4. Seed

Do you know ?

1. What is meant by seed botanically?
2. Material used for planting.
3. Types of seed and parts of seed
4. Different methods of propogation.

4.1 Definition and type

4.1.1 Definition

A fruit is defined as matured or ripened ovary which contains one or more ovules that develops into seed. Botanically seed is defined as matured (after fertilization) and ripened ovule which contains an embryo with food reserve and protective coat. As per seed technology science or agricultural point of view seed is any plant part which is used for raising or propagation or multiplication of new commercial crop. e.g. True seed, tubers, suckers, bulbs, cuttings, sets, grafts, etc.

Recall a little?

Major types of seed

a. Monocot seed : Seed having single cotyledon i.e. wheat, jowar, maize, etc.
b. Dicot seed : Seed having two cotyledons. i.e. groundnut, redgram, castor, etc.

4.1.2 Parts of seed

Structure of dicot seed

Castor seed:

Castor seed has two layers. The outer layer of seed coat is testa which is blackish and hard. The inner thin seed coat layer is tegmen.

The spongy whitish outgrowth present at one end of seed is called caruncle. Caruncle absorbs water during germination. Hilum which is covered by caruncle and raphe which run from hilum on the seed coat.

There is a whitish flattened body called endosperm. It acts as food storage tissue. Seed embryo consists of radical, axis and plumule. There are two cotyledons which have prominent veins. It acts as food absorbing organ.

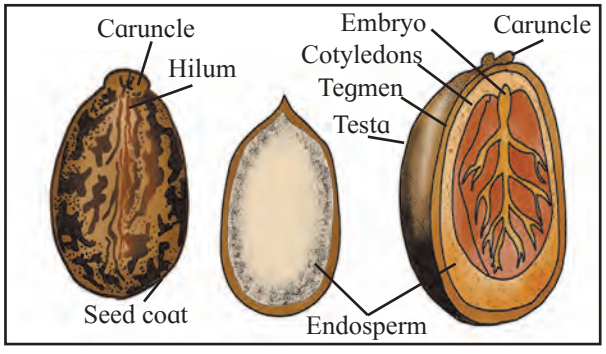

Fig 4.1 : Castor Seed

Structure of monocot seed

Maize seed

Maize seed coat is membranous layer adherent to the grain and is fused with the wall of the fruit. Seed is somewhat flattened. It is broader at one end and pointed at other end. The flattened portion of the seed may be creamy white, yellow or dark red in colour with distinct deloid area. Note that scar is present at both ends of the seed. The scar present at the broader end of the seed is the position of attachment of style. The scar at the narrow end is hilum. Observe that ridge is present in the centre of the seed which is axis of the embryo by cutting the seed through the centre longitudinally and putting few drops of dilute iodine on it. Two distinct regions separated from each other by a layer. Separating layer is called epithelium which secrets enzymes.

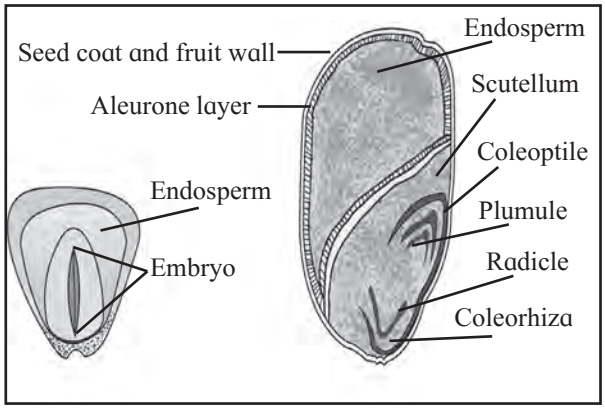

Fig 4.2 : Maize Seed

The bigger region which takes violet black stain is called endosperm. It is rich in starch. The embryo consists of radical, plumule and a single shield shaped cotyledon called scutellum. Scutellum absorbs food material from endosperm during germination.

Note that radical is towards pointed end and is surrounded by a sheath called coleorhiza. The plumule which is at the end of the embryo is surrounded by sheath called coleoptile.

Try this

- Collect the seed of maize and soak in water for 24 hrs.
- Take a longitudinal section of the seed by cutting the seed through the centre. Put few drops of dilute iodine on it.
- Study the external and internal part of maize seed.
- Draw the diagram of maize seed and label it properly.

4.2 Difference between seed and grain

Sr. No	SEED	GRAIN
1	It is the result of well-planned seed programme.	It is the part of commercial produce.
2	It is the result of sound scientific knowledge, organized effort, and investment on processing, storage and marketing facilities.	No such knowledge or effort is required.
3	The pedigree of the seed is ensured. It can be related to the initial breeders seed.	Its varietal purity is unknown.
4	During production, effort is made to rogue out off types designated plants, objectionable weeds and other crop plants at appropriate stages of crop growth which ensures satisfactory seed purity and health.	No such effort is made, hence the purity and health status may be inferior.
5	The seed is scientifically processed and packed and labelled with proper lot identity.	This is not labelled.
6	The seed is tested for planting quality namely germination, purity, admixture of weed seed and other crop seed, seed health and seed moisture content.	Routine seed testing is not done.
7	The seed quality is usually supervised by seed certification agency.	There is no quality control.
8	The seed has to essentially meet the “quality standards’. The quality is therefore well known. The labels, certification tags on the seed containers serves as quality marks.	No such standards apply here. The quality is non descript and not known.
9	Genetic purity is important.	Genetic purity is not important.
10	Embryo is important in case of seed.	Endosperm or cotyledons are important in case of grain.
11	Seed is used for sowing purpose.	Grain is used for consumption purpose.
12	Isolation distance required to maintain genetic purity.	Isolation distance is not required.

13	Seed treatment is required.	Seed treatment is not required.
14	Field inspection is required to maintain genetic purity.	Field inspection is not required to maintain genetic purity.
15	Comes under preview of seed act.	Comes under preview of food act.

Can you tell?

The quality judging aspects of seed.

4.3 Characteristics of seed

Following are the characteristics of good quality seed

(1) Improved variety : It should be superior to the existing variety i.e. the yield should be higher by 20-25% than the existing variety or it should have some desirable attributes like disease resistance, drought resistance, salt tolerance, etc. with good yield potential**.**

(2) Genetic purity: The seed should be true to type. The seed should possess all the genetic qualities / characters, which the breeder has placed in the variety; genetic purity has direct effect on the yields. If there is deterioration, there would be proportionate decrease in the yield or performance.

(3) Physical purity: Physical purity of a seed lot refers to the physical composition of the seed lots. A seed lot is composed of pure seed, inert matter, broken seed undersized seed, soil and dust particles, weed seed, other crop seed, etc. Higher the content of pure seed better would be the seed quality.

(4) Seed germination and vigour: Higher germination percentage and vigour give adequate plant population and uniform growth which have profound effect on yield and determine the planting value of the seed.

(5) Freedom from weeds and other crop seed: This is an extension of physical purity described earlier.

There are certain weeds species, which are very harmful to the crop and once established they are difficult to eradicate. An absolute freedom from seed of such species is highly desirable and is one of the important criteria for determining the planting quality of seeds.

(6) Seed health: The quality of a seed lot depends on its health; hence the seed should be free from seed borne diseases, insects and pest.

(7) Seed moisture: The seed moisture is the most important factor in determining the seed germination and viability during storage . At high seed moisture content there is high incidence of pest attack and at moisture content above 16% seed get heated and the viability is lost. Hence the seed should be stored at safe moisture levels of 11-13%.

(8) Seed size, weight and specific gravity: Seed size, weight and specific gravity has been found to have positive correlation with seed germination and vigour in many crops. Therefore the seed should be bold with high specific gravity.

(9) Seed colour: The colour of the seed often reflects the condition during seed maturation. The colour and shine deteriorate only when the weather conditions are adverse during maturation or when insects infest the crop or when it is handled badly.

The seed lot having high genetic purity, high germination and with a minimum amount of inert matter, weed seed and other crop seed and free from diseases is said to be of high quality .

Do you know ?

- Label and information on seed bag
- Process of seed multiplication.
- Precautions to be taken while purchasing the seed

4.4 Seed multiplication

Remember this

The process of development, release and notification of high yielding variety / hybrid is a continuous process. The spread of any improved variety or hybrid depends upon the quality of pure seed of that variety produced and supplied to the farmers every year.

The area under any crop is greater, it is not possible for the crop breeder or station to produce and supply entire quantity of seed required every year due to limited resources. It is therefore necessary to organize multiplication of the seed of varieties or hybrids through different stages by ensuring that the seed multiplied at each stage meets all seed certification standards prescribed for that crop variety or hybrid.

4.4.1 Stages of seed multiplication

(1) Nucleus seed

It is the initial amount of pure seed of improved variety or notified variety or parental lines of a hybrid produced under supervision of the plant breeder who has evolved that variety or hybrid. The nucleus seed is genetically cent percent pure and does not contain other physical impurities. The nucleus seed is produced strictly under isolation so as to avoid both genetical and physical contamination. Nucleus seed should retain vigour of the variety or parental line. There is no specific labelling for nucleus seed.

(2) Breeder seed

It is the progeny of nucleus seed. Generally breeder seed is produced in one stage. But if there is greater demand for breeder seed and there is low seed multiplication ratio, then breeder seed can be produced in two stages *viz;* Breeder stage I and II in such cases breeder seed, stage I be becomes source for breeder stage II.

Breeder seed can be produced by original plant breeder and sponsored institute by ICAR and rarely on government farm. Breeder seed plots are inspected jointly by team.

Breeder seed produced should meet all prescribed standards *viz.* genetic purity (99.9% or more), physical purity (98% or more) Germination (as per crop) moisture content (less than 12 %) . After passing the seed lot, breeder seed tags in buff colour or Golden Yellow are signed by the concerned plant breeder and tagged to the breeder seed bags and size of tag is 12 × 6 cm.

(3) Foundation seed

It is the progeny of breeder seed and can be produced in two stages *viz.* Stage I and Stage II. Foundation seed is produced on the farms of State Agril. Universities, Taluka Seeds Farms, other Govt. farms, State Seeds Corporations, National Seed Corporation and private seed companies, Foundation seed plots are required to be registered for certification with State Seed Certification Agency. Seed plot of foundation seed jointly inspected by concerned crop breeder, District Seed Certification Officer, NSC and MSSC. If a foundation seed lot meets minimum seed certification standards including field tests It is certified as foundation seed and after processing and testing of seed completed bags are tagged with white coloured tag and opal green colour label together and sealed the bag by using lead seal and size of foundation tag is 15 × 7.5 cm.

(4) Certified seed

It is the progeny of foundation seed. Plots of certified seed are offered for certification with seed certification agency which inspects the plots during crop growth and at harvesting. After processing of seed lot seed sample is drawn by seed certification officer and sent the seed sample to Seed Testing Laboratory for seed testing. When seed lot meets minimum certification standards prescribed for that crop, then it is bagged, tagged with blue colour tag and opal green colour labels together and sealed by using lead seal and size of certified tag is 15 x 7.5 cm.

(5) Truthful seed

It is the category of seed produced by cultivators, private seed companies and is sold under truthful labels. But field standards and seed standards should maintain as per seed act and certified seed stage. Under the seed act, the producer and seed seller are responsible for the seed. The bags of truthful seed tagged with opel green and seeded with lead seal. Source of seed to be used for production truthful seed different stages of seed (B/S, F/S and C/S) and the size of opal green colour label is 15 x 10 cm.

4.5 Seed germination and seed dormancy

4.5.1 Definition of seed germination

Germination is the awaking of the dormant embryo and to resume growth. In mature angiospermic seeds, embryo lies in the dormant stage. As soon as favorable conditions are available dormancy is broken and germination begins, thus it is resumption of active growth of the embryo after a period of dormancy in presence of favourable conditions viz. moisture, air, temperature, light, medium.

4.5.2 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 (e.g. Pea and gram) and some trees like mango, jack fruit, coconut and arecanut.

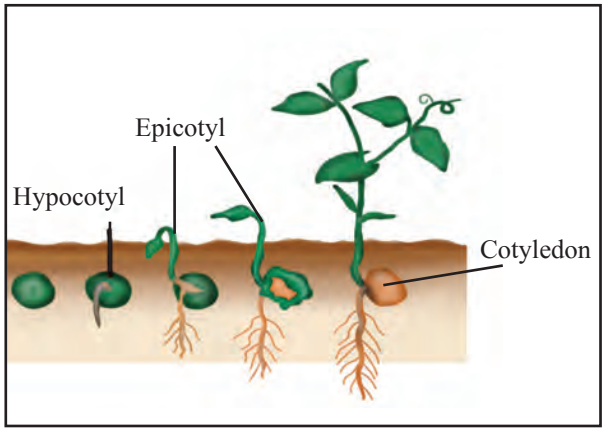

Fig 4.3 : Hypogeal germination

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 and woody plant species e.g. Cotton, cucumber, castor, sunflower, groundnut, tamarind and french bean.

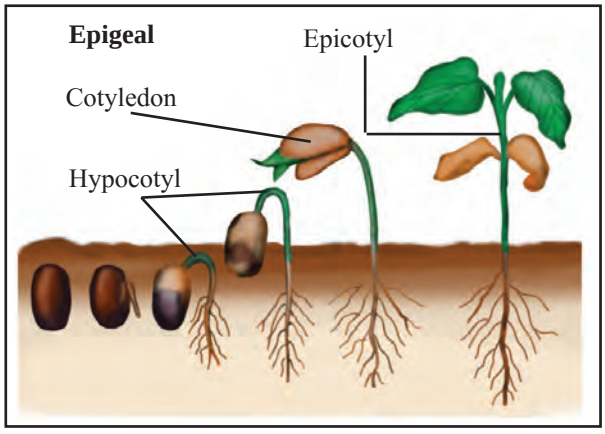

Fig 4.4 : Epigeal germination

3. Viviparous germination

Germination of seed inside the fruit attached to the mother plant (which also nourishes the seedling at initial stages just after germination) is known as 'Vivipary' and

it is observed in many plants which grows along sea coasts e.g. *Mangrooves*, *Rhizophora*.

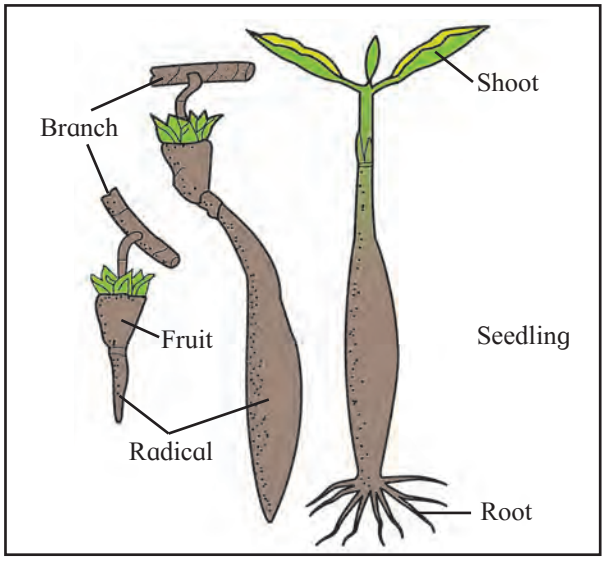

Fig 4.5 : Viviparous germination

It may happen

Pre-harvest sprouting

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

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*.

4.5.3 Factors affecting germination

Following factors are essential for normal germination of seed.

(A) External factors

1. **Water (Moisture):** It enables the resumption of physiological activities. Swelling of seed due to absorption of moisture causes bursting of seed coat, softening of the tissue due to which embryo awakes 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.

Try this

- Take a gram seed
- Plant the seed on germination paper
- Make three replications
- Put these bundles at different temperatures for germination in germinator
- Observe germination and decide optimum temperature for germination

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 grows more vigorously during darkness rather in light. However, for survival of germinating seedling, light is quite essential.
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 factors

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 seed remain viable for certain definite period of time and thereafter embryo becomes dead. It depends on maturity of seed, storage

conditions, vigour 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 favorable conditions of moisture. Many seeds do not germinate immediately after their harvest, they require rest period for certain physiological activities.

(C) Agronomic and other factors

1. Stresses during preharvest stage, harvesting and storage condition, unfavourable environmental conditions during seed setting, maturity and harvesting stage may affect viability and germination capacity. Mechanical injury to seed during pre harvesting and post harvest processing also affect germination. The structure made for storage, prevailing conditions during storage also cause loss in germination.
2. Special Treatments : Soaking of seed in water and other chemicals, X-ray and gamma ray treatment, etc. also have influence on seed germination.
3. Ecology : Special ecological conditions are essential for proper germinanation of certain seed.
4. Soil salinity : Some seed needs high salinity conditions of soil for germination.

4.5.4 Definition of seed dormancy

Failure of fully developed and mature viable seed to germinate under favourable conditions of moisture and temperature called resting stage or dormancy and the seed is said to be dormant.

4.5.5 Types of seed dormancy

There are several types of seed dormancy suggested by different scientists

(1) Primary dormancy

The seed gets dispersed from the mother plant, the dormancy may be induced before maturing, during maturity and after maturity.

The viable seed that does not germinate immediately after maturity under favourable conditions it seems germination under favourable condition after resting period is known as primary dormancy.

(2) Secondary dormancy

Some seeds are capable of germination immediately after they are shed. Such seeds, however can become dormant if they are placed in unfavorable conditions for some time. This type of induced dormancy is termed as Secondary dormancy. It can be induced by very low temperature, high CO_2 concentrate and absence of light.

(3) Exogenous dormancy

This is due to seed factors which are located out side of the embryo. The causes of this type of dormancy are

(i) Physical : Seed coats are impermeable to water and gases.

(ii) Chemical : Certain types of inhibitors of germination are present in seed coat.

(iii) Mechanical : This may be due to mechanical resistance of seed coat to germination.

(4) Endogenous dormancy

This type of dormancy is due to factors located in the embryo.

(i) Due to low or high temperature requirement.

(ii) Incomplete development of embryo in the seed.

(iii) Photoblastism : Light dependent dormancy

(5) Combined dormancy

This dormancy may be due to combination of two or more factors.

4.5.6 Methods of breaking seed dormancy

A. Scarification

1. **Pre-chilling :** the seeds are placed in contact with the moist substratum at a temperature of 5°C to 10°C for 7 days for germination e.g. cabbage, cauliflower, sunflower, broad bean.

2. **Pre-drying :**The seeds should be dried at a temperature not exceeding 40°C with free air circulation for a period of 7 days before they are placed for germination e.g. maize, lettuce.

3. **Pre-washing:** In some seeds, germination is affected by naturally occurring substances which act as inhibitors these can be removed by soaking and washing the seeds in water before placing for germination e.g.sugar beet.

4. **Pre-soaking :**Some seeds fail to germinate due to hard seed coat such seeds should be soaked in warm water for some period so as to enhance the process of imbibition e.g. chilli, subabhul and winged bean.

5. **Rubbing / puncturing seed coat:** Some seeds are subjected to mechanical scarification either by rubbing them against rough surface (sand paper) or puncturing the seed coat with pointed needle e.g. coriander, castor or chilli.

B. Stratification - In some seeds, after ripening low temperature and moisture condition require in artificial stratification. Seed layer altered with layers of moist sand/ appropriate material to store at low temperature e.g. *Brassica juncea* and *Arachis hypogea.*

C. Use of chemicals

1. **Potassium nitrate treatment**
The material used for placing the seeds for germination i.e. substratum may be moistened with 0.2 per cent solution of KNO_3 (2 g KNO_3+ 100 ml water) e.g. rice, tomato, chillies, etc.

2. **Gibberellic acid treatment:**
The substratum used for germination may be moistened with 500 ppm solution of GA_3 i.e. 500 mg in 1000 ml. of water. If dormancy is stronger GA_3 solution upto 1000 ppm may be used e.g. wheat, oat, etc.

3. **Thiourea**
Treatment generally 0.5 % thiourea solution is used for soaking seeds for short time and then transferring them to water e.g. gladiolous.

4.6 Seed testing

4.6.1 Germination tests

Germination test in laboratory indicates planting value of seed and its capacity of emergence as good and normal seedling in the field.

Observe and Discuss

Home cleaning of grains
Working of Seed testing laboratory
Routine tests in STL

4.6.2 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 vacuum 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 petri dishes or boxes and are kept in an incubator or germinator.

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 an upright position. Metal, glass or plastic frames can be inserted between papers to ensure ventilation However, paper should not be too wet to form water film if pressed with finger.

3. Germination in sand

Seed are planted in uniform layer of moist sand 1 to 3 cm deep and then covered with loose sand or seed are pressed into the of the sand, certain amount of water is added e.g. maize, groundnut and castor.

4. Germination in soil

Soil or an 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 germinated on paper or sand. Soil should be kept wet.

4.6.3 Procedure for germination tests

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 seed of given sample on germination paper with the help of counting board in four replications of 100 seeds each.
4. Cover the seed 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 seed 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 or 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 seed of variety to be tested at appropriate depth with proper spacing.
4. Cover the seed with soil or sand and give water if necessary and put them in germinator at appropriate constant temperature.

4.6.4 Evaluation of seedling after germination

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

1. Normal seedling

Seedling which shows the capacity for continued development into normal plants when grown in good quality soil.

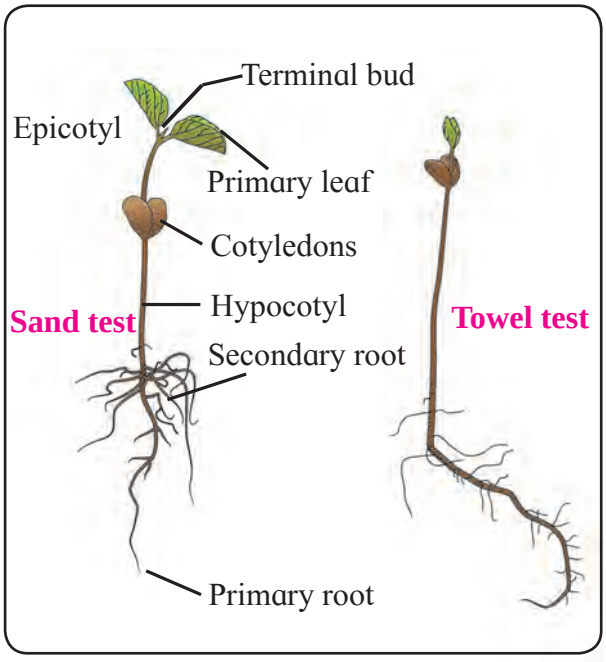

Fig. 4.6 : Normal seedling

Following seedlings may be treated as normal seedlings.

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

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

Fig. 4.7 Seed germinator

2. **Abnormal seedlings**

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 seedlings

(a) Seedlings without cotyledons, constrictions, splits cracks and lessions.

(b) Seedlings without primary root

(c) Seedlings having stunted root and plumules, coleoptile without primary leaves.

(d) Seedlings with decayed essential structure and discoloration.

3. **Ungerminated seed**

It consists of following seeds.

a. Hard seed : The seeds belonging to leguminoseae and malavaceae 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.

b. Fresh ungerminated seeds

Seeds other than hard seeds which do not germinate even after appropriate treatment for breaking dormancy are classified as fresh ungerminated seeds.

c. Dead seeds

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

4.6.5 Physical purity test

The purity test is done with following 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 seed and other crop seed 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 required for physical purity test

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

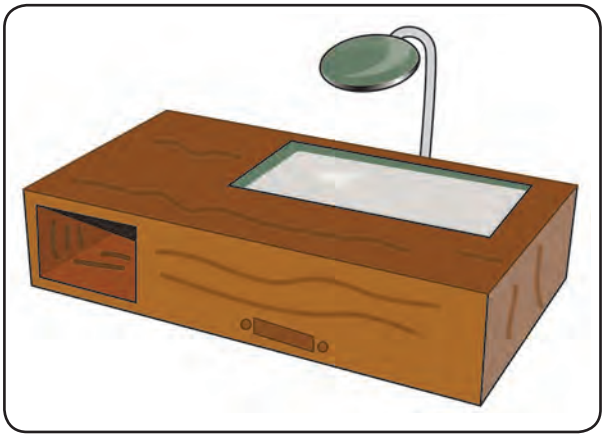

Fig. 4.8 Physical purity work board

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 forceps, needles and magnifiers, separate out the seed sample into following components.
   (i) Pure seed (ii) Other crop seed
   (iii) Inert matter (iv) Weed seed

Remember this

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

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 seed and inert matter.
5. Weigh the each of the three components.
   Wt. of working sample (g)
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 seed is more than 20, separate out all seed of that species from working sample as well as submitted sample.

Try this

Calculate the percentage value of each component on the basis of sum of weights of all components and not on the basis of the original sample.

(i) Pure seed (%) =

$$\frac{\text{Wt. of pure seed}}{\text{Total wt. of all seed components}} \times 100$$

(ii) Inert matter (%) =

$$\frac{\text{Wt. of inert matter}}{\text{Total wt. of all seed components}} \times 100$$

(iii) Other crop seed (%) =

$$\frac{\text{Wt. of other crop seed}}{\text{Total wt. of all seed components}} \times 100$$

(iv) Weed seed (%) =

$$\frac{\text{Wt. of weed seed}}{\text{Total wt. of all seed components}} \times 100$$

4.6.6 Seed health test - (Seed pathology)

Seed health refers to the presence or absence of disease causing organisms such as fungi, bacteria and viruses and animal pests. Hence, seed health testing is necessary to obtain information regarding health of seed lot.

Methods of seed health testing

A. Examination without incubation

It reveals presence or absence of pathogens examined., however does not give any indication about the viability of the pathogen.

1. **Direct examination** - Seed are directly examined with or without stereoscopic microscope. The ergot and sclerotin bodies, nematodes, galls, smut balls, insects, mites damage to seed etc. as well as discoloration of seed.
2. **Examination of imbibed seeds** - Seed are immersed in water or other liquid in order to liberate the spores and fruiting bodies more visible and after imbibition, they are examined with microscope.
3. **Examination of organisms removed after washing** - Seed are immersed in water or other liquid or alcohol and shaken vigorously to remove fungal spores, nematodes, etc. The excess liquid is removed by filtration, evaporation and extracted material examined by microscope.

B. Examination after incubation

In this method, the seed is incubated for a specific period.

The following media are commonly used for incubation.

(i) Blotters (ii) Sand
(iii) Agar plate

(i) Blotter method - In this method, seed are placed of moistened blotting papers at 20 mm apart. The blotters are rolled or placed in containers and incubated for specific number of days. Then it is examined under magnification for the presence of pathogen.

(ii) Sand method - Sand or similar media is used and seed without pre-treatment are suitably placed so as to avoid secondary spread of organism and incubated in conditions favourable for symptom development.

(iii) Agar plate - Seed after treatment are placed on the surface of 2% malt extract sterilized agar in petridishes and incubated. The colonies of fungi can be identified on agar directly or by lense.

C. Examination of growing plants

The growing of plants from seed for examination for disease symptoms is most practicable procedure for determining whether bacteria, fungi or viruses are present in the sample. Seed may be sown in the field or inoculums may be used for infection test with healthy seedlings.

4.6.7 Seed moisture test

Moisture content of seed is one of the important factor affecting viability and quality of seed. It is loss in weight when the seed is dried or the quantity of water collected when it is distilled. It is expressed as a percentage of the weight of the original sample.

Do you know ?

Seed entomology includes the study of pest of seed, their nature of damage and control measures in order to maintain viability and germination of seed.

4.6.7 Methods of moisture determination

The basic methods are-

1. Drying without heat

Samples are dried without heat or moderate heat in vaccum using phosphorus pentoxide ($P_2 0_5$) as desiccant.

2. Lyophilization

(Freeze dried)- Biological materials are frozen and water removed by sublimation in vaccum.

3. Reversibility method

(a) Red drying - This method determines drying time and temperature so that loss of weight by decomposition is accounted for.

(b) Karl Fisher titration method - In this method water is extracted from finely ground seed with methyl alcohol and then determined by titration by a special reagent. This is most accurate method. However, these methods require much time, equipments and high skills of operation and hence not practically used.

4. Hot air oven method

Method is most practical and commonly used for moisture determination.

Objective: To determine moisture content of a given sample.

Material

Grinding mill, hot air oven, chemical balance, crucible with lid, desiccators, spoon, trays and seed sample.

Procedure

1. Take 4 to 5 gms of duplicate working sample for determination of moisture from submitted sample accurately.

2. Crops of larger seed size (e.g. cotton, maize, sorghum, paddy, wheat, etc) are ground with grinding mill in such a way that at least 50 per cent of the ground material should pass through a wire sieve of 0.5 mm mesh and not more than 10 per cent remain on a top of wire sieve. For leguminous crop seed (e.g. pea, soybean, chickpea, etc) coarse grinding is necessary i.e. 50 percent ground material should pass through sieve with 4 mm mesh.
3. If moisture content of seed is more than 17 percent (Rice-13% soybean-10%) pre-drying is obligatory. Similarly, high moist seed of maize (above 25%) and others, samples should be dried at 70°C for 2 to 5 hours depending on initial water content.
4. Weigh the clean and dry crucible with lid accurately.
5. Put the ground seed sample prepared earlier (4-5 gm) in a crucible with help of spoon and again take the weight of crucible with lid very accurately.
6. Place the crucible rapidly in hot air oven as under
   (i) In low constant temperature oven method, keep the container at temperature 103°C ± 2°C and dry for 17±1 hrs. (e.g. onion, chillies, soybean, radish and brinjal, etc).
   (ii) In high constant temperature oven method, keep the material at 130°C ±2°C for 2 ± 1 hrs.

Table : 4.1 Temperature for oven dry method

Oven dry method recommended for different crops	Oven dry method
Rice, wheat, pearly millet, maize, sorghum, chickpea, lathyrus, pea, pigeonpea	High constant temperature (130 ± 2°C)
Groundnut, rape seed and mustard, soybean, sesame, linseed, castor and cotton	Low constant temperature (103 ± 2°C)

7. Remove the crucible with lid and cool in dessicator
8. Weigh the crucible with lid and contents.
9. Calculate the percentage of moisture content in seed sample by using formula-

$$\text{Moisture\%} = \frac{M_2 - M_3}{M_2 - M_1} \times 100$$

Where,

M_1 = Weight of empty crucible with lid

M_2 = Weight of crucible with seed sample

M_3 = Weight of cructible with seed sample and lid after drying

M_2-M_1 = Weight of sample

M_2-M_3 = Loss in weight after drying

5. Use of moisture metre

The moisture determination is based on the principle on that the moisture content in the seed is directly proportional electrical conductivity of seed. The various types of moisture metre are

(a) Universal electric moisture metre

(b) Steinlite moisture tester

(c) Marconi moisture tester

(d) Digital moisture metre

Laboratory work -

Determine the moisture percentage of seed sample given to you.

4.6.8 Seed vigour test

Seed vigour is the sum of those properties of seed which determine the potential level of activity i.e. rapid and uniform production of healthy seedling and stand establishment under a wide range of field conditions.

Objects -

(1) Main object of this test is to differentiate range of quality levels i.e. high, medium, low vigour seeds.

(2) This test evaluate seed performance under wide range of field conditions.

The test for determination of seed vigour

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 seedlings 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

1. First count:

The number of normal seedlings counted at the first count (4/5th day) represents the faster germinating seeds. Higher percentage of normal seedling during the first count indicates the seed vigour.

2. Speed of germination

Number of germinated seeds are counted every day from the first day and the cumulative index is made by the formula.

n1/1 + n2/2 ……. + nx/x = N

Where,

n1… nx are the number of seed germinated on day 1 to day x.

1 … x are the number of days.

3. Seedling growth rate

Twenty seeds are placed in straight line on a paper towel moistened with distilled water and kept at an angle of 75 in a germinator at optimum temperature. Only 10 competitive normal seedlings are selected for observation. The remaining seedling are removed. For the next 10 days the length of each seedling is measured daily in cm.

Seedling growth rate is determined by dividing the mean increase in length from each previous measure by the number of days the seedling had been in the germinator. Sum of each count at the end of the test period is expressed as seedling growth rate.

4. Seedling length

Length of 10 normal seedling grown in moist towel paper kept at optimum temperature is measured in cm on the day of final count. The lot showing maximum seedling length is considered as vigorous.

5. Seedling dry weight

The weight of seedling excluding the cotyledon is taken on 10th day after oven drying at 100^{0}C for 24 hr in g. The lot exhibiting the maximum seedling dry weight is considered as vigorous.

6. Vigour index length

A combination of standard germination test with seedling length provides broad evaluation of seedling vigour, seed lot with high vigour index is considered as vigorous.

7. Vigour index mass

Vigour index in terms of mass is determined by the multiplication of germination percentage with seedling dry weight on the day of final count.

4.6.9 Seed viability test

Viable seed is a seed that is capable of germination under suitable conditions.

Object

Object of the biochemical test is to determine quickly the viability of seeds of certain species which germinates slowly by regular germination process.

(1) Topographical Tetrazolium test or TZ 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 seed from a colourless dead ones. In addition to completely stained viable seed and completely unstained non-viable seed, partially stained seed may occur. Varying proportions of necrotic tissues occur in different parts of these partially strained seed. Localisation and spread of necrosis in the embryo and on endosperm and the intensity of colour determine whether such seed are classified as viable or non-viable.

General directions

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 within the range of 6.5 - 7.0, the tetrazolium salt should be dissolved in buffer solution. The buffer solution is prepared as follows.

Procedure

Each 4 replications of 100 seeds each from the pure seed fraction of physical purity test. To facilitate penetration of Tetrazolium solution, the seed 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 seed 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 solutions are 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.

Calculation

The results are reported as percentage of viable seed in relation to total seed tested.

Do yourself Collect information about seed testing labaratory

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Exercise

Q.1 A. Fill in the blanks.

1. The matured and ripened ovule after fertilization is known as ----------.
2. Breeder seed is the progeny of ---------- seed.
3. The awaking of the dormant embryo is called as ----------.
4. The test used to determine the viability of true seeds is ---------- test.
5. The brick gravel test is used for determining ----------.

B. Make the pairs

A	B
1. Seed dormancy	a. Moisture test
2. Crucible	b. TZ Test
3. Certified seed	c. KNO_3
	d. Brick gravel method
	e. Blue colour tag

C. State true or false

1. Castor seed is dicot and non endospermic seed.
2. Genetic purity of breeder seed is 99.8 percent.
3. Gram is an example of epigeal type of germination.
4. TZ test is used for testing seed viability.
5. Physical purity test used for testing germination of seed.

Q.2 Answer in brief

1. Write short notes on
   (i) Seed structure of castor
   (ii) Foundation seed
   (iii) Seed viability test
   (iv) Types of germination
2. List out seed multiplication stages.
3. Give difference between
   (i) Seed and grain
   (ii) Nucleus seed and Breeder seed
   (iii) Breeder seed and foundation seed
   (iv) Foundation seed and certified seed
   (v) Physical purity test and germination test
   (vi) Seed vigour test and seed viability test
   (vii) Hypogeal germination and epigeal germination
4. Give scientific reasons
   (i) Why cotyledon remains below the soil surface?
   (ii) Why cotyledon remains above the soil surface?
   (iii) Why foundation and certified seed multiplication seed stages are called as quality stages?
5. Give examples of
   (i) Endospermic seed
   (ii) Non endospermic seed
   (iii) Type of epigeal germination
   (iv) Hypogeal type of germination
   (v) Germination in sand

Q.3 Answer the following questions

1. Complete the following table

(a) Seed multiplication stages.

Sr. No.	Name of stage	Source of seed	Genetic purity
(i)	Breeder seed		
(ii)	Foundation seed		
(iii)	Certified seed		
(iv)	Truthful seed		

(b) Seed type and germination

Sr. No.	Name of seed	Type of seed	Type of germination
(i)	Bean		
(ii)	Maize		
(iii)	Castor		
(iv)	Gram		

2. Describe the structure of dicot seed.
3. Draw and label structure of monocot seed.
4. Calculate pure seed percentage when weight of pure seed is 180 gms and total weight of all component is 200 gms.
5. Write the procedure of germination test on towel paper.

Q. 4 Answre in detail.

1. Explain the different stages of seed multiplication.
2. Describe the different types of seed germination.
3. Define seed dormancy and explain the methods of breaking seed dormancy with examples.
4. What is mean by seed health and give details regarding examination without incubation.
5. Write the procedure of seed moisture test by hot air oven method with formula.

Activity :

Classify seed from given seed sample by using physical purity work board and determine their percentage.

Fig. 4.9 : Different seed material