PRACTICAL MANUAL

Seed Production of Vegetable, Tuber and Spice Crops

B.Sc. (Hons.) Horticulture

Semester : VIth (New)

Course No.: H/VS-367

Credits : 3 (2+1)

College of Horticulture

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Certificate

This is to certify that Mr./Miss._____ Reg. No._____ a student of VIth semester B.Sc. (Hons.) Horticulture has completed all the exercises successfully for the Course: Seed Production of Vegetable, Tuber and Spice Crops, Course No. H/VS-367 during the academic year_____.

Place : Parbhani

Date :

Remarks :

Signature of course teacher

Course Title	:	Seed Production of Vegetable, Tuber and Spice Crops
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STUDY OF SEED STRUCTURE, SIZE, SHAPE ETC.

Seed: Matured ovule consisting of embryonic plant together with store of food surrounded by protective coat.

Seed structure

Seed coat : It is protective coat made up of two layers, testa (outer thick layer) and tegmen (inner thin membrane) present as an envelop to profect the embryo and endosperm from desiccation, mechanical injury, effect of environmental functions and damage due to insects and micro-organisms.

Embryo: It is a rudimentary plant present in axis form with one tip known as plumule responsible to form shoot portion and the other tip known as radicle forms the root.The portion of embryonic axis extended above the cotyledon is known as epicotyl and below the cotyledon as hypocotyl.

Endosperm: It is a thick and massive structure made up of elongated cells containing abundant starch.On the basis of presence or absence of endosperm seeds are categorized into two groups. 1) Albuminous- endosperm present
2) Exalbuminous-endosperm absent.

Cotyledon: It is the extension of the embryo. On the basis of number of cotyledons, the crop species are divided into two groups i.e.i) monocot ii) dicot.

Epicotyl: A portion of embryo or seedling above the cotyledons, which gives rise to shoot of the plant is known as epicotyl.

Hypocotyl: A portion of embryo or seedling below the cotyledons, which gives rise to root of the plant.

Seed size: The size of seeds range from minute orchid seeds (dust like) to large double coconut. Seed size is the most obvious of the several characteristics and is influenced by environment during development. In case of seed size variation in the harvested seed lot of a variety which can be measured indirectly on the basis of weight or density.

Seed colour: The colour of seeds depends on the pigmentation of seed coat proper or the accessory layers of cover wherever present. It varies from black (onion); green (pea); red (cowpea); yellow (methi, tomato, brinjal, chilli); white (cucumber, muskmelon) to chocolate watermelon) in various shades of intense or dilute hue and often mottled in different combination of colours.

Seed shape: Flat, round, oval, oblong and irregular seed shape.

Seed texture: The seed surface may be smooth, wrinkled, striated, ribbed and or furrowed; reticulate; alveolate; pulpy or hairy. In some plants the features of seed are so characteristic that they help in indentification of the species and varieties.

Classification of seed:

1. Monocotyledonous : seed with single cotyledon.

a) Albuminous or endospermic: Seed having special food material i.e. food storage tissues (endosperm) eg. Onions, zinger, garlic, leek, shallot, asparagus etc.

b) Exalbuminous or non endospermic**:** Seed without food storage tissues and having single cotylendon e.g. Pothos, Orchids.

2. Dicotyledonous : Seed with two cotyledons.

a) Albuminous endospermic: Seed having two cotylendons and endospermic tissues for storage of food material e.g. Cabbage, broccoli, brussel sprouts, cauliflower, radish, beans, cowpea, okra, watermelon, cucumber,carrot, parsnip, parsley, celery, potato, tomato, egg plant etc.

b) Exalbumious/non endospermic: Seed having two cotylendons but without endosperm i.e. food storage tissues i.e. stam bean, pea, etc.

Objectives: 1) To know the different parts of seed
2) To study the functions of each part of seed.

Practical-1 : Study the structure of typical seeds of monocot and dicot plants.

Material: Seeds of pea soaked in water for 24 hours, razor, dish, dilute solution of iodine.

Procedure for pea seed:

1) Observe the pea seed, note that the seed is completely covered by a brownish coloured seed coat.
2) Remove the seed coat carefully with the help of razor. Note that seed coat is made up to two layers or integuments. The outer layer which is thick is called testa and the inner whitish thin layer is called tegmen.
3) Examine projected end of another seed. Note that a small oval dipression is present on its one side.
4) The depression which is the point of attachment of seed to its stalk is called hilum. Just below the hilum, a minute opening is seen. It is called micropyle.
5) Press the soaked seed gently with fingers. Note that water and air bubbles ooze out from the micropyle observe the portion of hilum.
6) Note that a ridge like structure is present. It is called raphe, a small tubular structure with two fleshy but flattened leafy structures are present. Tubular structure is called embryo and two fleshy leaf like parts are cotyledons.
7) The tapering end of the embryo is known as radicle and the other end bearing leaf like structures is called plumule.

Draw a neat diagram of pea seed and label its parts.

Seed Morphology

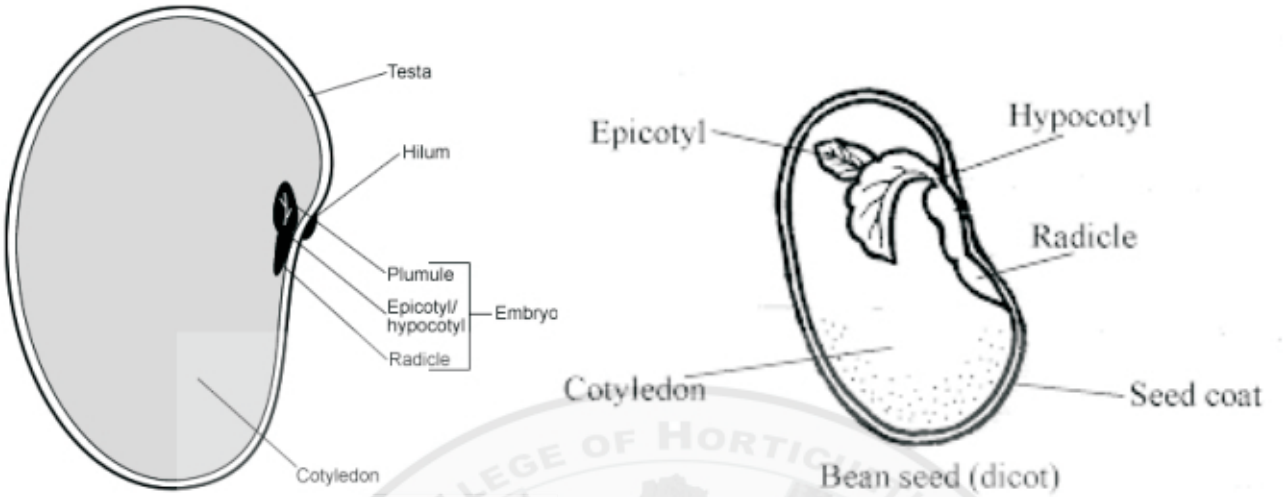

Fig.1.1 Structure of seed.

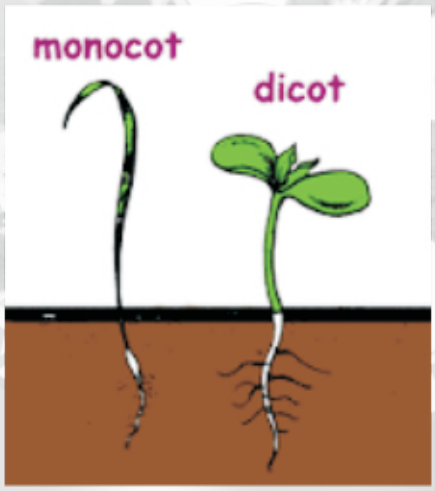

Fig.1.2 Seedlings of monot and dicot seed

Seed development: After fertilization, development of the seed starts in ovule. During fertilization one sperm nucleus combines with the egg cell and forms a zygote (2n). It further develops into an embryo. The second sperm cell combines with two polar nuclei (n+n) and forms the store of food known as endosperm (3n). In some plant species, cell of zygote multiplies and forms two cotyledons. The food material of endosperm is absorbed by the embryonic cells formed from the integuments of ovule.

Draw figures of fenugreek, onion and watermelon seed and label its parts.

OBJECTIVES AND PRACTICES OF FIELD INSPECTION.

Objective –Verification of the factors adversely affecting the quality of produce seed under field condition.

Factors which may deteriorate the quality in field are

a. Improper isolation distance and roguing, presence of volunteer plant, off type plants.
b. Presence of objectionable weeds and pathogens of seed borne diseases.
c. Presence of other crop and weed plants, infestation of insects and lodging

Field count: Number of plants of seed crop which should be observed during field inspection as one unit depending upon the cropping pattern and crop is known as field count.

Table : Minimum number of field counts required on the basis of field size.

Size of the field (ha)	Minimum number of counts
Up to 2.0	5
2.1 - 4.0	6
4.1 - 6.0	7
6.1 - 8.0	8
8.1 - 10.0	9

Crop stages for field inspection:

1. At the time of sowing- for verification of source of seed, land requirement, cropping history of seed field, isolation distance and other agronomical and seed production practices.
2. Pre flowering -Off-types, weed plants, objectionable weeds and other crop plants.
3. Flowering stage- Plants not identical in flowering, off types and plants affected by seed borne diseases.
4. Post -flowering and pre-harvest stage – Character of fruits on the basis of color, size and shape, off types, objectionable seed borne diseases and weeds.
5. General performance of the crop.

Table 2.2 : Stages of field inspections for different vegetable crops-

Minimum 2 and maximum 4 field inspections are standardized for certification of vegetable crops. The purpose of field inspection is to observe the presence of off-types, weed plants, objectionable weeds, other crop plants and plants affected by seed borne diseases in seed production field to avoid further contamination by roguing.

SN.	Name of the crop	Field inspection stages	
1	Cabbage	1) Before marketable stage 2) Head formation 3) Flowering	
2	Cauliflower	1) Before marketable stage 2) Curd formation starts 3) Curd formation stage 4) Flowering stage	
3	Carrot, Radish	1) 20-30 days after sowing 2) Selection of roots before transplanting 3) Flowering and fruiting stage 4) Before harvesting	
4	Onion	**Bulb-to-seed method** 1) Before lifting the bulbs. 2) Bulb lifting time. 3) Bulb replanting stage. 4) Flowering stage.	**Seed-to-seed method** 1) Seedling st age. 2) Bulb formation. 3) Flowering.
5	Garlic	1) Vegetative stage 2) Bulb formation 3) Uprooting stage	
6	Brinjal, Chillies, Tomato, Okra and all Cucurbits.	1) Before flowering 2) Flowering and fruiting 3) Mature fruit stage	
7	Indian spinach, Fenugreek, Amaranth, Coriander.	1) Pre-flowering 2) Flowering 3) Ripening of seeds	
8	Cluster bean, Cowpea, Garden Pea	1) Before flowering 2) Flowering and fruit stage	

OBJECTIVES AND PRACTICES IN ROGUING

Roguing: - The process of removal of off type (phenotypically different) plants from the field of an improved variety to avoid contamination is called as roguing.

Types of Roguing-

- Early: As per morphological feature of particular cultivar roguing is to be done.
- Mid late: Roguing of particular cultivar is to be done at conversion stage from vegetative to reproductive phase.
- Late: It is to be done from flowering to harvesting but before harvesting.

Table 3.1 : Practices of roguing on the basis of varietal characteristics in vegetable crops.

S.N.	Name of crop	Characters to be considered for roguing
1.	Tomato	Variation in plant height, shape and size of the leaf, early and delay in flowering, shape, size and color of fruits.
2.	Brinjal	Leaf and stem color, spines on the leaf and stem, growth habit and maturity standards should be consider for rouging.
3.	Chillies	Variation in plant height, shape and size of the leaf, early and delay in flowering , shape, size and color of fruit.
4.	Cabbage	Rogue out the heads with large number of wrapper leaves and less compact with heavy frames.
5.	Cauliflower	Rogue out all off types and diseased plants.
6.	Okra	**Before flowering -** The first roguing is done after one month of sowing. Rogue out all off-types in terms of plant height, vigour, leaf characters (size, shape and color) pigmentation of stem, leaf petiole, hairiness and non-hairiness of stem and leaves **Profuse flowering and fruit setting stage-** flower color, fruit shape and size to be considered for roguing. Rogue out yellow vein mosaic affected plants. **Mature fruit stage-** On the basis of fruit shape, size, color and late maturity roguing should be done.
7.	Cluster bean	Rogue out all off types and diseased plants before flowering, during flowering and fruiting stage on the basis of shape, size, color and maturity period.

8.	Cowpea	Rogue out all off types and diseased plants before flowering and fruiting stage on the basis of pod shape, size, color and maturity period.
9.	Garden Pea	Rogue out all off types and diseased plants before flowering, during flowering and edible pod stage on the basis of growth habit of the plant, color of foliage, pod size, shape, color and maturity period.
10.	Carrot	**Before uprooting of the roots -** Based on leaf characters. **Before transplanting of the roots -** Based on root characters i.e. shape, size and color. **Flowering and fruiting stage -** Based on leaf and umbel characters, umbel emergence, color of stalk and diseased plants.. **Before harvesting -** Based on maturity period and diseased plants.
11.	Radish	**Before transplanting of the roots -** Based on growth habit and leaf characters. **At the time of root transplanting-** Root shape, size, color of stem and diseased roots. **Flowering and fruiting stage-** Wild radish, wild turnip and mustard plants should be rogue out. Besides, maturity period, color of stem consider for roguing.
12.	Onion	All off types and diseased plants are removed twice at flowering and fruiting stages for high quality seed production. Different color, thick neck, double bottle necked, under and oversize bulb should be discarded during roguing.
13.	Garlic	Rogue out off-types and diseased affected plants at vegetative, bulb formation and uprooting stage.
14.	Indian Spinach	Roguing should be done on the basis of leaf and stalk characters. Rogue out off-types, diseased and early bolters.
16.	Coriander	Remove off-types, plants of other varieties and weed plants.
17.	Amaranthus	Remove off-types, diseased plants and wild amaranthus.
18.	Cucumber, All gourds, Watermelon and Muskmelon	**Before flowering-** Plants showing different growth habit, leaf and stem characters (shape, size & color) and diseased plants should be rogue out. **Flowering and immature fruit stage-** plants which are not identical in flowering and fruit characters. Besides mosaic affected plants are rogue out. **Mature fruit stage-** Rogue out which is not identical in fruiting characters and diseased plants.

SEED SAMPLING TECHNIQUES AND TYPES OF SEED SAMPLES

Sampling: The process of obtaining a sample of a size suitable for tests, in which the same constituents are present as in the seed lot and in the same proportions.

Sampling intensity:The number of primary samples taken from the seed lot.

Types of sampling

Primary sample: A primary sample is a small portion of seed taken from one point in the lot.

Submitted sample:The sample submitted to a seed testing laboratory.

Composite sample: A sample formed by combining and mixing all the primary samples taken from the lots.

Working sample: A reduced sample taken from the submitted sample in the laboratory on which one of the seed quality test is made.

Precautions in sampling or care to be taken in sampling:

1) A large sample is more representative of a lot than in a small sample. The larger quantity should be submitted.
2) The sample should determine that all seed bags sampled are identified as belonging to a single lot, either by label or mark on the bag.
3) Sampler must sample the prescribed number of bags for size of the lot at hand.
4) Care must be taken in reducing composite samples.
5) Any seed treated with a poisonous fungicide should be informed of the chemical hazard to persons who subsequently may handle the sample.
6) Few stiches should be open at one of the top corner of the bag and after sampling this should be closed with a hand stapling device.

Procedure for sampling a lot:

- Sampling should be carried out only by persons trained and experienced in seed sampling.
- The seed lot should be so arranged that each individual container or part of the lot is conveniently accessable. Upon request by sampler the owner should provide full information regarding the bulking and mixing of the lot.
- When there is a definite evidence of heterogeneity, sampling should be refused.
- The size of the seed lot should not exceed limits than recommended one.

Obtaining the composite sample:

If the primary samples are uniform they shall be combined and mixed to form the composite sample.

Obtaining the submitted sample-

To obtain submitted sample, the composite sample should first be thoroughly mixed. After through mixing the submitted sample should be obtained either by repeated halving or by abstracting and subsequently combining small random portions.

Disposal of submitted sample:

Each submitted sample should be marked in a way that establishes connection between lot and sample.

- The sample should be labelled properly.
- The label should contain all the necessary details such as variety, class of seed, quantity of lot, to whom it belongs, sampled by, date of sampling and the kind of tests required. After making the sample it should be packed so as to prevent damage during transit.
- For germination it should not be packed in moisture proof containers.
- For determination of moisture contant it should be packed separately in moisture proof containers from which air has been excluded.
- Sample should be displatched by the sampler to the seed testing laboratory without delay. They should never be left in the lands of the owner, or persons not authorized by the sampling agency.

SAMPLING EQUIPMENTS:

1) Stick or sleeve type trier.
2) Bin sampler
3) Nobble trier
4) Sampling by hand.

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

(I) GERMINATION TEST

Germination in laboratory test is the emergence and development from the seed embryo of those essential structures which, for the kind of seed being tested, indicate ability to develop into a normal plant under favourable conditions in the soil. The primary objective of this test is to gain information with respect to field planting value of the seed and provide results which can be used to compare the value of different seed lots.

Methods of Germination testing

At least four hundred seeds should be tested for germination. Seed selected for germination should be from 'pure seed' component separated in purity analysis and should be counted without discrimination as to size or appearance, by hand, counting boards or by vaccum seed counter.

1. **Top paper (T.P.)-** 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 an incubator or germinator. Moistened porous paper or absorbent cotton can be used as base for paper or even as an immediate substratum.
2. **Between paper methods (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 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 planted in uniform layer of moist sand and then covered with loose sand 1 to 3 cms. Seeds are pressed into the surface of the sand. Amount of water is added e.g. larger seeds like legumes may be germinated to 60% of its water holding capacity.
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 phytotoxic symptoms when germinated on paper or sand. Soil should be kept wet.

Procedure for germination Test

I. Germination on towel paper

1. Take rectangular germination paper (crape craft paper) and soak it in water, remove excess water.
2. Put it on 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 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 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 maintained at appropriate constant temperature.
5. Take the germination count and calculate the germination percentage.

III. Germination in sand and soil

1. Take earthen or plastic pots filled with sand or soil.
2. Add water to obtain 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. Observe the following from 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 seedlings.

a) Seedlings with well developed system of root with primary root intact hypocotyl, epicotly and a normal plumule and cotyledons.

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

2. **Abnormal seedling**: 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 lessions.

b) Seedlings without primary root, damaged and stunted root and plumules, coleoptile without primary leaves.

c) Seedlings with decayed essential structure and discoloration.

3. **Hard seed**: The seeds belonging to leguminoseae and malavaceae family which remain hard at the end of perscribed 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, classified as dead seeds.

Table 1. Minimum seed certification standards (%) for germination test

Foundation and certified	Crop
VEGETABLE CROPS	
60	Cucurbits, capsicum, chilli, spinach, carrot, sugarbeet
65	Okra, cauliflower
70	Clusterbean, brinjal, radish, tomato, fenugreek, cabbage, onion
75	Indian bean, cowpea, french bean

Laboratory work-

Calculate the germination percentage of provided samples of following vegetable crops and give **your** conclusion about the sample.

S.N.	Name of sample	Method used for germination test	Germination (%)	Conclusion
1	Cabbage			
2	Brinjal			
3	Onion			
4	Cowpea			
5	Fenugreek			

(II) SEED VIABILITY TEST

Object- The biochemical test is to determine quickly the viability of seeds of certain species which germinates slowly by regular germination process. By reason the principle of evaluation and its indicator, the test is designated as "the topographical tetrazolium test".

Principle : In a biochemical test the reduction process which takes place in living cells are made visible by the reduction of an indicator. The indicator used in the tetrazolium test for seeds is a colourless solution of the tetrazolium salt which is imbibed by the seed. Within the seed tissues it interferes with the reduction process of living cell and accepts hydrogen from the dehydrogenses. By hydrogenation of the 2, 3, 5 triphenyl tetrazolium chloride, a red stable and non-diffusible substance, triphenyl formagane, is produced in living cells. This makes possible to distinguish the red coloured living parts of seeds from a colourless dead ones. In addition to completely stained viable seeds and completely unstained non-viable seeds, partially stained seeds may occur."Varying proportions of necrotic tissues occur in different parts of these partially strained seeds. Localisation and spread of necrosis in the embryo and on endosperm and the intensity of colour determine whether such seeds are classified as viable or non-viable".

Reagents - A 1% aqueous solution (pH 6.5 - 7.0) of tetrazolium chloride or Bromide is used. If the pH of the distilled water is not with in the range of 6.5 - 7.0, the tetrazolium salt should be dissolved in Buffer solution. The buffer solution is prepared as follows.

Solution: Solution 1 : Dissolve 9.078 g of $KHgP0_4$ in 1000 ml. of water.
Solution 2 : Dissolve 11.876 g of $Na2HP0_4$ in 1000 ml of water.
Take 400 ml. of solution 1 and 600 ml of solution 2 and mix them together, to make a litre of buffer solution prepared as above and dissolve 10 g of tetrazolium salt. This gives a tetrazolium solution of pH 7.0.

Procedure : Each 4 replications of 100 seed each from the pure seed fraction of physical purity test. To facilitate penetration of Tetrazolium solution, the seeds are fully immersed in distilled water or kept in paper towel for 18 hrs. The testa of the dicot is removed and the monocot is exposed by dissecting the seed longitudinally or laterally. The seeds are then completely immersed in 1 % tetrazolium solution for 3 hrs. During treatments two preparations are kept in darkness at 20°C. After termination of the Tetrazolium test, the solution is decanted and the preparation is mixed with water prior to evaluation. For examination the preparations are spread on a plate and kept wet throughout the determinations. The seeds are evaluated with the help of magnifying devices. Individual seed is evaluated as viable or dead on the basis of staining pattern in embryo.

Calculate the viability % and report the results of the following samples

S.N.	Name of sample	Test weight (g)	Viability (%)	Remarks
1	Tomato			
2	Cowpea			
3	Pea			
4	Cluster bean			
5	Cucumber			

(III) PHYSICAL PURITY TEST

The purity test is done with the objects of determining the composition by weight of the sample being tested and by inference, the composition of seed lot.

Materials- Seed blower, purity work board, forceps, magnifying lens, spatula, dishes, sieves, needles and balance etc.

Procedure:

1. The working sample of desired weight is prepared.
2. Use seed blower, if seed sample is chaffy or grass species after adjusting air flow.
3. Place the working sample on a board or glass plate and with the help of forcep, needles and magnifiers, separate out the seed sample into following components.

i) Pure seed
ii) Other crop seed
iii) Inert matter
iv) Weed seed

i. Pure seed- It refers to the species stated by sender or predominating in the test and includes all botanical varieties and cultivars of that variety e.g. seed, achenes, florets caryopsis and spikelets etc.

ii. Other crop seed- In includes seed and seedlike structure of any plant species other than that of pure seed.

iii. Inert matter- It includes seed and seed like matters; mainly pieces of broken or damage seeds, achenes and caryopsis, empty glumes, other matter mainly soil, sand, stone, chaff, stems, leaves, pieces of bark, flowers, fungi bodies etc.

iv. Weed seed- The seeds, bulblets or tubers of plants recognized as weeds by official regulations (objectionable weeds) or by general usage (common weeds).

4. After complete separation of components of sample, retain the pure seed on purity work board for rechecking. After re-checking the pure seed separate other seeds and inert matter.
5. Weigh the each of the three components.
6. Calculate the percentage of each component on the basis of the sum of weights of the components and not on the basis of the original working sample.The sum total of percent of all components should be 100.
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 that species from working sample as well as submitted sample.
8. Reporting results:

a) Results of purity analysis are to be given in one decimal place.
b) The total of percentage of all components must be 100.
c) If percentage component is less than 0.05 per cent, than it is to be reported as trace.\
d) The percentage of each component 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.

Errors in Purity Analysis

1. **Moisture**- Variation in weight due to moisture may occur, while sample is being analysed or even it is left on desk for some time, which affect pure seed than the inert matter. Hence, the analysis should be completed without loss of time.
2. **Calculation error-** It is commonly overlooked. To avoid it, care should be taken in regard to weighing of purity fraction to the requisite decimal places accurately and latter in calculating the percentage of various component.

Laboratory work –

Find out various components of working samples of following vegetable crops and calculate the percentage of each and give your opinion about the sample.

S.N.	Name of sample	Weight (gm)	Remarks
1	Cauliflower	100	
2	Cabbage	100	
3	Tomato	100	
4	Cucumber	100	

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

Classes of seed: Nucleus seed, Breeder seed, Foundation seed, Registered seed, Certified seed.

1. Nucleus seed- The initial seed with limited in quantity**.** Produced by originating plant breeder.
Production: It is produced at the experimental farms of the concerned research institute under supervision of plant breeders.
Purity: It is genetically and physically cent percent pure.
Certification: Not required
Use: Production of breeder seed.

2. Breeder seed- It is the progeny of nucleus seed/breeder seed. It is produced under strict supervision of plant breeder. It is lebeled with buff or golden yellow tag having size 12 x 6 cm.
Production: Produced in isolation from other varieties.
Purity: Cent percent pure by maintained roguing.
Certification: Not required. Seed plot inspected by plant breeder and one representative of National Seed Corporation (NSC) and Seed Certification Agency (SCA).
Use: It is used for production of foundation seed.

3. Foundation seed- It is a progeny of breeder seed. Labeled with white color tag (15 x 7.5 cm)
Production: Produced by the NSC under strict supervision of research scientists**.** Production of foundation seed is taken up at seed multiplication plots of government, research farms of ICAR, Agricultural Universities and also on cultivators field by adopting proper isolation distance.
Purity: It is genetically cent percent pure, physical purity of 98% is permissible.
Certification: Certification is required which is undertaken by SSCA.
Use: Production of certified seed.

4. Registered seed- It is progeny of either foundation or registered seed labeled with purple color tag. In India registered seed is omitted and certified seed is produced directly from foundation seed.
Production: Produce at farms of progressive cultivators with technical advice and supervision of NSC.
Purity: 100% genetic purity and 98% physical purity is permissible.
Certification: Requires under SSCA
Use: Produce certified/registered seed

5. Certified seed- Progeny of foundation/registered seed labeled with blue color tag (15 x 7 cm)
Production: Produced in the field of progressive farmers under strict supervision of SSCA/NSC. Proper isolation distance is adopted.
Purity: 100% genetic purity and 98% physical purity.
Certification: Requires certification which is undertaken by SSCA. Seed must meet rigid requirements of purity and germination.
Use: Certified seed is available for general distribution to farmers for commercial crop production.

EXERCISE - 7

HARVESTING, EXTRACTION, PROCESSING AND DRYING OF SEEDS

The vegetable seed crops should be harvested at proper maturity and stage which differs from vegetable to vegetable/variety and depends on topographical factors. In premature harvesting the nutrients are yet to be transfered from the plant to the fruit/seeds, the fruit/seed is likely to have a lower dry weight and a higher moisture content which ultimately results in shrivelled light seeds on drying as well as seedlings of low vigour on germination. On the other hand if harvesting is delayed after the seed crop is ripe either the yield may be rapidly reduced by shattering/splitting or in wet weather, viability may be lost considerably because of germination/sprouting or the excessive development of pathogens. The correct time to harvest the seed crop is difficult to assess in vegetable/varieties in comparison to cereals, because of the greater range in ripening. Through practical knowledge of harvesting and extraction in vegetable seed crops is of pivotal importance right from seed sowing to seed maturity in general and stage and methodology in particular.

The crucifer vegetable seed crops should be harvested in two to three or more lots when branches turn yellow and then cured for 4-5 days in a covered heap to obtain uniformly ripened seed of the same colour. Similarly in garden beet, beet leaf, sugar beet and spinach the seed branches ripens first are harvested first bearing seed balls which are cured in the same way as the crucifers and then dried and milled to have single seed to avoid thinning operation. The harvesting of umbels of carrot, parsnip, onion and leek, infloresences of celery, parsley, lettuce and amaranths are cut in different lots depending on their proper maturity. The garden pea and beans, the whole plant is cut or uprooted and stacked for few days or some times threshed immediately if fully mature and dry. In Solanaceous vegetable seed crops, the mature selected fruits are picked / harvested either, when turns unfavourable and allowed to ripen fully under room temperatures. In ridge gourd, sponge gourd and bottle gourd, the fruits are completely dried, then broken and seed extracted, while for other cucurbits, seeds from mature fruits be extracted. In chillies and okra the fruits after properly ripen on the plant are harvested, dried and seeds are separated.

Methods of seed separation in vegetable crops: It is broadly classified into mainly three groups.

i) **Dry seed separation:** Brassicas, legumes, onion, leak, celery, parsley, garden beet, beet leaf, fenugreek, spinach, sugarbeet and carrot.

ii) **Fleshy fruits**: Which are dried before seed extraction e.g. chillies, capsicum, okra, bottle gourd, sponge/ridge gourds.

iii) **Wet fleshy fruits:** e.g. Tomatoes, brinjal, cucumber, melons and bitter gourd.

Methods of harvesting and seed extraction:

i) Manually – by hand
ii) Mechanised cutting machines and
iii) Combine harvesters

Manually – by hand - The vegetable seed crops raised need to be harvested in lots and harvesting operation is mostly done manually by hand with the help of sickle of different shapes and designs /weight available in different areas. The most seed crops prone to shattering are preferably cut in the morning hours with sharp sickles.Tied in bundles which ease in proper handling i.e. carrying, transporting, curing and stacking at each harvest because ripening is not uniform. In regions with frequent rains, plants should be tied into bundles and cured in stacks and left until hard and mature. If there are repeated showers after the harvest of the crop, the viability of the seed is affected.Harvesting is still done for very high value seeds *viz.* late cauliflower,sprouting broccoli etc. and when the total area to be harvested is very small (eg. breeders) and fields are small and terraced or in areas where there is adequate labour available or family labour particularly its true in the hills where women labour is available in plenty.In vegetable seed crops, seed heads, dried fruits (pods) or other forms of modified inflorescences containing the mature seeds (e.g. Leek flower heads and amaranths inflorescence) are picked or cut with knives or secateurs and put into bamboo baskets or kiltas or other suitable containers. In some vegetable seed crops which are cut by hand a larger part of the plant is removed with the seed heads. This is achieved, for example with radish, lettuce and brassicas by using knives, sickles or in case of some vegetable crops such as garden pea, beans, by pulling up the whole seed plant left in field for drying.

Normally a small threshing floor is maintained for all purposes preferably close to the house where manually harvested material is usually either dried further threshed and cleaned. However, with progressive farmers, tarpauline, polythene sheets or other suitable sheets are used or placed in suitable buildings or structures available or clean concrete floors or in any racks or boxes.

Mechanised cutting machines and combine harvesters-

The mechanised cutting machines and combine harvesters are not possible to use for harvesting because of small land holdings, undulating topography and limited area put under each vegetable seed crop.

Curing- Curring in vegetable seed crops is an important operation to obtain uniformity in seed maturity since the material is harvested in lots. Each lot is kept on the threshing floor or trapauline in such a way that the cut ends out side are stacked and covered for 4 days with tarpaulin or polythene sheet. On 5th day a turning is given in such a way that the flower material is taken up and vice-versa. This helps in uniform curing and maturity of the seed. On 6th day drying is followed by threshing and cleaning.

Threshing-

Mostly vegetable seed crops, after harvesting the material is spread on the threshing floor or on tarpaulin after proper curing and for complete drying in the sun in a thin layer. Usually turning of material is done once or twice till it is completely dry.The drier the material, the more

easily will the seeds get separated from the pods/siliqua/or any other part during the threshing process. However, there is more often considerable difficulty in threshing the seed material if immature or not properly cured or dried. Some times, the pods or siliqua will not break and let the seed (s) escape. Therefore, it is important to dry the seed material thoroughly before commencing the threshing. Dry seeds are removed from the moter plant material by flailing, beating or rolling the material. It is important to ensure that unnecessary fragmentation of plant material does not produce debris which is either difficult or costly to separate from the seed sample by subsequently processing; it is also extremely important to avoid damaging the seeds.Mostly different threshing methods are followed depending on the type of seed produced (nucleus, breeder, foundation or certified seed), variety (early, mid-season or late; dwarf, semi-tall or tall), acreage, economically high value,financial/social status of the farmer, special facilities provided by the Government agency and technical know how. On small scale hand threshing is preferred while on large scale, teading of animals and machine threshing but combines are not yet used.

I) Hand threshing, a common method mostly performed by women labour or family members. Relatively cheap, easy and make use of surplus local labour usually adopted for threshing of high value vegetable seed or elite varieties. Hand threshing may be done in the following ways for small seed lots and is still used in some regions for large seed lots where labour is cheap.

a) **Rubbing**: Rubbing seed materials with a pressure in an open-ended trough lined with ribber (bamboo container) is quite suitable for pod material such as brassicas and radish.
b) **Beating**. The seed material is beaten with the help of wooden sticks repeatedly with a tolerable force as the seeds are separated but not broken.The beating of seed material may be i) against a wall ii) wooden plank and iii) the ground.
c) **Flailing**. Specially designed instruments are used for separating the seeds from the plants e.g. seed in sweet corn is separably by a threshing instrument.
d) **Walked on**. The seed material is spread on the threshing floor and children or other persons are asked to walk on the seed material till the seeds are separated. Seeds which have been hand threshed are usually still mixed with the plant debris and further separation is done by winnowing or sieving.
e) **Animal teading**. The seed materials are spread on the threshing floor in a 10-15 cm thick layer and allow drying in the sun. A pole is erected in the center and the draft animals are loosely tied from the neck with a rope and are allowed to walk in a round fashion till the seeds are separated. The number of animals to be used will depend on their availability, social status of the farmer, size of the threshing floor and the seed material to be threshed etc. This method is commonly used in the hills for commercial seed production where machine threshing is not possible.

II) **Machine threshing**- The main feature of threshing machine is a revolving cylinder in a concave; the cylinder is driven by a motor or engine and is capable of reaching 1200-1500 revolutions per minute. Speed of 1100 rpm for large seeded legumes. This speed can be regulated according to the size of seed to be threshed. Now a day some types of threshers incorporate sieving, screening or an aspirating compnents to assist in the initial separation of seeds from plant debris. These modifications include the possibility of adjusting cylinder speed, cylinder clearance, concave mesh, air flow and screens. These refinements are essential for dealing with a range of vegetable species.

III) **Combines-** As the name implies, reapes, threshes and partially or fully cleans the seed all in one operation by rotation, rubbing, moving and beating actions.

Damage to vegetable seed during threshing- It depends on the methods of threshing used, manual, animal or thresher the possibility of surface and sub-surface damage to seeds is increased during threshing if the cylinder speed is too fast, the cylinder clearance is narrow or the mesh of the concave is too small.

Harvesting of vegetatively propagated crops:

The harvesting of vegetatively propagated vegetable crops depends on the part used for raising future crop *viz*. rhizome, corn, clove etc. The maturity of the seed crop of ginger, turmeric is indicated by yellowing of foliage (pseudostem) and their dropping down. Seed ginger gets ready for harvesting in hills in November-December before the frost/snowfall is received. The rhizomes are uprooted carefully by spade without any injury and on large scale, the seed ginger fields are ploughed with furrow turning plough, the healthy rhizomes are collected. The harvested rhizomes are kept separate as the farmer are sold or consumed and the latter are retained for seed after thorough selection and curing.

Colocasia- The time of harvesting and maturity of seed corms depends on the cultivar (whether early, mid-season or late), date of planting and elevation. Normally for seed purpose in most colocasia growing area it get ready in October-November.

Garlic- The garlic bulbs begin to mature in about 4-6 months after planting depending on cultivar, soil, mulch used, season, elevation etc. The bulbs are lifted carefully, cleaned and the leaves are tied at the top. The bulbs are dried for a week or so under shade. This helps in curing of the bulbs and cuts, bruises and injury etc get healed up by subrization. Then these are stored in cool and dry place in well ventilated warehouses.

Methods of seed extraction from wet or fleshy vegetable fruits:

Vegetable seeds are extracted from ripe fruits which have been either hand picked into containers or collected by a single mechanised harvester which removes all the fruit from the seed crop in a single operation. The seed extraction form wet/fleshy fruits can be done by the following methods:

1. **Manual methods**.

(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 (f) Extraction e.g. Squashes

2. **Fermentation Method**
3. **Mechanical Method**
4. **Chemical Method** (a) Acid use (B) Alkali use
5. **Juice and seed extraction method**

1. Manual Method : The seed separation by hand is common method followed for quantities of fruit or large quantities by either or above mentioned methods required to be followed in different vegetables. It may be maceration, scooping etc. The seeds are not damaged while separating from the fruits. This method is time consuming, labour intensive and unhygienic.

2. Fermentation Method: The tomato pulp containing seed is left to ferment for upto 2-3 days at about 20-25°C and cucumber pulp for 1 hour. The rate for fermentation will depend on the ambient temperature and may even take upto five days. In the higher elevation of hill regions it may take 4-5 days because of low temperature but in the valley area close to plains the fermentation process is normarly completed with a day or so, as fermentation is rapid and satisfactory. However, frequent checking of the pulp will determine when the seeds gelatinous coating has broken down or not. The pulp mixture must be stirred times a day to maintain a uniform rate of fermentation in the container and to avoid discolouration of the seed. Moreover, over fermentation will affect the seed viability considerably. The fermentation time must not be extended beyond that required for breaking down the mucilage or else the subsequent seed quality will be affected by premature germination. There are claims that the fermentation process helps in controlling the seed borne bacterial canker of tomato if continued up to 96 hours and at a temperature of 21.1°C. The fermentation method is simple, convenient and economical for seed separation and can be done by the seed producers easily.

3. Mechanical Method: In this a specially designed machine with axial-flow vegetable seed extraction has been developed at Punjab Agricultural University, Ludhiana. The machine is capable of extracting seeds of vegetable fruits like tomato, brinjal, capsicum, summer squash and melons. It is quite efficient, economical and hygienic. Seed loss and damage to the seed coat is negligible.

4. Chemical Method :

a) Alkali Method : This method is relatively safe and can be used for small quantities of seed in cooler temperate areas where the fermentation method is not used. The pulp containing the extracted tomato seed should left for up to 48 hours at room temperature and after washed out in a sieve and subsequently dried. This method is used by vegetable breeders and other workers for maintaining breeding material and inbred parent lines. But, it is not suitable for commercial seed production as sodium carbonate (washing soda) tends to darken the testa of the seed.

b) Acid Method : Acid method is often favoured by large commercial seed producers as it produces a very bright clean seed. Addition of 10-12 ml of hydrochloric acid (HCl) per litre of seed and pulp mixture, stirred properly and left for half an hour is successful. It is very important that the acid is added to the mixture (pulp) and never mixture to the acid, otherwise a dangerous effervescence will occur. All workers handling acid solutions should bear appropriate protective gloves and clothing. By proper arrangement of equipment it is possible to have an almost continuous process. The benefits of this methods are (i) seed extraction and drying is done on the same day, (ii) less number of containers are needed, (iii) the problems of low and high temperatures are avoided (iv) Discoloured seed resulting from fermentation is entirely avoided. The seed borne bacterial canker can also be controlled by treating the mixture with 0.8 % pure acetic acid in water for 24 hours at 21°C.

5. Juice and Seed Extraction- Normally this system of seed extraction is done in co-operation with a processing plant/factory. The factory line is generally organized to produce pure or juice processed for domestic use. During the operation the puree or juice is separated from the relatively dry residual mixture (pumice) of seeds, pulp and skins. Special lines of apparatus are

used in processing plants which intend to secure the seed in this way. The system is used for the production of commercial quality seed for large-scale industrial tomato crops. It should never be used where seed of high genetical quality is needed for further multiplication.

Washing- The seeds which have been extracted by fermentation or chemical methods are washed in clean water to remove the pulp etc. Immediately the extraction time has been completed or after scooping, maceration etc. on small scale washing is done by using a series of sieves. On large scale, water is added to the container with the pulp and seed. Thoroughly stirring is done in the container and the seeds get settled down and the water with mucilage skin etc. is decanted. This process is repeated until the seeds are clean. The skill of doing all these operations comes with experience.

Seed Drying

The process of elimination of moisture from the seed is known as seed drying.

Methods of Drying

I) Field/Natural/Sun drying
II) Mechanical/Artificial drying
- Forced natural air
- Forced artificial heated air
- Use of Desiccants
- Infrared rays

Natural Drying- It is conventional method of drying which is carried out in the field/threshing floor by the radiant energy of the Sun. For uniform drying seed should be spread in thin layer. The moisture content in the seed is <17% can be dried under shade/light sunlight but >17% then to be dried under heavy sun. 2-4 days of drying is needed to reduce moisture content to 10-12%.

Advantages - Cheap and easy method of drying.
Disadvantages - Rate of drying is slow, large floor area is required, loss due to attack by insect, birds and animals, laborious method, dust, dirt and other foreign material get admixed and high weather risk.
Mechanical Drying- Involves artificial seed drying by using heated/unheated air or other means.

i. **Forced natural air drying-** Generally 2 types of ventilators provided to seed godowns for free air movement. In modern godowns electric blower is used for forcible air circulation for seed drying.
ii. **Forced heated air drying-**Burner heated air is circulated in the godown. This principle is employed in several types of the modern drier.

Types of Dryers

I) **Natural driers**
II) **Artificial driers**
a) **Batch bin/Metal bin dryers** eg. Circular metal bin drier and Rectangular metal bin drier

Seed Processing

Seed processing is a vital part of the total technology involved in making available high quality seed. It is important for maximizing seed viability, vigour and health.

Purposes of seed processing- To increase the longevity of seeds, reduce the variability in vigour by removing low vigour seed and to improve the uniformity in seed shape/size by grading.

Objects of seed processing

1) Separation of other seed /inert matter
2) Elimination of poor quality seeds
3) Homogeneity in produce
4) Ultimate object is to obtain pure seed with maximum germination potential

Advantages of processing

1) It gives protection against natural deterioration
2) Maintain high germination of seeds during storage
3) Growth and vigour improved significantly
4) Protect seed from storage pests
5) Enhance field establishment
6) Significantly reduce storage fungi
7) Early plant growth
8) Augment crop yield

PACKAGING, LABELLING AND STORAGE OF SEEDS

The processed seed is required to be packed properly in uniformly sized bags. During transfer of seed from the processing plant to the field, seed is subjected to jolting and rough handling which may deteriorate the quality of seed if not packed properly.

The packaging consists of following operations.

1) Filling of seed bags to an exact weight.
2) Placing leaflets in seed bags regarding improved cultivations practices.
3) Attaching labels, certification tags on the seed bags and sewing of the bags.
4) Storage/shipment of seed bags

- Bags manufactured from cloth, paper or plastic film are normally used to pack seed.
- Cloth bags made from jute or cotton or from synthetic fibres such as nylon or other polymers may be used. These bags however are not suitable for seed treated with highly poisonous pesticides.
- Polyethylene plastic bags are being increasingly used for packaging owing to their strength and impermeability to moisture.
- Bags may be closed by tying them with a string or sewing with machine.
- Polyster bags are usually heat sealed.
- Information about the species, culture, grade, lot number and other details as specified by the law must be accompanied by each bag in the form of tag.
- The package size should be adapted to local conditions, taking into consideration the upper weight limit that a man can carry during loading and unloading operations.

Instrument used for packaging

1) **The bagger wigher** –This machine fill and weigh a bag accurately.
2) **Automatic scale**: It is used for small packages particularly vegetable and flower seed. In this machine entire weighing and filling is done automatically.

SEED STORAGE

Seed is required to be constructed through proper storage for a short or long period of several months. The reasons of seed storage are.

1) It may be unecomomic to multiply each year/annually.
2) It is not possible to estimate seed yields.
3) Demands for seed may fluctuate.
4) Good seed stock is valuable and can be difficult or costly to produce.

General Principles of Storage

1) Seed storage conditions should be dry and cool.
2) Effective storage pest control.
3) Proper sanitation in seed store
4) Before placing the seeds into storage they should be dried to safe moisture limits.
5) Determine seed storage needs in view of period or length of storage time.

METHODS OF STORAGE

Traditional methods- Based on local climatic conditions and needs various traditional methods are employed by the farmers. In drier tropics and subtropics seeds are stored in WOVEN SOCK or Heap on ground under shade and protecting against animals and rodents and some protection is given from rain in the form of cover. In temperate region seed is stored in woven sock or on Barn Floors which are always covered. Sometimes seed are stored in Earthen pots, Bins or in gourds sealed with clay. Smaller quantity of seed stored in baskets hung in the kitchen out of reach of rodents in a dry smoky atmosphere.

Improved storage- Large quantities of seed may be stored in bins, boxes or bags by specially constructed stores. In these building adequate protection against thefts, rodents, birds, insects is provided. In these storehouses control of temperature and relative humidity to minimize losses in seed viability due to ageing or other factors is provided. Store has no windows and has only one door constructed of metal which can be sealed properly and locked. The material used for construction may be stone, concrete, brick metal or wood. The foundation is made up of stone at its height is about 90 cm from ground level. The ventilation openings are screened against birds and rodents.

METHODS OF SEED PRODUCTION IN COLE CROPS

1. Cauliflower

Botanical Name : *Brassica oleracea* var. Botrytis
Family : Cruciferae
Chromosome No. : 2n = 18, 20, 36
Origin : Eastern Mediterranean region
Mode of pollination : Cross pollination
Land Requirement : Avoid land on which same or other cole crops taken for last two years.
Varieties- Early Kunwari, Improved Japanese, Pant Shubhra, Punjab Giant 26, Pusa Deepali, Pusa Ketki, Pusa Snowball-1, Pusa Snowball- 2, Pusa Himjyoti, Snowball-16, Pusa Synthetic.

Sowing Time- Early season cultivars sown in the month of May-June and mid-season cultivars in July –August.

Seed Rate- 500-600 g/ha (Early variety)
300-400 g/ha (Mid late variety)

Methods of Planting-

- **Seed to seed Method**- Seed sown at a spacing 60X45 cm for early and 60x60 cm for late variety.
- **Curd to seed Method-** In November-December, uproot true to type curds and transplant in main field.

Manures and Fertilizers- 150-200 q/ha FYM and 100:80:80 kg /ha NPK
Intercultural Operations-

Keep seed plot weed free by giving shallow and frequent intercultural operations and also by applying pre-emergence weedicide i.e. Fluchloralin @ 1.20 kg ai./ha. Light but frequent irrigation is to be given.

Rouging- Rogue out all off types and diseased plants to maintain purity.
Pests - Cabbage aphid, Diamond back moth.
Diseases- Damping off, Black rot.
Field Inspections-

1) Before marketable stage
2) Curd formation starts
3) Curd formation stage
4) Flowering stage

Harvesting and Storage- Harvest fully ripened plants. Thresh out by wooden stick, winnowing, screening, drying to be given and stored in air tight containers under dry and cool places.
Yield- 5-6 q seed/ha obtained from early variety whereas, 3-4 q/ha seed from late variety.
Field Standards:

(A) General Requirements	
Class	**Minimum distance (m)**
Foundation	1600
Certified	1000

(B) Specific Requirements		
Factor	**Maximum permitted (%)**	
	Foundation	**Certified**
Off types	0.10	0.50
Plants affected by seed-borne diseases	0.10	0.50
Plants affected by phyllody	0.50	1.0

Seed standards:

Factor	**Standards for each class (%)**	
	Foundation	**Certified**
Pure seed (Minimum)	98.0	98.0
Inert matter (Maximum)	2.0	2.0
Other crop seeds (Maximum)	0.05	0.10
Weed seeds (Maximum)	0.05	0.20
Germination (Minimum)	65.0	65.0
Moisture (Maximum)	7.0	7.0

2. Cabbage
Botanical Name- *Brassica oleracea* var.capitata
Family- Cruciferae
Chromosome No.- 2n=18
Mode of pollination- Cross pollination
Land Requirement- Avoid land on which same or other cole crops taken for last two years.
Varieties- Copenhagen Market, Early Drum Head, Late Drum Head, Pusa Drum Head, Golden Acre, Pride of India, Pusa Mukta, Pusa Synthetic.

Sowing Time- In hills July–August.
Seed Rate- 400-500 g/ha
Planting-
A) In situ method-
- This method is usually followed in commercial seed production.
- The plants are allowed to overwinter in their original position.

B) Head to seed method-
- During November-December, selected true to type, fully mature head bearing plants are uprooted.
- Transplanted in a well prepared new field at 60x60 cm distance.

Manures and Fertilizers- 150-200 q/ha FYM and 100:60:60 Kg NPK/ha
Intercultural Operations-
- Light irrigation at regular interval**.**
- Deep cultivation should be avoided.
- Earthing up at stalk emergence stage is necessary

Rouging- The heads with large number of wrapper leaves and less compact with heavy frames.
Pests- Cabbage white butterfly, cabbage root fly, cabbage aphid.
Diseases- Black rot, club root, root knot and black leg.
Field Inspections-
1) Before marketable stage
2) Head formation
3) Flowering

Harvesting and Storage- Harvest fully ripened plants. Thresh out by wooden stick, winnowing, screening, drying to be given and stored in air tight containers under dry and cool places.
Yield- 5.0 to 6.5 q/ha seed from early varieties.
3.5-5.0 q/ha seed from late varieties.
Field Standards: Same as cauliflower

METHODS OF SEED PRODUCTION IN ROOT VEGETABLES

1. Carrot

Botanical Name : *Daucus carota* Linn.
Family : Umbelliferae
Origin : Erope, South Western Asia
Chromosome No. : 2n=18
Mode of pollination : Cross pollination
Land Requirement : Land should be free from volunteer plants.

Varieties- Chantney, Early Nantes, Nantes, Pusa Kesar, Sel. 233, Pusa Yamdagni, Pusa Meghali, Imperator, American Beauty, Zeno.

Sowing time- In Plains- August-September and in Hilly region- March month.

Planting distance- 30 x 10 cm distance.

Seed rate- 15 to 20 kg/ha.

Method of Planting

Root-to-seed Method- Dug out well developed mature roots from nursery beds and select healthy and true to type roots. The stecklings are prepared by cutting 1/3rd shoot and 1/4th root. Planting should be done at 60 x 30 cm spacing and soon after planting irrigate the field.

Manures and Fertilizer- 200-250 q/ha FYM should be incorporated before field preparation alongwith 50:50:80 kg NPK/ha.

Intercultural Operations- Shallow cultivation will keep down weeds, provide aeration and enhance root formation. Thinning is essential. Pre-sowing irrigation is advocated for rapid germination and irrigate the crop at frequent interval.

Roguing :

- Before uprooting of the roots
- Before transplanting of the roots
- Flowering and fruiting stage
- Before harvesting

Field inspections-

1) 20-30 days after sowing
2) Selection of roots before transplanting
3) Flowering and fruiting stage
4) Before harvesting

Insect Pests Carrot weevil, spotted leaf hopper and rust fly. These can be controlled by spraying malathion or carbaryl dust @ 5 kg/ha.

Diseases- Soft rot, cercospora leaf blight and Bacterial blight.
Harvesting, storage and yield- Harvest the plants when umbels are fully ripe. Collect the harvested umbels on threshing floor and allow them to dry and after drying, extract seed by beating with sticks, clean and rubbed by hand to remove bristles. Finally store the dried and graded seeds in polyethylene coated bags. **Yield-** 6-7 q/ha
Field Standards

A) General requirements

Class	Minimum distance (m)
Foundation	1000
Certified	800

B) Specific requirements

Factor	Maximum permitted (%)	
	Foundation	Certified
Off types	0.10	0.20
Diseased plants	-	-

Seed standards:

Factor	Standards for each class (%)	
	Foundation	Certified
Pure seed (Minimum)	95.0	95.0
Inert matter (Maximum)	5.0	5.0
Other crop seeds (Maximum)	0.05	0.10
Weed seeds (Maximum)	0.10	0.20
Germination (Minimum)	60.0	60.0
Moisture (Maximum)	8.0	8.0

2. Radish

Botanical Name : *Raphanus sativus* Linn.
Family : Cruciferae
Origin : Probably China and India
Chromosome No. : 2n=18
Mode of pollination: Cross pollination
Land Requirement- Avoid land on which same kind of crop was grown in last two years or otherwise such field was inspected by certification agency and was found free from seed borne diseases.

Varieties-

Tropical types	Temperate type
Arka Nishant, Japanese White, Kalyanpur No.1, Punjab Safed, Pusa Chetki.	White Icicle, Scarlet Globe, French Breakfast, Rapid Red, Pusa Himani, Scarlet Long, Woods, Long Frame.

Sowing time : In plains- October
Planting distance : 30 x 8 cm distance
Seed rate : 3-4 kg/ha (Seed crop)
Planting Time : November-December
Method of Planting-
Root-to-seed Method- Dug out well developed mature roots from nursery beds. Select healthy and true to type roots for planting. The steckling are prepared by cutting 1/3rd shoot and 1/4th root and planting is done at 60x30 cm distance soon after planting irrigate the field.
Manures and Fertilizer- 200-250 q/ha FYM and 80:50:80 kg NPK/ha. Half dose of nitrogen should be given at planting while remaining half dose to be applied at the time of flowering.
Intercultural Operations- Thinning, shallow hoing and irrigate the crop at frequent interval
Roguing and field inspections- Should be done at 20-30 days after sowing, during transplanting and at flowering and fruiting stage.
Insect Pests - Aphids, flea beetle and mustard saw fly.
Diseases- Damping off, white rust and radish mosaic virus.
Harvesting, storage and yield - Seed crop of radish is generally ready to harvest in April month. Harvest the crop at fully ripe stage before complete drying of pods. After drying separate the seeds by winnowing, sieving and then grading are to be done. Finally store the harvested seed in air tight containers in dry and cool places. Yield- 6 to 8 q/ha
Field Standards
A) General requirements

Class	Minimum distance (m)
Foundation	1600
Certified	1000

B) Specific requirements

Factor	Maximum Permitted (%)	
	Foundation	Certified
Off types	0.10	0.20
Plants affected by seed borne diseases	0.10	0.50
Plants affected by Phyllody	0.50	1.0

Seed standards:

Factor	Standards for each class (%)	
	Foundation	Certified
Pure seed (Minimum)	98.0	98.0
Inert matter (Maximum)	2.0	2.0
Other crop seeds (Maximum)	0.05	0.10
Weed seeds (Maximum)	0.10	0.20
Germination (Minimum)	70.0	70.0
Moisture (Maximum)	6.0	6.0

METHODS OF SEED PRODUCTION IN BULB CROPS

1. Onion

Botanical Name : *Allium cepa* Linn.
Family : Alliaceae
Origin : Mediterranean region
Chromosome No. : 2n=16
Mode of pollination : Cross pollination

Land Requirement- Avoid the land on which same kind of crop was grown in the previous year unless the crop grown in the previous year was of same variety and was certified by certification agency.

Varieties- N-53-1, Baswant-780, Phule Safed, Pusa White Flat, Phule Suvarna, Agrifound Dark Red Agrifound Light Red, Arka Niketan, Arka Pragati, Pusa Red, Pusa White Round, Early Grano.

Methods of Planting-

Seed to seed method- Seedlings are raised on raised nursery beds in the month of August and transplanting is done in September about 500 m^2 areas is enough for planting on 1.0 ha prior sowing seed treatment with thiram @ 2 g/kg is to be done.The seed is sown at 5-7 cm distance in rows. About 8-10 kg seed is required for planting 1 ha area for planting at 30 x 10 cm distance. Irrigate the crop just after transplanting.

Bulb-to-seed Method- Select healthy, true to type and disease free bulbs of 2.5-3.0 cm diameter and planting is done in the month of October at 30 x 10 cm distance. Before planting prepare the land properly by mixing well decomposed FYM along with 50:25:40 NPK kg/ha at the time of planting. About 12-15 q/ha bulbs are required for 1 ha area prior treat the bulbs with GA_3 at 300 ppm for flower initiation and higher yield. This method is recommended for production of high quality seed.

Manures and Fertilizer- Incorporate 20-25 t/ha FYM along with 60:50:60 kg NPK/ha.

Roguing- All off types and diseased plants are removed twice at flowering and fruiting stages for high quality seed production. Different color, thick neck, double bottle necked, under and over size bulb should be discarded during roguing.

Field inspections :

Bulb-to-seed method- It is done at different stages as before lifting the bulbs, bulb lifting time, bulb replanting stage and at flowering stage.

Seed-to-seed method- It should be done at seedling, bulb formation and at flowering stage.

Harvesting and Storage- Harvest only fully ripe heads and allow them to dry them under sun and are extracted by beating. After winnowing, seed should be allowed to dry in sun. Store in polyethylene coated bags. Seed remain viable up to 3-4 years under cold storage. However, under ordinary condition seed can be stored for 1 year.

Yield- Seed yield -8-10 q/ha. Bulb yield- 300-350 q/ha.

Field Standards

A) General Requirements		
Class	**Minimum distance (m)**	
Foundation	1000	
Certified	400	
B) Specific requirements		
Factor	**Maximum permitted (%)**	
	Foundation	**Certified**
Off types	0.20	0.50

Seed standards:

Factor	Standards for each class (%)	
	Foundation	**Certified**
Pure seed (Minimum)	98.0	98.0
Inert matter (Maximum)	2.0	2.0
Other crop seeds (Maximum)	0.05	0.10
Weed seeds (Maximum)	0.10	0.20
Germination (Minimum)	70.0	70.0
Moisture (Maximum)	8.0	8.0

2. Garlic

Botanical Name : *Allium sativum*.
Family : Alliaceae
Origin : China
Chromosome No. : 2n=2x=16

Land Requirement- Select fertile well drained loamy soil having pH 6 to 7. Highly alkaline and saline soils are not suitable for seed production of garlic and it should be free from volunteer plants.

Varieties- Agrifound Parvati (G 313), Agrifound White (G 41), G-282, Yamuna Safed.

Planting time- It should be done during August to October.

Seed rate- 500 kg cloves are enough for 1 ha area. Bulbds should be 8-10 mm diameter and have 6-12 cloves in a bulb.

Methods of planting- planting can be done by dibbling of cloves in a furrow or broadcasting.

Spacing- 15 x 10 cm.

Field inspections and Roguing-

1) Vegetative stage 2) Bulb formation 3) Uprooting stage

Diseases- Purple blotch, Stemphylium blight, Cercospora blight, Powdery mildew.

Insect Pests- Thrips, Stem and bulb nematode and Mites.

Harvesting and Storage- Bulbs are ready to harvest when most of the lower leaves become browned color. Garlic is ready to harvest when about half of the leaves have died back. During harvesting soil should be loosen with fork to avoid damage. Lift the plants, shake off loose soil & allow drying for few hours. After harvesting curing is necessary for prolong storage life of bulbs. Store it in good air movement for 5-8 months.

Yield- Bulb yield- 100-200 q/ha.

Field Standards

A) General requirements

Class	Minimum distance (m)	
Foundation	05	
Certified	05	
B) Specific requirements		
Factor	**Maximum permitted (%)**	
	Foundation	**Certified**
Off types	0.10	0.20

Seed standards: Average weight of bulb shall be 25 g. Seed material shall be clean, healthy and firm. The plants of other variety shall not be exceed more than 0.10% and 0.20% in foundation and certified seed plot respectively. Cut bruises, cracked, immature or damaged by insect shall not exceed >2.0% of its weight.

METHODS OF SEED PRODUCTION IN SOLANACEOUS CROPS

1.Brinjal

Botanical Name : *Solanum melongena* L.
Family : Solanaceae
Chromosome No. : 2n=24
Mode of Pollination : Often cross pollination

Land Requirement- Land should be free from volunteer plants.

Varieties- Vaishali, Pragati, Krishna, Manjarigota, Phule Harit, Azad Kranti, Pusa Purple Long, Pusa Purple Cluster, Pant Rituraj, Pusa Anmol, Pusa Kranti, Black Beauty.

Seed rate- 500 g/ha.

Sowing time- Prepare raised beds. Top soil should be mixed with well decomposed FYM/Compost. The seeds are sown about 1 cm deep in rows and 5 cm apart. Seed germinate in 12-18 days.

Three seasons of sowing

1) Autumn- June-July 2) Spring – November- December 3) Rainy – March -April

Transplanting- Seedlings become ready for transplanting in about 5-6 weeks after sowing. The seedlings should be hardened by withholding water for 4 days before transplanting. Irrigate the beds at the time of transplanting and seedlings are planted at 60 x 60 cm (Non-spreading), 75 x 60 cm (Spreading) distance. Soon after planting light irrigation is given.

Manures and fertilizer- Apply 200-250 q/ha FYM at the time of land preparations along with 100:50:80 kg NPK/ha.

Intercultural operations- Light and frequent irrigation is required. Shallow cultivation needed for weed control pre-emergence weedicide may used to control weed infestations.

Rouging- Leaf and stem color, spines on the leaf and stem, growth habit and maturity standards should be considered for rouging.

Insect Pests- Epilachna beetle, Shoot and fruit borer, Jassids, Aphids, Root knot nematodes

Diseases- Damping off, Phomopsis blight, Wilt and Little leaf.

Field Inspections- Seed field should be inspected at different stages i.e. before flowering, at flowering and and at mature fruit stage.

Harvesting and storage- Completely yellow color fruits are harvested and outer covering is peeled off. The fruits are also crushed by beating with wooden stick and flesh with seed material soaked in water overnight. The seeds are then separated by sieving and dry under partial shade. Store it in dry, clean containers in cold storage at 50°F temperature.

Yield- 1.2-1.5 q/ha.

Field Standards:

Class	Minimum distance (m)
Foundation	200
Certified	100

B) Specific requirements

Factor	Maximum Permitted (%)	
	Foundation	Certified
Off types	0.10	0.20
Plants affected by seed borne diseases	0.10	0.50
Plants affected by little leaf	0.05	0.20

Seed Standards:

Factor	Standards for each class (%)	
	Foundation	Certified
Pure seed (Minimum)	98.0	98.0
Inert matter (Maximum)	2.0	2.0
Other crop seeds (Maximum)	None	None
Weed seeds (Maximum)	None	None
Germination (Minimum)	70.0	70.0
Moisture (Maximum)	8.0	8.0

2. Chillies

Botanical Name : Capsicum annum L., Capsicum fruitescence L.
Family : Solanaceae
Chromosome No. : 2n=24
Mode of pollination : Often cross pollination
Land Requirement : Land should be free from volunteer plants.
Varieties-
Sweet pepper- Arka Basant, Arka Mohini, Arka Gaurav, Bull Nose, California wonder, Yolo wonder.
Hot pepper- Pusa jwala, Parbhani Tejas, Agnirekha, Jyoti, NP-46 A, Pant C-1.
Seed rate- 1.5-2.0 kg/ha.

Transplanting- Seedlings become ready for transplanting in about 4-5 weeks after sowing. The seedlings should be hardened by withholding water for 4 days before transplanting. Watering to the beds is given at the time of transplanting. 30-35 days old seedlings should be planted at 60x45 cm or 60x60 cm distance. Planting on ridges and furrows in rainy season is advisable.
Manures and Fertilizer- Apply 20-25t/ha FYM and 50:60:50 NPK kg/ha.
Intercultural Operations- Supply light but regular irrigation and keep the plot weed free.
Rouging- Variation in plant height, shape and size of the leaf, early and delay in flowering , shape, size and color of fruit should be consider.
Insect Pests - Thrips, fruit borer, mites and aphids.
Diseases- Damping off, anthracnose, wilt, fruit rot, leaf curl and mosaic.
Field Inspections- Before flowering, flowering and fruiting, mature fruit stage
Harvesting and Storage- Harvest pods at fully ripe stage, allow drying and seed is extract by beating. Store it in polyethylene coated bags.
Yield- 1.0 to 1.25 q/ha.

Field Standards

A) General requirements

Class	Minimum distance (m)	
Foundation	400	
Certified	200	
B) Specific requirem ents		
Factor	**Maximum permitted (%)**	
	Foundation	**Certified**
Off types	0.10	0.20
Plants affected by seed-borne diseases	0.10	0.50
Plants affected by viral diseases	0.05	0.20

Seed Standards

Factor	Standards for each class (%)	
	Foundation	**Certified**
Pure seed (Minimum)	98.0	98.0
Inert matter (Maximum)	2.0	2.0
Other crop seeds (Maximum)	0.05	0.10
Weed seeds (Maximum)	0.05	0.10
Germination (Minimum)	60.0	60.0
Moisture (Maximum)	8.0	8.0

3.Tomato

Botanical Name : Lycopersicon esculentum M
Family : Solanaceae
Chromosome No. : 2n=24
Mode of pollination : Often cross pollination
Land Requirement : Land should be free from volunteer plants.

Varieties- Parbhani Yashashree, ATH-1, Bhagyashree, Roma, Deogiri, Siox, Marglobe, Pusa Ruby, Punjab Chhuhara, Arka Gaurav.

Seed rate- 400-500 g/ha

Sowing time- Winter crop –June-August and Summer crop- November- December.

Transplanting- 30-35 day's old seedlings should be planted at 75x40 cm in winter and 60x30 cm distance in summer. After planting light irrigation needed.

Manures and Fertilizer- Apply 20-25 t/ha FYM and 100:60:100 NPK kg/ha.

Intercultural Operations- Light and regular irrigation is required with frequent shallow cultivation is necessary. Mulching is essential.

Rouging- Variation in plant height, shape and size of the leaf, early and delay in flowering , shape, size and color of fruit should be consider.

Field Inspections- Before flowering, flowering to immature fruit stage, mature fruit stage

Harvesting and storage- Harvest fruits at fully ripe stage. Extract the seed by using fermentation and acid treatment. Allow to dry under partial shade and finally store in cool and dry places.

Yield- 1.0 to 1.25 q/ha.

Field Standards

A) General requirements

Class	Minimum distance (m)	
Foundation	50	
Certified	25	
B) Specific requirements		
Factor	**Maximum Permitted (%)**	
	Foundation	**Certified**
Off types	0.10	0.50
Plants affected by seed borne diseases	0.10	0.50

Seed standards:

Factor	Standards for each class (%)	
	Foundation	**Certified**
Pure seed (Minimum)	98.0	98.0
Inert matter (Maximum)	2.0	2.0
Other crop seeds (Maximum)	0.05	0.10
Weed seeds (Maximum)	None	None
Germination (Minimum)	70.0	70.0
Moisture (Maximum)	8.0	8.0

METHODS OF SEED PRODUCTION IN CUCURBITACEOUS CROPS

1. Cucumber

Botanical Name : *Cucumis sativus* Linn.
Family : Cucurbitaceae
Origin : Asia and Africa
Chromosome No. : 2n=14
Mode of Pollination : Cross pollinated
Land Requirement : Free from volunteer plants

Varieties- Japanese Long Green, Kalyanpur Green, Poinsette, Straight Eight, Pusa Sanyog, Himangi, Phule Shubhangi, Sheetal, Poona Khira, Balam Khira, Solan Hybrid, K-75.

Planting- (Summer) January-February and (Rainy) June-July. Furrows are made at row to row spacing (2.0 m) and seeds are sown on the edge of the furrow 60 to 90 cm apart on both sides.

Seed rate- 4-5 kg/ha

Manures and fertilizer- 20 t/ha FYM and 25:30:40 NPK kg/ha should be applied at the time of sowing. Additional 25 Kg N/ha will be top dressed at 30-35 days after sowing.

Intercultural operations- Perform shallow intercultural operations. Use pre-emergence weedicide to control weed growth. Frequent and regular irrigation is required to supply at fruiting stage.

Roguing and field inspection-

- **Before flowering-** Plants showing different growth habit, leaf and stem characters (shape, size and color) and diseased plants should be rogue out.
- **Flowering and immature fruit stage-** plants which are not identical in flowering and fruit character and besides mosaic affected plants are rogue out.
- **Mature fruit stage-** Rogue out which is not identical in fruiting characters and diseased plants.

Insect Pests -Red pumpkin beetle, epilachna beetle, fruit fly, aphids, mites and nematodes.
Diseases- Powdery mildew, downey mildew, anthracnose, bacterial leaf spot, wilt, angular leaf spot, fruit rot, scab and mosaic.

Harvesting and storage- Fully ripe fruits are harvested. Seeds are extracted as soon as possible from the ripe fruits. Fruits are cut and seeds are extracted by rubbing gently with wood ash and washed up with clean water. Allow to dry them in partial shade. After complete drying store the seed in polyethylene coated bags in cool and dry places.

Yield- 1.0 to 1.25 q/ha.

Field Standards

General Requirements

Class	Minimum distance (m)	
Foundation	800	
Certified	400	
Specific requirements		
Factor	**Max imum permitted (%)**	
	Foundation	**Certified**
Off types	0.1	0.20
Other weed plant	None	None
Plants affected by virus disease	0.1	0.20

Seed Standards

Factor	Standard to each class (%)	
	Foundation	**Ce rtified**
Pure seed	99.0	99.0
Inert matter (max)	1.0	1.0
Other crop seed (max)	0.05	0.10
Weed seed (max)	None	None
O.D.V.	0.10	0.20
Germination (min)	60.0	60.0
Moisture (max)	7.0	7.0

2. Bitter Gourd (Karela)

Botanical Name- *Momordica charantia* Linn.
Family- Cucurbitaceae
Origin- Tropical Africa and Asia
Chromosome No.- 2n=22
Mode of pollination- Cross pollinated
Land Requirement- Free from volunteer plants
Varieties- Arka Harit, Coimbatore long, Kalyanpur Baramasi, Priya, Pusa Do-Mausami, Pusa Vishesh, CO-1, MDU-1, Hirkani, Phule green, Konkan Tara, Priyanka.
Method of Planting- Planting is done in furrow method. Seeds are generally sown on the side of furrows. The distance between furrows may be 120-150 cm and seeds are sown at 50-60 cm apart.

Sowing time and Seed rate - In summer- (January to March) and in Rainy season (June to July). 5-6 kg seed will be enough for 1ha area.

Manures and Fertilizer- Apply 20-25 t/ha FYM and 20:30:30 NPK kg/ha. Additional 20 Kg N/ha top dressed at flowering and fruiting stage.

Intercultural Operations- Shallow intercultural operations before spread of vines have done. Mulching is to be done for summer crop. Light and frequent irrigation should be given at flowering and fruiting stage.The vines should be trained on wooden sticks for higher yield.

Roguing and field inspection-

- **Before flowering-** Plants showing different growth habit, leaf and stem characters (shape, size and color) and diseased plants should be rogue out.
- **Flowering and immature fruit stage-** plants which are not identical in flowering and fruit characters and besides mosaic affected plants are rogue out.
- **Mature fruit stage-** Rogue out which is not identical in fruiting characters and diseased.

Insect Pests - Red pumpkin beetle, epilachna beetle, fruit fly, aphids.

Diseases- Powdery mildew, downey mildew, fruit rot and mosaic virus.

Harvesting and Storage- Fully ripe fruits are harvested when color changes to yellow or reddish yellow. Extract the seed at earliest. Cut the fruit and extract seed and pulp by washing with water. Allow them to dry under partial shade. After complete drying store the seed in polyethylene coated bags. Seed remain viable for 4-5 years under proper storage.

Field and seed standards- Same as that of cucumber crop.

Yield- 2.5 to 3.5 q/ha.

3.Pumpkin

Bot. Name : *Cucurbita moschata*
Family : Cucurbitaceae
Origin : Mexico and Peru
Chromosome No. : 2n=40

Land requirement- It is warm season crop. Ideal temperature for cultivation is 25-30°C. It can't withstand frost. It requires longer growing season than other cucurbits. It prefers well drained fertile sandy loam or silt soil.

Varieties: CO 1, CO 2, Arka Chandan

Season: January – February and June - July

Spacing- Prepare pits of 45 cm^3 size at 2.5 x 2 m distance.

Manuring- apply 10 kg FYM and urea 30 g, super phosphate 72 g and potash 19 g per pit. Then mix the above nutrients with soil and fill the pits and level them. Top dress 22 g urea/pit 30 days after sowing.

Sowing- Seed required for one ha (1kg/ha) may be treated with fungicides before sowing. Then five seeds may be sown in a pit at equal distance.

Use of PGR- Spray of ethrel at 200 ppm for four times starting from four leaf stage and at weekly intervals (i.e. 2.0 ml of ethrel in 10 lit of water) is recommended.

Roguing- During vegetative stage roguing should be done by considering characters like plant height, leaf shape, size, surface of leaf and fruit characteristics like length of fruit, size, shape and color. Plants showing symptoms of yellow mosaic are also removed. Roguing should also be done at fruit formation and harvesting stage.

Harvesting - Harvest the fruits when it changes the color from orange or pale yellow color.

Seed extraction method- Reject the fruits weighing less than 1.5 kg. First cut the fruits into two halves by crosswise then remove the seed by scraping and wash it with water.

Seed cleaning and processing- After proper drying, seed processing should be done using BSS 4 wire mesh sieve or 16/64" round perforated metal sieves.

Seed treatment- prior storage, seeds are mixed with carbendazim 4 g/kg and stored with moisture content of 6-8% in thick polythene bag and are sealed tightly.

Field standards

FACTORS	FOUNDATION	CERTIFIED
Off types (Max limit)	0.10%	0.20%

Seed standards

FACTORS	FOUNDATION	CERTIFIED
Pure seed (min)	98%	98%
Inert matter (max)	2%	2%
Other crop seed (max) no/kg	None	None
Total weed seed (max) no/kg	None	None
Germination (min)	60%	60%
Moisture (max)	7%	7%

METHODS OF SEED PRODUCTION IN LEAFY VEGETABLES

1. Indian Spinach

Botanical Name : Beta vulgaris var. benghalensis Hort.
Family : Chenopodiaceae
Origin : Indo-chinese region
Chromosome No. : 2n=18
Mode of pollination : Cross pollination

Land Requirement- Avoid the land on which same kind of crop was grown within the previous two years or otherwise the such types of field was inspect by certification agency.

Varieties- All Green, Pusa Jyoti, Jobner Green, Pusa Harit.

Sowing time- It can be sown throughout the year. To obtained high quality and yield of seed it should be sown in October-November.

Planting distance- 60 x 10 cm.

Seed rate- 10-12 kg/ha

Manures and Fertilizer- 20-25 t/ha FYM and 40:40:50 NPK kg/ha. Full dose of P and K and half dose of N should be applied as a basal whereas, remaining half dose of N should be top dressed after leaf cutting. In addition 20 kg/ha N should be top dressed at flowering.

Intercultural Operations- Thinning is essential, shallow cultivation and irrigate the crop at frequent interval.

Roguing- Rogue out off-types, diseased and early bolters. Roguing should be done on the basis of leaf and stalk characters.

Field inspections- Pre-flowering, flowering and ripening of seeds.

Insect Pests- Aphids, leaf eating caterpillar.

Diseases- Damping off and leaf spot.

Harvesting and Storage- Crop will be ready for harvest within 150-160 DAS. Harvest at full ripe stage and allow drying. After drying, thresh the material and clean the seed by winnowing. Store in polyethylene coated bags. Seed remain viable 3-4 years under good storage condition.

Yield- 15-18 q/ha

Field Standards

General requirements

Class	Minimum distance (m)	
Foundation	1600	
Certified	1000	
Specific requirements		
Factor	**Maximum permitted (%)**	
	Foundation	**Certified**
Off types	0.10	0.20
Diseased plants	-	-

Seed standards:

Factor	Standards for each class (%)	
	Foundation	**Certified**
Pure seed (Minimum)	96.0	96.0
Inert matter (Maximum)	2.0	2.0
Other crop seeds (Maximum)	0.10	0.20
Weed seeds (Maximum)	0.10	0.20
Germination (Minimum)	60.0	60.0
Moisture (Maximum)	9.0	9.0

2. Amaranthus

Botanical Name : Amaranthus tricolor
Family : Amarylidaceae
Mode of pollination : Self pollination
Land Requirement : Land should be free from volunteer plants.

Varieties- CO-1 to CO-5, Chhoti Chauli, Badi Chauli, Pusa Kirti, Pusa Lal Chauli, Pusa Kiran.

Sowing time- February- March and May-June

Method of sowing- Amaranth seeds is very small and hence mixed fine sand/soil for even distribution. Seed should be sown in 25-30 cm apart in rows.

Seed rate- 1.5-2.5 kg/ha.

Manures and fertilizer- FYM 20-25 t/ha. Ammonium sulphate 100 kg/ha should be top dressed just before irrigation.

Intercultural Operations- Weeding and 2-3 hoeings are necessary.

Roguing- Remove off-types, diseased plants and wild amaranthus.

Field inspections- Vegetative and flowering stage

Harvesting and Storage- Harvest when most of leaves turn yellow. Plants after cutting allow for drying for few days on threshing floor. After fully drying separate the seed by beating. After cleaning and winnowing, Store the seed in good condition.

Field Standards

A) General requirements

Class	Minimum distance (m)
Foundation	400
Certified	200

B) Specific requirements

Factor	Maximum permitted (%)	
	Foundation	Certified
Off types	0.10	0.20

Seed standards:

Factor	Standards for each class (%)	
	Foundation	Certified
Pure seed (Minimum)	95.0	95.0
Inert matter (Maximum)	5.0	5.0
Other crop seeds (Maximum)	0.05	0.10
Weed seeds (Maximum)	0.10	0.20
Germination (Minimum)	70.0	70.0
Moisture (Maximum)	8.0	8.0

METHODS OF SEED PRODUCTION IN LEGUMINOUS VEGETABLES

1. Cluster bean

Botanical name : Cyamopsis tetragonoloba T.
Family : Leguminosae
Origin : West Africa and India
Mode of pollination : Self pollination
Chromosome no. : 2n=14

Land requirement- Avoid land on which same crop or variety of same crop was taken during previous year.

Varieties- Pusa Mausami, Pusa Navbahar, Durgabahar, Pusa Sadabahar.

Sowing time- Rainy season –June-July and in summer season- February - March

Planting distance- 45x15 cm

Seed rate- 20-25 kg/ha

Manures and Fertilizer- Incorporate 15-20 t/ha FYM and 10:50:50 NPK kg/ha.

Intercultural Operations- Irrigate the crop as per necessity and shallow intercultural operations are required to keep crop weed free.

Roguing- Disease affected and off-type plants are rogue out.

Field inspections- Before flowering, at flowering and fruiting stage

Insect Pests - Bean beetle, bean aphids, seed cron maggots.

Diseases- Powdery mildew, anthracnose and bacterial blight

Harvesting and storage- Fully ripe pods are harvested along with entire plant. Allow drying and seeds are extracted. Winnowing and cleaning is to be given and seed is store in polyethylene coated bags.

Yield- 10 to 12 q/ha.

Class	Minimum distance (m)	
Foundation	50	
Certified	25	
B) Specific requirements		
Factor	**Maximum permitted (%)**	
	Foundation	**Certified**
Off types	0.10	0.20
Plan ts affected by seed borne diseases	0.10	0.20

I) General requirements: Field Standards

Seed standards:

Factor	Standards for each class (%)	
	Foundation	Certified
Pure seed (Minimum)	98.0	98.0
Inert matter (Maximum)	2.0	2.0
Other crop seeds (Maximum)	0.10	0.20
Weed seeds (Maximum)	None	None
Germination (Minimum)	70.0	70.0
Moisture (Maximum)	9.0	9.0

2. Garden Pea

Botanical name : Pisum sativum L.
Family : Leguminosae
Origin : Ethiopia
Chromosome no. : 2n=14

Land requirement- Avoid land on which same crop or variety of same crop was taken during previous year.

Varieties- Arkel, Meteor, Lincoln, Bonneville, Jawahar Matar-5, Pant Upahar, Hara Bona, NP-29

Sowing time- October – November

Planting distance- 30 x 10 cm

Seed rate- 100 kg/ha

Manures and fertilizer- 10 t/ha FYM and 20:70:50 NPK kg/ha.

Intercultural operations- At early stage of crop one hoeing is necessary. Sufficient watering, at flowering and fruiting stage is given.

Roguing- Disease affected and off-type plants rogue out.

Field inspections- It should be done before flowering, flowering and edible pod stage.

Insect pests- Pea stem fly, pea aphids and pea thrips.

Diseases- Powdery mildew, wilt, rust, pea mosaic virus and bacterial blight.

Harvesting and storage- Harvest fully ripe pods when plants start drying. Threshing, cleaning and winnowing are done and after drying, store the seed in gunny bags.

Yield- 15 to 20 q/ha.

Field Standards

A)General requirements

Class	Minimum distance (m)
Foundation	20
Certified	10

B) Specific requirements

Factor	Maximum permitted (%)	
	Foundation	Certified
Off types	0.10	0.50
Plants affected by mosaic	0.50	1.0

Seed standards:

Factor	Standards for each class (%)	
	Foundation	Certified
Pure seed (Minimum)	98.0	98.0
Inert matter (Maximum)	2.0	2.0
Other crop seeds (Maximum)	None	None
Weed seeds (Maximum)	None	None
Germination (Minimum)	75.0	75.0
Moisture (Maximum)	9.0	9.0

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

Photographs of seed processing machines and seed testing instruments

Batch bin dryer

Continuous flow dryer

Seed cleaning machine

Seed Grader

Seed sampling probe

Seed magnifier

Seed divider

Digital seed counter

Digital moisture meter

Hot air oven

Seed germination racks

Seed germinator

Purity work board

Assignment:

i) Visit the seed production, processing unit and seed testing laboratories and write the report.

ii) Draw the diagrams of important seed processing equipments.

iii) Enlist various important equipments used in seed technology laboratory with its diagram.

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