander fruit contains two seeds which are fully capable of germination. Therefore, it is highly essential to divide fruit into halves (mericarps) by rubbing on rough floor with a wooden roller holding by hands at both the ends. This operation not only reduce 50 per cent seed requirement (both halves) but only enhance early and high percentage of germination.

Sowing: For irrigated crop, sowing is generally done in rows spaced at 30 to 40 cm apart with 15 cm between hills. Soil depth should not exceed 3.0 cm. Three to five seeds are sown in a hill and later on thinned to two plants per hill.

Seed treatment: Water soluble inhibitors are present in coriander schizocarp which prevents seed germination. Seed leaching in running water for 16 hr and then soaking in double the quantity of 100 ppm GA3 solution for 16 hr will enhanced the germination and vigour index.

Main field manuring: About 10 tonnes of farm yard manure is applied at the time of last preparation. In addition, to this, 20 kg N, 30 kg P and 20 kg K per hectare should be applied at the time of sowing for both irrigated and rainfed crop. For irrigated coriander an additional dose of 40 kg N/ha should be applied in two equal splits, first at 30 and second at 75 days of sowing.

Irrigation: First irrigation is given 3 days after sowing and thereafter at 10 to 15 days interval depending upon the soil moisture available in the soil.

After cultivation: The first hoeing and weeding are given in about 30 days. Thinning the plants is also attended simultaneously, leaving only two plants per hill. Depending upon the growth one or two more weeding are done.

Rouging: A minimum of 3 inspections shall be made during before flowering, 50% flowering and prior to harvest to verify the true nature of plant.

Field Standards

Factors	**Foundation seed**	**Certified seed**
Isolation distance (m)	10	5
No. of field inspection	2	2
Off-types (%)	0.10	0.20

Harvesting and processing: Harvesting has to be done when the fruits are fully ripe and start changing from green to brown colour. Delaying of the harvest should be avoided reduces shattering during harvest and splitting of the fruits in subsequent processing operations. The plants are cut or pulled and piled into small stacks in the field to wither for 2 to 3 days. The fruits are then threshed out from the plants by beating with sticks or rubbing with hands. The produce is winnowed, cleaned and dried in partial shade. After drying the produce is stored in gunny bags lined with paper. The irrigated crop yields and average 600 to 1200 kg/ha. Coriander seeds treated with halogen mixture @ 3g/kg of seed and packed in 300 gauge poly lined cloth bag stored for more than 5 months.

Seed standards

Factors	**Foundation**	**Certified**
Pure seed (minimum)	98%	98%
Inert matter (maximum)	2%	2%
Other crop seed (maximum) (no./kg)	10 /kg	20/kg
Total weed seed (maximum) (no./kg)	10/kg	20/kg
Germination(minimum)	65%	65%
Moisture (maximum) (normal container)	10%	10%

Fenugreek (*Trigonella foenum-graecum* L.)

Botany

Fenugreek is a self-pollinated and quick growing crop produces bright orange to yellow flowers. The pods are sickle shaped containing small deeply furrowed seed. The flowers open between 6.00 and 9.00 am. The stigma becomes receptive 12 hour before and the anthers also dehisce before the flower actually opens.

Method of seed production

Stages of seed production: Breeder seed ---- Foundation seed ---- Certified seed

Varieties: CO1, Rajendra Kanti, RMT-1, Lam Sel.1, Hissar Sonali

Isolation: Foundation Seed 10 m;

Certified seed 5 m

Climate and Soil: It has a wide adaptability and is successfully cultivated both in the tropics as well as temperate regions. It is tolerant to frost and freezing weather. It does well in places receiving moderate or low rainfall areas but not in heavy rainfall area. It can be grown on a wide variety of soil but clayey loam is relatively better. The optimum soil pH should be 6.0 to 7.0 for its better growth and development.

Land preparation and sowing: Land is prepared by ploughing thrice and beds of uniform size are prepared. Broadcasting the seed in the bed and raking the surface to cover the seeds is normally followed. But, line sowing is advocated in rows at 20 to 25 cm apart which facilitates the intercultural operations.

Season: Sowing in the plains is generally taken up in September to November while in the hills, it is grown from March. Approximately 20 to 25 kg of seed is required for one hectare and the seed takes about 6-8 days to complete its germination.

Manures and fertilizers: Besides 15 tones of farmyard manure, a fertilizer dose of 25 kg N, 25 Kg P2O5 and 50 kg K2O per ha is recommended. Half of the N dose and the entire quantity of P and K are applied basally and the remaining half N is applied 30 days after sowing.

Irrigation: First irrigation is given immediately after sowing and subsequent irrigation is applied at 7 to 10 days interval.

Inter cultivation: Hoeing the weeding during the early stages of plant growth is required to encourage proper growth. Thinning may be done on 20 to 30 days to keep the distance between the plants at 10 to 15 cm and to retain 1 to 2 plants per hill.

Rouging: The off-types should be removed both at flowering and at maturity stage. The plants of *melilotus spp* should also be removed from the field prior to harvest.

Field standards

Factors	Breeder seed	Foundation seed	Certified seed
Isolation distance (m)	50	10	5
No. of field inspection	-	2	2
Off-types (%)	-	0.10	0.20
Inseparable other crop plants (%)	-	-	-
Objectionable weed plants (%)	-	0.01	0.02
Plant / affected by designated diseases (%)	-	-	-

Harvest: Fenugreek seeds attained physiological maturity 45 days after anthesis when the seed moisture content was around 20 per cent. Harvesting should be done when the lower leaves start shedding and the pods have become yellowish. Harvesting should be done by cutting the plants with sickles. Delay in harvesting leads to shattering and lose of seeds. The harvested plants are tied in bundles and allowed to dry for 4-6 days. Threshing should be done on clean floor or tarpaulin. The seeds are separated by beating followed by winnowing or by the use of mechanical threshers.

Seed grading: Seed grading is done with 6/64" round perforated metal sieve.

Seed yield: 1200 – 1500 kg/ha.

Seed standards

Factors	Foundation	Certified
Pure seed (minimum)	98%	98%
Inert matter (maximum)	2%	2%
Other crop seed (maximum) (no./kg)	5/kg	10/kg
Total weed seed (maximum) (no./kg)	10/kg	20/kg
Germination (minimum)	70%	70%
Moisture (maximum) (normal container)	8%	8%

Fennel (*Foeniculum vulgare*)

Botany

Two kinds of flowers on this umbelliferous plant. The first of the tiny yellow flowers to bloom on an umbel or hermaphrodite with a few isolated staminate ones. These hermaphrodite flowers are completely protandrous. After the five stamens of a blossom dehisce and their pollen drops off, the stigma becomes receptive and continues to be receptive for 2-4 days .The pollen remains viable for 10 hrs. Flower opening started at 6 A.M. and reached a maximum between noon and 2.00pm.

Variety: RF 101, RF 125, PF 35**,** CO-1, Gujarat Fennel-1

Season: Mid September to Mid October

Nursery: For transplanted crop nursery is raised in the month of June or July. The seedlings of 45-60 days are transplanted in the month of August

Seed rate:

Direct sowing: 10-12 kg/ha

Transplanted crop: 3-4 kg/100m2 in nursery is sufficient for transplanting in one hectare

Sowing: Sowing should be done in rows 45-60 cm x 20 cm or broad casting and the depth of sowing should not be more than 2 cm in case of direct sowing.

Manuring: FYM/compost at the rate of 10-15 t/ha should be applied at the time of field preparation. In addition to this 90 kg N/ha in 3 equal splits, first as basal dose with 40 kg/ha P2O5 at the time of sowing, second at 30 DAS and third at 60 DAS with irrigation should be applied to obtain good yield.

Weed control: Because of slow germination it faces severe weed competition. At the time of thinning i.e. 30 DAS, one hand hoeing and weeding should be done and it should be repeated twice or thrice as required.

Irrigation: It is a long duration crop or it requires more irrigations. The crop is irrigated at an interval of 15-25 days until the seed maturation.

Harvesting: It matures in about 170-180 days. All the umbels do not mature the same time. So plucking of umbels is done when seeds are fully developed but still green. Harvesting is completed by plucking twice or thrice at an interval of 10 days. Plucked umbels are dried in sun for 1-2 days and then in shade for 8-10 days. Longer exposure to sun changes the colour and lustre of the seeds which reduces the quality. A sieve with 1/14” x ¾” perforations was recommended for grading of fennel seed.

Yield: 900-1000 kg/ha.

Field Standards

Factors	Foundation seed	Certified seed
Isolation distance (m)	10	5
No. of field inspection	2	2
Off-types (%)	0.10	0.20

Seed standards

Factors	Foundation	Certified
Pure seed (minimum)	98%	98%
Inert matter (maximum)	2%	2%
Other crop seed (maximum) (no./kg)	5/kg	10/kg
Total weed seed (maximum) (no./kg)	10/kg	20/kg
Germination(minimum)	70%	70%
Moisture (maximum) (normal container)	8%	8%

EXERCISE NO: 15 Date:

METHODS OF SEED PRODUCTION OF LEGUMINOUS VEGETABLES

Vegetable cowpea (*Vigna unguiculata* L.)

Botany

Vegetable cowpea is a self-pollinated crop. The flowers of cowpea are hermaphrodite and opens between 7.00 to 9.00 am. The time of dehiscence of anthers is from 10.00 am to 12.45 pm. The dehiscence takes place before flower opening.

Isolation distance

50 m for foundation seed and 25 m for certified seed production.

Climate and Soil

Vegetable cowpea is a warm season crop and therefore it can be grown both in spring and in rainy seasons in the plains of India. It cannot tolerate cold weather, heavy rainfall and water logging.

Method and time of sowing

The seeds are dropped in the furrow in such a way that maintains distance approximately 10 to 15 cm in the rows which are at 40 to 60 cm apart for rainy season crop whereas summer crop is sown at the row distance of 25 to 30 cm.

Seed rate

The requirement of seed for spring season crop is 20 to 25 kg/ha and for rainy season crop is 12-15 kg/ha.

Manuring

Vegetable cowpea responds well to an addition of manure and fertilizers.

Application of 25 to 30 t/ha FYM improves the yield and quality of cowpea. About 20-25 kg nitrogen and whole dose of phosphorus (50-60 kg/ha) and potassium (50-60 kg/ha) areapplied in soil during the last field preparation (6.1). Cowpea is highly sensitive to Zn deficiency. Application of 10 to 15 kg zinc sulphate per hectare would be beneficial.

Rouging

The seed crop of cowpea is rogued out for all off-types and diseased plants form the crop before flowering and during flowering. When the pods mature, at this stage off-types can be detected.

Field standards

Factors	Foundation	Certified
Off types	0.10%	0.20%
Designated Diseases	0.20%	0.20%

Harvesting

The seed crop of cowpea matures in 75 to 125 days, depending upon the season and the variety. The pods turned into straw colour. Entire plant is harvested at the ground level and are allowed to dry in the field or heaped at one place in threshing floor for drying.

Threshing and winnowing

The dried material is threshed by thresher or trampled. By winnowing all inert matter, chaffy seeds etc. are taken out.

Drying

Cleaned seed of cowpea is spread on tarpaulin for drying till 10 percent moisture remained in seed.

Seed yield

Seed crop of cowpea produces about 10-15 quintals of seed per hectare.

Seed standards

Factors	**Foundation**	**Certified**
Pure seed (max.)	98%	98%
Inert matter (max.)	2%	2%
Other crop seed (max.)	None	None
Total weed seed (max.)	None	None
Other distinguishable varieties (max.)	5/kg	10/kg
Germination (max.)	75%	75%
Moisture (max.)	9%	9%

Cluster bean (*Cyamopsis tetragonoloba* (L.) Taub)

Botany

Cluster bean is a self-pollinated crop having about 9 per cent maximum natural out crossing. The plants are normally fully fertile; a few semi-sterile ones have also been reported.

Isolation distance

Isolation distance of 50 metres for foundation and 25 metres for certified seed is essential.

Sowing

Cluster bean can be sown twice in a year, February - March in Northern plains and December - January in Southern plains.

Seed rate

In order to sow one hectare area about 30-40 kg seed of cluster bean is required.

Nutrition

The yield of cluster bean has been maximum when the crop was applied with 40 kg nitrogen and 60 kg phosphorus per hectare. The application of micronutrient to cluster bean crop proves very

beneficial. Two sprays of molybedenum at 0.15 per cent at 15 and 30 days after seedlings emergence give better yield.

Rouging

The first rouging should be done before flowering, the second one during flowering and fruiting stage and the third rouging at maturity.

Field standards

Factors	Foundation	Certified
Off types	0.10%	0.20%
Designated Diseases	0.20%	0.20%

Harvesting

When cluster bean pods attained full maturity (they turn grey in colour) the harvesting is done either by cutting entire plant at ground level or the plants are cut just below the first pod from ground level. Seed quality will be higher when seed crop is harvested after taking two pickings of fresh pods for vegetable use.

Seed extraction

It is done by threshing followed by cleaning (winnowing).

Drying

Cleaned seed is again allowed to dry in open sun on tarpaulin to 9.0 per cent moisture.

Seed yield

Under good crop management, about 10-12 quintals of seed yield is obtained per hectare.

Seed standards

Factors	Foundation	Certified
Pure seed (max.)	98%	98%
Inert matter (max.)	2%	2%
Other crop seed (max.)	None	None
Total weed seed (max.)	None	None
Other distinguishable varieties (max.)	5/kg	10/kg
Germination (max.)	75%	75%
Moisture (max.)	9%	9%

French (garden) bean (*Phaseolus vulgaris*)

Botany

The French bean is also known as garden bean, snap bean, kidney bean, haricotbean, navy bean, string bean. French bean flowers are cleistogamous, but they are selfcompatible and self-pollinated although some chances of cross-pollination (1.1%)

Isolation distance

Isolation distance of 50 metres for foundation seed and 25 metres for certified seed crop.

Method and time of sowing

French bean can be sown twice in a year, i.e., in January - February and July - September in the plains and March - June in the hills.

Distance of sowing

Bush types are planted at 45-60 cm x 10-15 cm (row x plant) whereas pole types at 100 cm x 22-30 cm.

Nutrition

Nitrogen at higher level decreases nodulation. But nitrogen at low level enhances microbial activity in the soil and plants while phosphorus at double the level than nitrogen required for better up take of nutrient and nodulation. Similarly, potassium plays important role for higher seed yields. Potassium has also been found to induce early flowering.

N (kg/ha) P (kg/ha) K (kg/ha) FYM (t/ha)

Hills 180 125 100 30

Plains 100 100 50 12.5

Rouging

Rouging is performed at four stages. They are

1. Before flowering

The first rouging is done before flowering. This is based on plant habit, vigour, according to type (bush type or pole type), leaf shape and colour. Besides, severely affected plants by diseases particularly seed borne diseases.

2. At flowering

At this stage, plants are removed on the basis of vigour and flower colour, and plants affected with seed borne diseases.

3. At pod developing stage

At this stage, plants are removed based on pod characters such as pod shape, colour and plants affected with seed borne diseases.

4. At maturity

At this stage, later flowering and late maturing off-types can easily be detected, which are removed.

Field standards

Factors	Foundation	Certified
Off types	0.10%	0.20%
Designated Diseases	0.20%	0.20%

Harvesting

Harvesting is done when pods are fully ripe and have turned yellow i.e. about to shatter. Crop is harvested manually or by machine. The harvested plants are staked for 7-10 days for drying.

Threshing

Fully dried matter is threshed either by bullock or by threshing machine.

Seed yield

The average seed yield of French bean is about 12 to 18 quintals per hectare.

Seed standards

Factors	Foundation	Certified
Pure seed (max.)	98%	98%
Inert matter (max.)	2%	2%
Other crop seed (max.)	None	None
Total weed seed (max.)	None	None
Other distinguishable varieties (max.)	5/kg	10/kg
Germination (max.)	75%	75%
Moisture (max.)	9%	9%

EXERCISE NO: 16 **Date:**

VISIT TO SEED PRODUCTION PLOTS, SEED PROCESSING UNITS AND SEED TESTING LABORATORY