UNIT 1 SEED DEVELOPMENT PRODUCTION AND STORAGE

Seed development

A true seed is defined as a fertilized mature ovule consisting of embryo, stored food material andprotective coats.. The important events involved in seed development and maturation include

Seed Formation: The seed formation takes place by the following steps:

1Gametogensis 2.Pollination 3.fertilization 4.Development of seed

Gametogensis: Formation of male and female gametes with haploid chromosome number for fertilization is known as gametogensis. Gamate formation take places separately in male (anther) and female (Ovule) part of the flower. It involves two steps i.e., sporogensis followed by gametogensis in both male and female reproductive parts.

Sporogensis: Its the formation of spores in a reproductive part I.e, spores of male and of female Formation of male gamates.Its has two steps microsporogensis and microgameteogensis. Androceium (stamen) is the male part of the flower with anther and filament is its part.Anther has four chambered structure placed on filament.Each chamber is known as pollen sac (Microsporangia)

Microsporogensis: In the pollen sac,pollen grains are formed. Inner most layer of pollen sac in known tapetum that provides nutrients for development of pollen mother cell(2n) in each pollen sac.The diploid pollen mother cell under goes meiosis cell division,first form two dyad and then for haploid cell. Each one is known as microspore.

Megasporogensis

Female: Seeds of Angiosperm originate from meristematic tissue of the ovary wall called Ovule primordia. Within the nucellus, one cell known as Archesporium cell (2n) develops a special characteristic that distinguishes it from the adjacent cells. It develops larger than the surrounding cells, having a large nucleus and denser cytoplasm called Megaspore mother cell (MMC). MMC undergoes a meiotic division, giving rise to four megaspores, each containing a haploid chromosome set. Among the four cells one megaspore survive to give rise to an embryosac. Whereas other three aborts. Development of functional megaspore from MMC is called megasporogenesis. The nucleus within the functional magaspore undergoes three successive divisions to form eight nuclei. Eight nuclei are arranged as three antipodal cells at the chalazal end, two central polar nuclei,one egg cell with two synergids at the micropylar end. Development of eight celled embryosac from the functional magaspore is called as magagametogenesis.

Pollination

Floral biology

Flower is a reproductive organ bearing pistil, stamen and usually sepals and petals. Male part of a flower is androecium consisting of anther sac, anthers and pollen grain . Female part is gynoecium consisting of ovary, style and stigma. The flower is said to be perfect, when they contain both male and female parts. A flower with both functional male and female is called as bisexual or hermaphrodite. Sometimes male or female mature slightly at different times. This nature is called dichogamy which favours cross pollination. If male matures first it is called as protandry, iffemale – protogyny. Imperfect flowers have either male (staminate flower) or female (pistillate flower) part. Such flowers are called as unisexual flowers. When both type of flowers occur in same plant monoecious, if they occur in different plants dioceious.

Seeds usually developed from the fertilized flower for which pollination (transfer of pollen from anthers to stigma) is pre requisite. For successful fertilization viable pollen and receptive stigma are two pre requisites. The mature anthers dehisce and release pollen grains (haploid microspores). When pollen grains are transferred from an anther to the stigma of the same flower the process is calledself-pollination or autogamy. If they are transferred to the stigma of another flower is called cross-pollinationor allogamy is said to have occurred.

Self-pollination occurs in those plants where bisexual flowers achieve anther dehiscence and stigma receptivity simultaneously. The majority of angiosperms bear chasmogamous flowers i.e., flowers do not open before pollination. In some plants, flowers do not open at all such flowers is called cleistogamous, and this is the most efficient floral adaptation for promoting self-pollination.

Cross-pollination is ensured in plants which bear unisexual flowers. In bisexual flowers also self-pollination may be prevented by self-sterility, dichogamy (maturation of male and female organs at different times), herkogamy (where the structure of male and female sex organs proves a barrier to self pollination) and heterostyly (where flowers are of different types depending on the length of the style and stigma and pollination occurs only between 2 dissimilar types).

The important self-pollinated crops are wheat, rice, barely, mungbean and cowpea and cross pollinated are maize, rye, forage legumes and vegetables like carrot, cauliflower and onion. There is yet another category of crops called often cross pollinated crops such as cotton and pigeon pea where there may be 10-40% cross pollination.

Fertilization: Ovules are developed in the female gametophyte and pollen in the male gametophyte. Fertilization always takes place in female gametophyte, therefore pollen must transferred from male to female by pollen vector which may be abiotic including wind (anemophily) and water (hydrophily) or biotic including insects (entomophily) and bats (cheiropterophily).

Apomixis: Development of seed without fertilization i.e. the seed formation occurs without sexual fusion, the process is known as Apomixis. This occurs by several mechanism, however, all apomitic seed have genetic material only from the female plant. Apomixis may or may not require pollination and pollen tube germination to initiate seed formation, however sexual union never occurs.

Parthenocarpy: Development of fruit without fertilization

Seed Development After fertilization, development of fertilized ovule into a mature seed involves several different stages. Seed formation begins within the minute embryosac with certain expectations, which is about the same in shape, size, and arrangement. In spite of initial similarities, the seed develops according to the genetic specification for each species, which are coded in the nucleus (chromosomes) of each cell.

- The integument of the ovule becomes the seed coat of the mature seed.
- Normally the nucellus is absorbed and is absent. The nucellus may persists in some genera such as Nutmeg, Clove, Rubber, Papaya, Pepper, Beet root, etc. as a thin layer called Perisperm, lying inside the seed coat and supplies food material to the embryo.

- The Endosperm serves as a principal nutritive support for the embryo of many species (especially monocotyledons) during both seed development and germination. The endosperm normally grows more rapidly than embryo.
- In Monocotyledons, endosperms usually reach the maximum morphological development at physical maturity and persists to comprise a major part of the seed.
- In Dicotyledonous spp., the endosperm may not develop or may be used up by the developing embryo and comprise none or a small part of mature seed.

Embryogensis

Embryo: The first few cell division from the zygote forms the Pro-embryo. Although the mature embryo of monocotyledons and dicotyledons appears considerably different, their pattern of embryogeny are similar. The Pro-embryo is divided into Suspensor and Embryo proper. The suspensor forms into a chain of cells, pushing the embryo proper into the center of the ovule thus making it in contact with the available food supply. The pro-embryo may vary greatly in size and shape.

1. Embryo Development

The first division of the zygote is transverse in dicots and it results in a small apical cell and a large basal cell .Cell ca divides vertically forming 2 juxtaposed cells and cb undergoes a transverse division forming 2 superimposed cells. These results in a T-shaped, 4 celled proembryo. Cell ci divides transversely giving rise to n and n'. These 2 cells divide further resulting in a row of 3 or 4 cells, forming suspensor. Cell m and its derivatives undergo vertical divisions forming a group of 4 to 6 cells. This group divides by oblique-periclinal wall forming a set of inner cells and a row of outer cells. The inner cells form the initials of the root apex and the outer cells form the root cap. The 2 cells formed as a result of the division of ca again divide vertically forming quadrant. Each cell of the quadrant divides transversely and thus an octant containing 2 tiers of cell l and p is formed. The cells of the octant undergo vertical division resulting in a globular proembryo. Periclinal divisions occur in the peripheral cells of the globular proembryo that delimit an outer layer, the dermatogen. The tier l gives rise to cotyledons and shoot apex and l forms hypocotl-radicle axis.Certain deviations from the above pattern of embryo development are found in different plants. Different types of embryogeny are distinguished depending on the plane of division of the apical and the extent of contribution of the basal cell towards embryo development (in some plants cb remains undivided and does not take part in embryo development at all).

In monocotyledons, the cell cb remains undivided and develops into a haustoria of the suspension. Cell ca divides into 2 by a transverse division. The terminal cell of these 2 by repeated divisions in different planes gives rise to a single cotyledon. The embryo development in grasses is different from that of other monocotyledons. A dorsiventral symmetry is established as a result of the peculiar oblique position of cell walls early in the embryogeny. The single cotyledon is reduced to absorptive scutellum and additional structures like coleptile and coleorrhiza are formed.

Development of Embryo

2. Endosperm Development There are 3 types of endosperm development (a**nuclear**- where the endosperm nucleus undergoes several divisions prior to cell wall formation, e.g., wheat apple, squash, (b)**cellular**- in

which there is no free nuclear phase and (c)**helobial -**where the free nuclear division is preceded, and is followed by cellularization as in some monocots. During the course of seed development, reserve food materials are accumulated in the endosperm from the adjacent tissues.

In endospermic dicot seeds, endosperms are retained as a permanent storage tissue. In non-endospermic dicot seeds, endosperm reserves are depleted and occluded by the developing embryo. The reserves are then reorganized in the cotyledons, which in turn act as the source of stored reserved food for embryo after germination. A part of the endosperm is depleted in cereals during embryo maturation and this lies as a layer between the starchy endosperm and scutellum.

Seed Growth and Maturation: Wheat and soybean representing monocots and dicots may illustrate the changes in the pattern of accumulation of reserve materials at different stages of seed maturation.In wheat, the dry weight of the seed increases rapidly in about 35 days after anthesis. The water content of the grain is maximum between 14 and 21 days after anthesis, and then it declines rapidly. The amounts of reducing sugar and sucrose are high between 7 and 14 days and decline rapidly thereafter due to conversion to starch.Since in wheat, starch is the major reserve material of the seed, the pattern of starch accumulation is similar to that of dry matter accumulation.

The speed of germination is faster in wheat varieties that begin to lose water early during seed development. The seed is said to have physiologically matured only when it attains maximum dry weight, germinability and vigour. Normally the seed is harvested at field maturity, a stage when the moisture content is reduced to about 6-10 % in wheat. Field maturity is a crop specific character.

A soybean seed attains maximum dry weight between 48 and 54 days after flowering. Oil accumulation is less during 12-18 days after fertilization; maximum oil accumulates between 24 and 42 days after flowering, after which the rate decreases. The protein content in the seed is maximum during 12-18 days after fertilization and decreases subsequently. The initial high percentage of protein may be due to the high content of non-protein nitrogen, which decreases with seed age. Oil accumulation picks up only after protein accumulation completes in the seed.

Seed Dormancy: Is the resting stage (or) survival mechanism of the seed because dormancy delays germination, therefore it is of great importance and effectiveness as a survival mechanism. According to Amen (1963) dormancy is defined as "endogenously controlled but environmentally imposed and it is the temporarily suspension of growth accompanied by reduced metabolic activity and relatively independent of ambient environmental conditions. According to Simpson (1965) seed dormancy is defined as failure of viable seed to germinate at specified length of time in a set of environmental conditions, later evoke germination when the restrictive state of seed is removed naturally or artificially.

Based on Amen (1963) definition,the dormancy can be classified in to 2Types
A.Innatedormancy/Primarydormancy
B. Secondary dormancy

A. Innate dormancy / primary dormancy

It is the state of the seed itself or dormancy induced in the seeds at the time of dispersal from the mother plant i.e. the dormancy may be induced before maturity, during maturity and after maturity but before seed is dispersed from mother plant.

B. Secondary dormancy

Secondary dormancy can take place only in a matured and imbibed seed by certain environmental conditions, which are unfavourable to germination. (e.g.) Spring wheat and winter barley, the secondary dormancy could be imposed by

Exposure of dry barely seed to temperature between 50 and 90 degree Celsius Storage of winter barely for seven days in high moisture containers at 20degree Celsius.

Storage of spring wheat for one day at high moisture content in airtight containers at 50degree Celsius .

Placement of seed under water and in darkness for 1 to 3 days at 2degree Celsius .

Induction of secondary dormancy was possible one and half months after physiological maturity. Secondary dormancy in Spring wheat could not be broken by two weeks of storage. However, it was completely broken by treatment with 0.1% GA3, 0.5 to 1.0 % Ethanol, low temperature stratifications, removal of pericarp and storage at 20degree Celsius .

Secondary Dormancy Mechanism

Imposition of blocks of crucial points in the metabolic sequence that leads to germination.

An un favourable balance of growth promoting versus growth inhibiting primary dormancy (coat imposed dormancy)In many species seed dormancy is imposed by the structures surrounding the embryo (seed coat), which may include glumes, palea and lemma (grasses, the pericarp, perisperm and endosperm). The embryo in these cases are non dormant one.

Primary dormancy is further classified into endogenous and exogenous.

Exogenous dormancy:Is due to the seed coat factor either due to presence of inhibitors or hard seed nature. It is further classified into,

Physical– Dormancy is due to the hard seed coat which prevents the entry of water and sometimes gaseous exchange is also prevented. e.g. Hard seeds of pulses, acacias. Prosopis, sapota etc.,

Chemical– Presence of some inhibitors in the seeds coat which prevents the germination

Mechanical– restriction of the growth of protruding radicle due to structure. (e.g.) inadequate space in the seeds of*Terminalia*sp.

Endogenous dormancy– Dormancy due to embryo. May be the presence of inhibitors , immature embryo or combination of both. It is further classified into

Morphological– Due to immature embryo, which is not able to putforth germination even under favourable conditions . (e.g.) Apple

Physiological– Due to arrest of the metabolic activity in the seeds due to presence of some inhibitors like ABA, coumarines phenols etc.,

Morphophysiological– Combination of immature embryo with inhibitors.

Secondary Dormancy: Whose germination is inhibited , fail to recover even when the inhibitory factor is removed. Adoptive mechanism to pass the adverse environmental condition.

Types of secondary dormancyThermo– Dormancy due to temperature
Skoto– Light; Photo – Quality of light and Osmotic – stress or high osmotic stress prevents germination

According to Harper (1977) dormancy may be classified into following,

1. Nature of origination i. innate ii. Induced iii. Enforced
2. Time of origin i. Primary ii. Secondary
3. Location of dormancy i. Exogenous ii. Endogenous iii. Combined

Advantages of dormancy

1. Storage life of seed is prolonged
2. Seed can pass through adverse situation
3. Prevents the *in situ* germination.

Disadvantages

1. Long periods of time needed to overcome dormancy (for uniform germination)
2. Contributes to longevity of weed seed.
3. While raising a crop it is very difficult to maintain the population in the field with dormant seed lot

Dormancy breaking treatments

Physical dormancy

I. **Scarification**

Acid ii. Mechanical ii. Physical treatment – hot water treatment

Scarification Any treatments may be physical or chemical that weakens or softens the seed coat is known as scarification. This method is more applicable to Malvaceae and Leguminaceae group of seeds.**)**

1. **Acid scarification** By using concentratedH2SO4@ 100 ml/kg of seed for 2-3 minutes treatments dormancy can be overcome in the above group of seeds. The duration of treatment will vary and it depends on type and nature of seed coat e**.g.** Tree crops 1-3 hours, Rose seeds, treat the seed partially with acid and then given with warm stratification.

b) Mechanical scarification

Seeds are rubbed on a sand paper or with a help of mechanical scarifier or by puncturing on seed coat with the help of needle to enhance / increase the moisture absorption by seeds. **E.g.**Bitter gourd for sand scarification, sand and seed 2:1 ratio should be followed. Rub against hard surface of seed for 5 to 10 minutes.

2. Hot water treatments

It is effective in case of leguminous tree crop seeds. The seeds should be soaked in boiled water for 1-5 minutes for 60-80 minutes. Some crops like Bengal gram and Groundnut, hot water treatment for more than 1 minute is found injurious to seed.

3. Stratification treatment

When seed dormancy is due to embryo factor, seeds can be subjected to stratification treatments.

a) Cold stratification

Incubate the seed at low temperature of 0-5 degree Celsius over a moist substratum for 2-3 days to several months. It depends on the nature of seed and kind of dormancy. (e.g.) Cherry and oil palm seeds.

b) Warm stratification

Some seeds require temperature of40-50 degree Celsius for few days e.g. paddy. In case of oil palm it requires temperature of40-50 degree Celsius 0for 2 months for breaking dormancy. Care should be taken during the treatment and moisture content of seed should not be more than 15%.

4. Leaching of metabolites (Inhibitors)

The seeds can be soaked in water for 3 days. But once in 12 hours fresh water should be changed to avoid fermentation or seeds can be soaked in running water for a day to leach out the inhibitors. (e.g.) Coriander (Coumarin), Sunflower (Hydrocyanic acid)

5. Temperature treatments

a) Low temperature treatments: Plants which grow in temperate and cooler climates, require a period of chilling for breakage of dormancy. e**.g.**Apple seed dormancy can be released by low temperature treatment by storing the seeds at5 degree Celsius .

b) High temperature treatment: Normally high temperature treatments are exhibited by early flowering "winter " annuals.e**.g.**Blue bell (*Hyacinthoides nonscripta*). Their seeds are shed in early summer and do not germinate until they have been exposed to the heat during high summer.

c**) Alternate temperature treatments**

Most of the plant species which grow in temperate and cool temperate regions require alternate temperature for breakage of dormancy (e.g**.**) Bull rush (Typha).

d) Fire treatment

Many shrubs and trees of sub tropical and semi-arid regions have extremely hard seeds in which the seed coat is very impervious to water. Dormancy in such seeds is clearly coat imposed, and maybe broken by exposure toextremeheat suchasfire.**E.g.**Seeds o *Calluna vulgaris* dormancy is broken by fire.

Seed dispersal: Seed rain is the total contribution of seed by the parent plant to the soil seed bank.Seed rain is the equivalent of seed production. Seed dispersal pattern contribute to the genetic structure of plant populations and to be potential for genetic drift and response to natural selection.Long distance seed dispersal by wind animal and even ocean currents has determined by composition of flora of many isolated island.

Why seed are Dispersed?

1.It enables the germinating seedling to avoid established competitive conditions around around the mature parent plant.
2.Disperseal enhance the avoidance of natural enemies such as pathogen,predator,parasite and herbivores that accumulate around an established site.
3.Sibling competion for the same environmental resources is minimized
4.Some plants have special seed dormancy traits that must be staisfied before germination occurs.
Seed disperseal enhances the probability that atleast some of the seeds will encounter the appropriate condition to break dormancy.The seeds dispearsel are discussed by Murray 1986.Animals (zoochory) chory means to wander ,wind(anemochory),water(hydrochory) and plant itself(autochory)
Vander pilj(1972)divided zoochory in to three groups (1)endozoochorous plants where the seeds are ingested by animals and pass through the digestive tract with out damage,(2)epizoochorus plants where the seeds adhere to the fleece,coat or feathers of animal and then loosen and fall to the ground and (3) synzoochorous plant where the seeds are collected and cached for feeding.
In endozoochory,various animals such as fish,reptiles,birds and rodents eat seed. These seeds are typically posses attractive features to animal such as colour,odor and abundance of storage material and large size. Many fruits change colour from green to red as they mature,which contrast them against green foliage .This morphological change assures easy visiblity to foraging animals,signifies that the fruit is ripe and simultaneously ensure that the seeds are mature and capable of reproduction.
Epi zoochory.Seeds develop at least two animal adhering mechanism that assist their dispersel(1)hooklike spine(2) sticky substances.Hook like spines are usually more common in fruits than seed,but they can found also on seeds.The hairs and bristle of some seeds that assist in wind dispersal also cling to animals.Sticky substances such as mucilage extruded from moistened seed coat allow the seed adhere to passing animal in the morning when dew are present,and then to be deposited elsewhere when mucilage dries later in the day.Mucilage production common in the Brassicaceae, Asteraceae.
Synzoochory. Seeds are collected and stored by animals for nutritional reasons.In some cases,the nutritional part of the seed is fleshy appendages called an elaisome that can be easily detached from the remainder of the seed,which is hard and inedible.Example Acacia where ants harvest the seed carry them to their nest where elaisomes are separated from seed
Anemochory. Wind is most effective of all seed dispersal agents.Appropriately seeds have developed specialized structure to assist their dispersal in air,this include small seed size,ballons,and wings.Seed size is importantant in wind dispersal because small seeds can be transported in air
Hydrochory. Seed are dispersed in water because they possess a specialized air filled tissue that allows the seed to be buoyant in water.This tissue can contain spongy,inter celluar space filled with air
Autochory. Plants have develop mechanism to disperse their own seed ballistically.This can occur by explosive opening of the fruits
Concept of classes of seed
The four generally recognized types seeds are:Nucleus seed, Breeder's seed, Foundation seed, and Certified seed. The Association of Official Seed Certifying Agencies (AOSCA) has

Nucleus seed: Is the original seed of a variety available with the producing breeder or any other recognized breeder of the crop. This seed has 100% genetic and physical purity along with high standard of all other quality parameters. Nucleus seed is multiplied and maintained by selecting individual pods/spikes/plants and growing individual pod /spike progenies. Each pair of row is the progeny of single plant of wheat in

the previous season from the nucleus seed of the plot. This process is repeated continuously. Therefore,nucleus seed is available in small quantity.

Breeder seed: The seed or vegetatively propagated material directly controlled by the originating or the sponsoring breeder or institution which is the basic seed for recurring increase of foundation seed. Breeder seed is genetically so pure as to guarantee that subsequent seed class shall conform to the prescribed standard of genetic purity. Minimum seed standards for breeder seed are less stringent than those of nucleus seed,but they are more stringent than foundation seed. The quality norms of breeder seed is indicated in the label attached to seed bag. The breeder seed tag is golden brown in colour.

Foundation seed: It is the progeny of breeder seed. The seed stock handled to maintain specific identity and genetic purity, which may be designated or distributed and produced under careful supervision of an agricultural experiment station. When seed is the progeny of breeder seed it is called foundation stage 1 while its called foundation stage 2 when its progeny of certified foundation seed. The minimum seed standard for both foundation seed are similar. Bags of foundation seed carry tags of white colour which contain information about seed quality.

Certified seed: It is the progeny of the foundation seed. Its production is so handled to maintain genetical identity and physical purity according to standards specified for the crop being certified. It should have the minimum genetic purity of 99%. Certified seed may be the progeny of certified seed , provided this reproduction does not exceed three generations beyond foundation seed and provided that if certification agency determines the genetic and physical purity, if not be significantly altered. In case of highly self pollinated crops certification of one further generation may be permitted. Certified seed produced from certified seed shall be eligible for further seed increase under certification, except in case of highly self-pollinated crops, where certification of one further generation may be permitted. Certification tags issued once for certified seed not eligible for further seed increase under certification. The tag of certified seed is of blue colour and carries all the relevant information about the certified seed lot contained in the bag.

Genetic Purity:The genetic purity of a variety or trueness to its type deteriorates due to several factors during the production cycles. Kadam (1942) listed the following important factors responsible for deterioration of varieties.

Maintenance of Genetic Purity during seed Production

1Control of seed source 2.Proceeding crop requirement 3.Isolation 4.Rouging 5.Seed certification 6.testing of seed for genetic purity 4.Change of seed after every three years

Control of seed source:Use of approved seed only in seed multiplication. Inspection and approval of fields prior to planting. Field inspection and approval of growing crops at critical stages for verification of genetic purity, detection of mixtures, weeds, and for freedom from noxious weeds and seed borne diseases etc

Isolation: The main objective of isolation is to keep the seed crop away from the source of genetic contamination. Maintenance of genetic purity of seed crop by keeping variety in isolation from the varieties of the same species and some cross compatible other species to avoid out crossing is known as isolation it has three types time isolation,barrier isolation and border row-to-row

Time isolation: Out crossing may be checked by adopting different time of sowing for different varieties,so that their blooming period will not coincide with each other. Time isolation is permitted for hybrid seed production of maize for the in isolation distance.

Barrier isolation: Isolation can be maintained by providing physical barrier of optimum plant height around seed production plot. It reduces the movement of wind blown pollen by controlling the velocity of air. Physical barrier of polythene sheet of 3 metre height or planting of sesbania 15 days before transplanting of rice.

Border row: hybrid seed production plot of maize are surrounded by the male parent used in hybrid seed production programme at the same time by sowing and with same seed rate crop. These plants check the entry of foreign pollen as a physical barrier.

Growing of samples of potentially approved stocks for comparison with authentic stocks.

The various steps suggested for maintaining genetic purity are as follows:

a. Providing adequate isolation to prevent contamination by natural crossing or mechanical mixtures

b. Rouging of seed fields prior to the stage at which they could contaminate the seed crop.

c. Periodic testing of varieties for genetic purity.

d. Avoiding genetic shifts by growing crops in areas in their adaptation only.

e. Certification of seed crops to maintain genetic purity and quality of seed.

f. Adopting the generation system.

g. Grow out tests.

Genetic Purity Maintenance in Hybrid Seeds

Maintenance of the genetic purity of hybrid seeds is a complicated one requiring elaborate procedures.

Nucleus Seed of Inbred Lines

The nucleus seed of inbred lines can be maintained by self pollination, sib- pollination,or a combination of the two procedures (hand pollination).

Some breeders prefer 'sibbing" because it maintains vigour. "Selfing" is used to stabilize inbred lines if a change in breeding behavior is noticed.

Some parental material is preferably maintained by alternate selfing and sibbing from one generation to other.

Individually selfed or sibbed ears should be examined critically, discarding off types or inferior characteristics (texture, colour, seed size, chaff color and shape of ear head).

The uniform ears are then threshed separately and planted in ear to row method to easily detect and discard off types from individual ears if any.

Alternatively all of the ears from an individual inbred line may be composited for bulk planting in the next season.

The hand pollination seed is sown on clean, fertile soil having no previous crop of the same kind or variety during the previous year (bearing maize).

It is rather important to ensure that the crop is well isolated, with the requirement varying from crop to crop and depending upon the nature of the material to be protected by isolation, the nature of the contaminant, and the direction of the prevailing wind.

The isolation can be achieved either by distance or by time (maize). The inbred line maybe composited for bulk planting in the next season.

Maintenance of genetic purity in inbred lines through hand pollination and adequate isolation alone is not enough to achieve perfection.

The isolated fields must be critically rogued for off types and other impure types prior to the shedding of pollen.

The nucleus seed crop is harvested after physiological maturity if artificial drying facilities exist.

Ear to harvest lines are harvested separately and piled; These are again critically examined for ear characteristics, sorting out of all off-coloured, diseased, or otherwise undesirable ears.

If the overall percentage of off types exceeds 0.1%, hand pollination should be repeated to produce the second year's breeders seed.The uniform ears are bulked, dried in a clean dry bin at temperatures not exceeding43degre celcius, shelled, cleaned, treated with pesticides, and stored under ideal storage conditions as breeder stock seed. This seed may be increased during the following season by paying adequate attention to isolation, roguing, etc., to maintain high genetic purity

Rice Oryza sativaL.

Hybrid Rice Seed Production Seed Production

Success of Hybrid Rice Technology depends on efficient and economic seed production on large scale. It determines whether the heterosis of hybrid rice can be fully exploited or not. It is reported that the yield of F1 hybrids will decrease by 0.8% when the seed purity decreases by 1%, so it is very important to establish a sustainable system of seed production to ensure the purity of hybrid seeds in hybrid rice development.

The existing rice hybrids used in commercial production in India are developed by using cytoplasmic genetic male sterility and fertility restoration system (CMS system). This system involves three lines viz., cytoplasmic genetic male sterile line (CMS or `A' line), maintainer (`B' line) and restorer (`R' line) lines for developing rice hybrids. Hybrid Seed Production using the CMS system involves the following two steps.

Production of `A' line (A x B)

Production of Hybrid Seed (A x R)

The `B' and `R' lines are multiplied in the same way as inbred varieties.

Seed Parent A line

Maintainer B line

A line Produces non viable pollen grains

Seed Parent A line

Pollen parent R line

Hybrid

Produces viable pollen and sets seeds which are used to plant commercial rice crop

Thus the procedure of hybrid rice seed production, in which two different lines including male sterile lines (seed parent) and restorer lines (pollen parent) are planted alternatively in a certain row ratio in the same field and the out crossed seeds are harvested from the male sterile plants, differs from that of inbred varieties, in which only one line is grown and the selfed seeds are harvested. Therefore, in to whole process of hybrid seed production, it requires a set of complicated techniques entering on raising the out crossing rate to obtain a high seed yield. Rice is self-pollinated crop, where the extent of natural out crossing is only 0.3to 3.0%. Therefore hybrid rice seed production requires specialized techniques,which need to be thoroughly understood before embarking upon this venture. The success of hybrid seed production depends on various factors such as choice of field,

isolation, seeding time, planting pattern and weather conditions during the period of flowering, roguing synchronization in flowering of parental lines, supplementary pollination techniques, proper harvesting, processing, packing and effective seed distribution etc.

1. Choice of location:Choosing a desirable location for hybrid seed production is very important. In

the well isolated area, the paddy field with fertile soil, a desired irrigation and drainage system, sufficient sunshine, and no serious disease and insect problems are essentially needed.

2. Isolation:

Rice pollen grains are very small and light, and can travel very far with the wind. In order to ensure the purity of hybrid seed and avoid pollination by unwanted rice varieties, the hybrid seed production plots should be strictly isolated by the

following methods.

Space isolation: A space isolation of 50 – 100 m would be satisfactory for hybrid seed production, which implies that within this range no other rice varieties should be grown except the pollen parent.

Time isolation: Wherever, it is difficult to have space isolation, a time isolation of over 21 days would also be effective. It means that the heading stage of the parental lines in hybrid seed production plot should be 21 days earlier or later than that of other varieties grown within the vicinity.

Barrier isolation: In some places, the natural topographic features such as mountains, rivers, forests can serve as the most effective barrier. A crop barrier with maize, sugarcane, sesbania covering a distance of 30 m would also serve the purpose of isolation. Artificial barrier with polythene sheets of about 2 m height can also be used for small scale seed production. However, the most ideal locations are the areas covered with hillocks and mountains, which act as natural barriers.

3. Favorable climatic conditions:

Climatic conditions have profound influence on the seed yields. Seeding of the parental lines should be planned in such a way that the flowering coincides with the most favorable climatic conditions,

Sufficient sun shine with moderate wind velocity.

There should not be rains continuously for three days during the period of flowering.

Seed yields will be adversely affected if the temperature is below 20oc and above 35oc.

4. Seeding of parental lines in the seed bed Puddle the seedbed field properly. Puddle the field twice at an interval of 6-7days to destroy weeds, weed seeds and germinated rice seeds.

Prepare raised seedbeds (5-10 cm height) of 1m width of any convenient length. Provide drainage channels in between seedbeds to drain excess water.

Apply recommended fertilizer to the nursery beds

Sow pre germinated seed uniformly on the seedbed (1-2 kg seed/20m2)Use 15 kg of `A' line seed and 5 kg of `R' line seed to produce sufficient seedlings to grow one hectare.

Transplanting:Commence transplanting seedlings of A and R lines as and when they attain theage of 21-25 days, which ensures timely heading, and flowering of parental lines. Transplanting of older seedlings delays flowering and transplanting of younger seedlings advances flowering. If the transplanting of seedlings of `A' line is delayed,then delay transplanting the `R' line seedlings by the same number of days to synchronize flowering. Transplant one or two seedlings per hill of the `A' line and two seedlings per hill of `R' lines.

Transplanting in a specific Row Ratio & Row direction: In hybrid rice seed production the seed parent and pollen parent are planted in a certain row ratio at certain spacing. The row ratio and spacing of pollen parent and seed parent have a distinct effect on the hybrid seed yields.

The row ratio or row proportion refers to the number of rows of the male parent(R line) to that of the female parent (A line) in a seed production plot. Suppose if we plant 2 rows of `R' line followed by 8 rows of `A', the row ratio can be taken as 2:8. In hybrid rice seed production plot the recommended male (R) to female (A) row ratio is 2:8.

Transplanting of the R line:Transplant the seedlings of R line in paired rows. Leave a space of 145 cms inside block between paired rows of `R' line seedlings for transplanting 8 row blocks of `A' line seedlings. Transplant 2-3 seedlings per hill with a row-to-row distance of 30 cms and plant-to-plant spacing of 15 cms.5.4 Transplanting of CMS line (A line)

Transplant `A' line seedlings in blocks of 8 rows in between the paired rows of `R' line. Transplant with 1-2 seedlings per hill at a spacing of 15 x 15 cms Leave a 20 cms wide alleyway between A line rows and nearest R line row.

Seed parent (A line) has 10 day longer growth duration than pollen parent (Rline): Transplant 25day old seedlings of the `A' line, 10 days earlier than the second `R' line seedlings. The seedlings of the R line are transplanted when the seedlings from the second R line seeding are 25 days old. At this time the age of seedlings from the first R line seeding will be 21 days old and the age of seedlings from third R line seeding will be 29 days old.

Seed parent (A line) has 10 day shorter growth duration than pollen parent (R line): The seedlings of the R line are transplanted when the seedlings from the second R line seeding are 25 days old. At this time the age of seedlings from the first R line seeding will be 21 days old and the age of the seedlings from the third R line seeding will be 29 days old. Later transplant 25 days old

seedlings of the A line 10 days later than the second R line seedlings.

Seed parent (A line) has same growth duration as pollen parent (R line): The planting of both R and A lines can be done simultaneously. First complete the Aline plantings with 25 day old seedlings followed by R line plantings with the seedlings ages of 21day old first R line, 25 days old second R line and 29days old third R line.

Roguing:The purity of hybrid rice seeds used in commercial production must be more than 98%. To meet this requirement, the purity of the restorer and CMS lines must be more than 99%. Therefore, in addition to ensuring strict isolation, it is necessary to remove all rogues from the seed production plots. Roguing is the removal of undesirable rice plants from the hybrid seed production plots. Undesirable rice plants are those plants either in A or R line rows that differ from plants that are true to type. Roguing helps to prevent the off-types from cross pollinating the true to type A line plants and thus enhancing the purity of hybrid seed.

Promotion of exertion of panicle:Most of the male sterile lines based on WA cytoplasm have imperfect exertion of panicle, with the result as much as 15% spikelets remain enclosed in the flag leaf and almost exposed for out crossing. Through following methods, the exertion of the panicles can be promoted to a great extent. It is an efficient and effective growth hormone, which stimulates the cell elongation, thus can be used to enhance panicle exertion in CMS line.

In hybrid seed production plots of rice, 5-10% panicle emergence stage is most appropriate for first spraying (40%) and the remaining 60% of GA3 should be sprayed on the following day. The ideal time for spraying is from 8 to 10 AM and from 4 to 6 PM.

A dose of 45-60 g/ha of GA3 is optimum. The hormone does not dissolve in water and it should be dissolved in 70% alcohol (1 g of GA3 in 25-40 ml of alcohol).

Flag leaf clipping: Normally the flag leaves are erect and longer than the panicles and they come in the way of easy pollen dispersal thus effecting the out crossing rate. The clipping of flag leaf helps in free movement and wide dispersal of pollen grains to give higher seed production. The flag leaves should be clipped when the main culms are in booting stage.

Supplementary pollination:Rice is basically a self-pollinated crop and hence there is a need to go for supplementary pollination in order to enhance the extent of out crossing. Supplementary pollination is a technique of shaking the pollen parent so that the pollen is shed and effectively dispersed over the A line plants. Supplementary pollination can be done either by rope pulling or by shaking the pollen parent with the help of two bamboo sticks.

Harvesting, threshing and processing: Harvesting: Harvest all R lines rows first. Remove the R line harvest and keep it in a safe place separately. Carefully remove the left over R line panicles in the field.

Threshing: During threshing, the `A' line parent and `R' line parent harvests must be kept separate from each other. The A and R lines should be threshed separately. Before starting threshing, all the threshing equipment, threshing floor and tarpaulin to be thoroughly cleaned.

Use new gunny bags for storing the seeds. Prepare two labels for each bag – one to place inside the bag and one to attach to the bag outside.

Seed drying helps seeds maintain their ability to germinate and their vigour for a longer period.

Drying controls mold growth and the activity of the other organisms, that reduce the quality of stored grain

Seed Processing: Seed Processing has to be done to remove impurities like trash,leaves, broken seeds sand etc., weed seeds and to remove immature, shriveled, unfilled and empty spikelets.

Seed production:

a) Varieties

The seeds are sown in isolation and by open pollination seeds are allowed to set and later

multiplied in different stages. Nucleus seeds are preserved by ear to row method.

b) Hybrids

The tool involved in hybrid seed production is known as cytoplasmic genic male sterility system. It is a three line breeding system, where three lines (A, B and R lines) are involved. Aline is a male sterile line and serve as female parent of F1 hybrid. B line is the maintainer line of A line and is male fertile. It is isogenic to A line in all aspects except male fertility. R line is the male line in actual hybrid seed production. It restores the fertility of A line and hence it is known as restorer line.

Season

The hybrid seed yield is higher in Rabi (January-April) season compared to Kharif (May-August) season. Seeding of parental lines should be done in such a way that flowering coincides with the following favourable climatic conditions. Daily mean temperature should be 25-30°C. The RH should range from 70-

80%. The difference in temperature between day and night should be 8-10 °C. There should be sufficient sunshine with moderate wind velocity (2-3m/sec.). The location should be free of continuous rain for one week during flowering. ForCORH1 hybrid seed production , May-June and December-January are the ideal season for

sowing.

Land Requirement

Land should be fertile with good irrigation and drainage facilities. It should be free from volunteer plants. It should have good sunlight and aeration. The seed crop should be isolated from other varieties of the same crop. The field should not have been grown with the same crop in the previous season. If grown, it should be the same class of seed for the same variety and approved by seed certification agency.

Isolation

Isolation distance is 3 m for varieties in both foundation and certified class of seed. For hybrid the isolation requirement is 200 and 100 m at foundation and certified seed stages respectively. When space isolation is not possible the time isolation of over 21 days or barrier isolation with polythene sheets of 2m height or barrier crops like sesbania, sugarcane and maize covering a distance of 3m would serve as isolation.

Source of seed

The basic seeds should be obtained from authenticated seed source with respective certification seed tag and purchase bill. The seed requirement will be 20 Kg, 10 Kg and 10 Kg ha-1 of A, Band R lines, respectively. The seeds are sown in nursery beds and are transplanted in the main field. The seed rate for varieties is 60 Kg ha-1.Upgrade the seeds on weight basis before sowing by density grading using common salt solution having a specific gravity of 1.13 (1.5 kg of salt in 10 litres of waters) and collect only the heavy seeds that sink at the bottom and rinse with water.

Presowing Seed Hardening Treatment

The paddy seeds are soaked in 1% KCl solution for 10 hours in 1:1 ratio. Then they are dried back to original moisture content (11-12%). Then the seeds are treated with Captan/Thiram @4g Kg-1 and also with Azospirillum/ Azatobacter @ 3 pockets/acre seeds. To raise wet nurserythe rice seeds should be pre germinated as the seeds will not germinate in the water logged anaerobic condition since oxygen is very essential for germination, which is not available in the submerged condition. For pre germinating, the seeds are soaked overnight in loosely tied moist gunny bags. Then the gunny bags are tied tightly with thread. This bags are incubated in dark for 24 hours. The emerged plumule can be seen as white dots on the gunny bags after 24hours.

Dormancy Breaking Treatment

Seeds may be soaked in 0.18% conc. HNO_3 (240 ml in 45 liters of water) at 1:1 equal volumefor 12–16 hours. The seeds may then be air dried to original moisture.

Seed Treatment

Treat the seeds with panostine quazatine at 0.2 % dissolved in dichlormethane or with cumanat 1.0 % dissolved in 20% PEG for 12 hours to kill H. oryzae internally seed borne pathogenthen air dry the seeds.

Main Field Preparation

Sodic Soils

For sodic soils with pH values of more than 8.5 plough at optimum moisture regime, apply gypsum at 50% requirement uniformly, impound water, provide drainage for leaching out soluble salts and apply green leaf manure at 5 t/ha , before 10 to 15 days of transplanting. Mix37.5 kg of zinc sulphate ha-1 with sand to make a total quantity of 75 kg and spread the mixture

Age of Seedlings

The optimum age of seedlings for transplanting is 18-22 days for short, 25-30 days for medium and 35-40 days for long duration varieties.

Pulling Out of the Seedlings

Pull out the seedlings at the appropriate time and tie the seedlings into a convenient bundles of5-8 cm diameter with soft materials such as banana twine and keep the root portion submerged in water. Do not allow the seedlings to dry.

Saline Soils

For saline soils with EC values of more than 4 m.mhos / cm, provide lateral and main drainage channels (60 cm deep and 45 cm wide), apply green leaf manure at 5 t/ha at 10 to 15 days before transplanting and 25 % extra dose of nitrogen should be applied in addition to recommended dose of P and K and ZnSO4 at 25 kg /ha at planting.

Manures and Fertilizers

Farmyard manure can be applied on last puddling @ 12.5 tonnes/ha. The recommended dose of NPK for the hybrid seed production is 150:60:60 Kg ha-1. The P is added at last puddling stage. The N and K are applied in three splits viz., (1) Basal (2) Active tillering and (3) Panicle initiation stage. Additional nitrogen application delays panicle development whereas P and K promote the same. For varieties the recommendation is 150:50:50 Kg ha-1 of NPK and N is applied in three split doses.

Rouging

From vegetative phase up to harvest the seed production plot should be checked for rouging out volunteer, diseased and off type plants. Rouging should be done daily from ear head emergence to dough stage. The pollen shedders (presence of B line in A line) and other off types are to be checked at all times and the same should be removed to maintain genetic and physical purity of seeds.

Weed Management

Pre-emergence:Use butachlor 2.5 l ha-1 or Thiobencarb 2.5 l ha-1 or Fluchloralin 1 l ha-1 or Pendimethalin

3 l ha-1 or Anilophos 1.25 l ha-1 as pre-emergence application. Alternately, pre-emergenceapplication of herbicide mixture viz., Thiobencarb 1.2 1 + 2,4 DEE 1.5 l ha-1 , butachlor 1.2 l+ 2,4 DEE 1.5 l ha-1, Fluchloralin 1.0 l + 2,4 DEE 1.5 l ha-1 or Pendimethalin 1.5 l + 2,4 DEE1.5 l ha-1 followed by one hand weeding on 30-35 days after transplanting.

Pest mangement

Brown Plant Hopper

Phosphomidon 85 WSC 500 ml, Monocrotphos 36EC 1250 ml, Phasalone 35 EC 1500 ml,Carbaryl 10% dust 25 kg , methyl demton 25 EC 1000 ml, Acephate 75 SP 625 gms,Chlorpyriphos 1250 ml, Dichloravas 76 WSC 350 ml, Neem seed kernel extract 5% 25 kg,Neem oil 3% 15 liters, Illuppai oil 6% 30 litres.

Leaf Folder Fenitrothion 50 EC 1000 ml, Phosphomidon 85 WSC 300 ml, Monocrotophos 36 WSC 1000ml, Chlorpyriphos 20 EC 1250 ml, Phasolone 35 EC 1500 ml, Carbaryl 50 WP 1 kg, Quniolphos25 EC 1000 ml, Fenthion 100 EC 500 ml, Dicholorvas 76 WSC 250 ml, Neem seed kernelextract 5% 25 lit

Rat: Use 1 part poison bait of zinc phosphide with 49 parts popped corn / rice/ dry fish or warfarin0.5 % 1 part with 19 parts of popped corn / rice / dry fish or bromodiolone 0.25 WW (1:49)at 0.005 %.

Disease Management

Blast:Edifenphos 500 ml, carbendazim 250 gms, IBP 500 ml, Tricyclozole 75 WP 500 gms. Spraypseudomonos fluorescens 500 gms ha-1dissolved in 500 liters of water and used for one hectare.

Brown Spot:Spray edifenphos 500 ml, Mancozeb 1000gms when grade reaches 3. If necessary, repeat 15days later.

Bacterial Leaf Blight:Streptomycin sulphate + Tetracycline 300 gms + Copper Oxy Chloride 1250 gms per ha.

Maize

SEED PRODUCTION

Method of Seed Production

Varieties

Raise the varieties under isolation and allow the seeds to set by open pollination.

Hybrids: Inbreds

The basic genotype used for hybrid seed production is known as Inbreds. It is relatively a truebreeding strain resulting from repeated selfing.

Isolation 200 metre for varieties and 400 metre for hybrids

Land Requirement

The land selected should be fertile and should be free from volunteer plants. The same cropshould not have been grown in the previous season.

Seeds and Sowing

Seed should be purchased from authenticated source with tag and bill. Proper stage of seed should be used. The seeds should be sown in ridges and furrows at 4 cm depth one seed/ holein case of Ganga 5, CO 1 and two seeds per hole in the case of K1.

Seed Rate Spacing

Varieties: 10 kg/ha 45 × 10 cm

Hybrids: Female: 12 kg/ha 60 × 25 cm

Male : 4 kg/ha 60 × 25 cm

Manure's and Fertilizers

Compost: 12.5 ton/ha

NPK: 100:75:75 kg/ha

(i) Basal: 40:75:40 NPK kg/ha(ii) Top Dressing: 50:0:0 N kg/ha (20 days after sowing) 10:0:35 N & K kg/ha (40 days after sowing)Foliar Application: 2% DAP spray (50% flowering stage)

Detasselling:The tool employed in hybrid seed production of maize is known as detasselling. Tassel is themale inflorescence of maize. Detasselling is removal of tassel/male flowers from the plant. Detasselling should be done in the female parent of hybrid alone. It should be removed before anthesis and immediately after emergence. Detasselling should be completed when the tassel iswell out of the boot leaf but before the anthers shed the pollen. It is done everyday from an thesis, up to 14 days.

Procedure for Detasselling

The stem is to be held with left hand and the tassel is to be removed with right hand in one upward pull. The pulled tassel should be taken away from the field and buried beyond the isolation distance. In any case no spike let should be left which may cause genetic contamination. The leaves also should not be removed as it favour reduction of seed yield.

Roguing

:Roguing, is the removal of unwanted, off type and diseased plant from the seed production plot. The roguing is done based on leaf waveriness, tassel colour, cob shape, stem colour, silkcolour, number of leaf, and presence or absence of auricle.

Weed Management

:Apply the pre-emergence herbicide, Atrazine 50WP at 500 g/ha (900 lit of water) 3 days after sowing as spray on the soil surface using knapsack/rocker sprayer fitted with flat fan (or) deflection type of nozzle followed by one hand weeding on 40–45 days after sowing. For maize + Soybean intercropping system, apply pre-emergence alachlor at 4.0 l/ha or Pendimethalin at 3.3 lt/ha on 3rd day after sowing as spray.Apply herbicide when there is sufficient moisture in the soil do not disturb the soil after herbicide application .Hoe and hand weed on the 17th or 18th day of sowing, if herbicide is not applied. Note : If pulse crop is to be raised as intercrop, do not use atrazine.

Pest and Disease Management

:Mix any of the granular insecticides with sand and to make up to a total quantity of 50 kg and apply in the leaf whorls on the 20th day of sowing. Quinolphos 5 G 15 kg/ha, carbaryl 4 g 20 kg/ha.If granular insecticides area not used, spray Quinolphos 25 EC 1 lit of carbaryl 50 WP 1kg/ha on the20th day of sowing for the control of stemborer, weevils, and aphids (500 lt of spray fluid/ha.).

Downy Mildew

CO 1, COH 1 and COH 2 are resistant to downy mildew. Rogue out affected plants. SprayMetalaxyl 701 WP @ 1 kg/ha, Mancozeb 1 kg/ha 20 days after sowing.

Leaf Spot

Spray Mancozeb or Captan 1 kg/ha when the disease intensity reaches grade 3.

Irrigation

:Regulate irrigation according to the following growth phase of the crop Germination phase 1to 14 days, Vegetative phase 15 to 39 days, Flowering phase 40 to 65 days, Maturity phase 66to 95 days. Irrigation should be given once in a week after life irrigation (3rd day after sowing).The critical stages for irrigation which affect the seed quality are silk formation stage and milky stage of cob.

Harvesting

:The cobs of male should be harvested first and are to be removed from the field. The female cobs are harvested as once over harvest. The crop reaches physiological maturation 45 days after flowering. Darkening of silk and drying up of husk to yellow colour are the visual symptoms of physiological maturation.

Seed production in pea

Source of seed. For the seed production of pea seed must be obtained from approved source.

S**election of field** . Afield should be selected for seed production of pea in which the same crop was not grown in the previous year. Such field can be considered in which pea crop fulfilled the certification standard. The field should be well drained.

Isolation distance. Pea is a self pollinated crop. So isolation of seed crop of foundation and certified seed is 10 meters and 5 meters respectively from other fields of pea is sufficient'

Preparation of field. The field for sowing is prepared by one ploughing with soil Turning plough and 2-3 harrowing. The field is then leveled.

Sowing.The seed crop is sown in last week of November 150 kg seed for per hac.

Fertilizer. Pea is leguminous crop and nitrogen fixation took place in its root nodule by bacteria,so nitrogen requirement is reduced and 20 kg nitrogen 50 kg phosphorus and 40 kg potash are abundant.

Irrigation. If there is no rain 3-4 irrigation may be given.

Weed control. Weeds are controlled by hoeing and weeding

Diseases control. Wilt,Blight and stem rot are main diseases

Insect control for controlling pod borer 10 kg aldrin per hac.

Seed production in Mustard

Brassica sp (2n = 16)

Brassicaceae or cruciferae.

The genus Brassica contains more than 3000 species of which 40 are of economic importance.

Source of seed. For the seed production of mustard for foundation breeder and certified seed production,the seed must be obtained from approved source. The purity of the seed is verified from the tags and labels attached with seed bag and these are retained after sowing.

S**election of field** . Afield should be selected for seed production of mustard in which the same crop was not grown in the previous year. Such field can be considered in which in which the crop was grown from c certified seed. The field should be well drained.

Isolation distance. Isolation is 100 metres for foundation and 50 meters for certified seed from other fields of mustard and related species is sufficient

Preparation of field. The field for sowing is prepared by one ploughing with soil Turning plough and 2-3 harrowing. The field is then leveled.

Sowing.The seed crop is sown in mid of October to mid November.Sowing should be done in rows 25-30 cm apart and 3 cm metre deep and 5 to 8 kg of seed per ha.

Fertilizer.75 kg nitrogen 40 kg phosphorus and 40 kg of potash per hectare is required for seed crop of mustard are abundant.

Irrigation. If there is no rain at least two irrigation are essential first at 4-6 leaf stage,after 30 days of sowing and second at flowering stage after 70-75 days of sowing

Weed control. Hoeing and weeding once with in 30 days of sowing is sufficient for controlling Weeds

Diseases control. For control of blight 2 kg Dithane m 45 per 1000 litres of water per hectare should be sprayed,which should be repeated 3 times on 20 days interval

Insect control for of mustard saw fly 1.25 litre chalropyriphos ,35 EC IN 1000 litres of water per ha. For aphids 1 litre Metasytox 25 EC in 1000 litres of water. For controlling hairy catterpillar 1000 litreS of 0.04 per cent solution of Monocrotophos per hectare should be sprayed.

Roguing. Off type and diseases plants and weeds are removed from time to time at least twice. Plants related to species should be removed before flowering. The plants of Mexican poppy should be removed and when noticed and in any case not a single plant should remain at the time of harvesting.

Harvesting and threshing . The seeds of crop plant of mustard is harvested as a plant turns yellow due to the problem of shattering. After drying 2-3 days in sunshine threshing can be done. The seeds are stored at 8-9 % moisture content.

SEED PROCESSING

Seed lots received from the field are often at high moisture content and contain trash and other inert material, weed seeds, deteriorated and damaged seeds, off-size seeds, etc. Seed processing is necessary in order to dry the seeds to safe moisture level; remove or reduce to theextent possible the various undesirable material, weed seeds, other crop seeds, deteriorated or damaged seeds. Other than this the seed lot heterogeneity in its physical characters like size, colour, shape etc.The seed lot is heterogeneous due to the following reasons

1.The soil is heterogeneous and there is a lot of variability in the fertility status of the soil due to the availability of nutrients, physical, chemical and biological properties.

2. Variability is introduced due to the position of seed set on the plant/fruit , time of pollination and fertilization over a period of time

- Variability is created by biotic factors like pest and variability infestation. Variability is also due to the management practices like water, land preparation,leveling, staggered sowing, and uneven distribution of fertilizer and irrigation water uneven plant protection sprays and uneven maturity at harvest. The inherent qualities such as germinability and vigour are exemplified by certain physical characteristics of the seed i.e., large size, a denser seed, optimum length etc., So, if grading is done to obtain a particular range of size, shape, length and density of the seeds, the quality of the lot is up graded. In its common usage in India, seed processing refers to all the steps necessary for preparation of harvested seed for marketing, namely, handling, drying, shelling, preconditioning cleaning,size grading, treating and packaging, etc.

Seed processing equipments

1. **Air screen cleaner**

This is the most important machine of every cleaning plant. It uses screens and aspiration(air blow) for two separations. A coarse upper screen removes larger material, a lower fine screen stops the seeds and lets through fine matter and then the seed fraction passes through a transverse or nearly vertical air stream which can separate light impurities such as empty or partly filled seeds, husks and glumes from the seed. In most

cases a number of sieves with different sized perforations are used and the cleaning is a process of gradually shifting out smaller particles. Factors which determine the quality and quantity of seed cleaned include(i) size of the perforations, (ii) the precision of the perforation, (iii) the angle at which the sieves operate, (iv) the amplitude and speed of movement of the sieves and (v) correct cleaning and maintenance of the equipment

- **Cleaner cum grader**

The dried seeds should be cleaned and graded with help of a cleaner cum grader. For large scale cleaning and grading the commonly available machine is the "Crippen Model Seed Cleaner cum Grader".

- **disc seprator**

It consists of a series of discs, which revolve together on a horizontal shaft inside the cylindrical body. Each disc contains many under cut pockets. The seed enter the intake end of the separator and move through the open centers of the discs towards the discharge end of machine. As the discs revolve through the seed mass the pockets lift out short seed but rejects longer seed. Longer seeds are conveyed by flights on the disc spokes towards the discharge end of the machine where they go out through the tailings gate. The rate of seed travel the open disc centers is controlled by conveyor or blades attached to the spokes of the discs. The disc separator makes a very precise separation. No factor other than seed length and shape affects its separation. Flexibility is obtained by varying size of the pockets.

- . **Indented cylinder separator**

The indented cylinder separator is a rotating, almost horizontal cylinder with movable,horizontal separating adjustments which are mounted inside it. Indent lines are there in side the surface of the cylinder. The indented cylinder revolves, turning the seed mass to give each seed a chance to fit into indent. Short seeds are lifted out of the seed mass and are dropped into the lifting and long seeds remain in the cylinder and are discharged out via., a separates pout at the end of the cylinder.

- **Specific gravity separator**

Seeds of the same size and general shape can often be separated because they differ in specific gravity or relative weight. This difference is very useful in removing light, immature seeds or heavy sand and rocks to improve the purity and germination of crop seeds.

Importance of processing

1.Complete separation

2.Minimum seed loss

3.Up gradation up to required quality

4.High efficiency

5.Minimum requirement of labour

SEED TREATMENT

Maintaining the quality of seed is dependent on many environmental factors, some of which are moisture, temperature, humidity, and storage conditions. Even though these factors are properly accounted for, seed quality may still be reduced by certain seed borne diseases or destroyed by insects and other pests. Research has shown that treating seed with one or more pesticides is the most economical and efficient way to protect seed from these pests and improve seed quality. Since pesticides are poisonous, extra care and safety precautions must be taken when applying them and in handling seed after it has been treated.

Merits of seed treatments

Wide spectrum it controls both systemic and non systemic pathogens

prevent spread of both systemic and non systemic pathogenic

Protects seed from seed borne and soil borne pathogens

improves germination through control surface mould

improves field emergence by enhancing vigour

Enhance shelf life of seed

easy to apply

cost effective

Optimum plant population with reduced seed rate

Precautions required in seed treatment

Use appropriate recommended chemical for crop,pathogen and disease

Use precise dose of chemicals and formulation for large scale

Never use chemical of expiry date for seed treatments

Seed should be properly dried before seed treatments

Never use treated seed as food or feed

Seed should be properly mixed with chemicals with out mechanical damage

First treat the seed with fungicide,thereafter insecticide and finally with rhizobium this sequence is followed wherever recommendation is made

Types of Seed Treatment

A. Pre sowing seed treatments

:It is the treatments given to the seeds before sowing to improve the germination and vigour

potential and as well as to maintain the health of the seed.

Pre sowing seed treatments includes the following

I. Chemical treatments to improve germination and vigour potential. II. Insecticidal and fungicidal treatment.

1. Special treatments

Seed Treatment Fungicides

:Fungicides are applied to seed prior to planting to provide effective protection against many seed and soil-borne plant pathogens. Chemical (fungicide) treatment guards against the various seed rots and seedling blights that occur during storage or after planting. It is not usually a "cure-all" and will not provide disease protection throughout the growing seasona fter the plants become self-sufficient. (An exception to this would be the control of loose smut by seed disinfection).

Fungicidal seed treatment may be divided into three categories, depending on the nature and purpose of the treatment. These categories are: (1) seed disinfection, (2) seed disinfestation,and (3) seed protection. A given fungicide may serve in one or more of these categories.

Seed disinfection - Disinfection is the elimination of a pathogen which has penetrated in to living cells of the seed, infected it and become established-for example, loose smut of barley and wheat.

Seed disinfestations - Disinfestation is the control of spores and other forms of pathogenic organisms found on the surface of the seed.

Seed protection - Seed protection is chemical treatment to protect the seed and young seedling from pathogenic organisms in the soil.

Seed treatment materials are usually applied to seed in one of four forms: dust; slurry (amixture of wettable powder in water); liquids; and planter-box formulations.

SEED STORAGE: Maintenance of seed vigour and viability in terms of germination from harvest until planting is of the utmost importance in any seed production programme. Care should be taken at every stage of processing and distribution to maintain the viability and vigour. The harvested seeds of most of the orthodox crop seeds are usually dried and stored for atleast one season until the commencement of the next growing season, except those of the recalcitrant seeds which require high moisture content for safe storage (once dried the viability will be lost. E.g. – Jack,Citrus, Coffee, Cocoa, Polyalthea, etc.,). In such recalcitrant seeds senescence starts in the mother plant itself. The dry weather alters moisture content of the seed, thereby reducing the viability. Some seeds require an after ripening process as in Pinus and Fraxinus. In most on the Agricultural crops ageing starts at physiological maturity, which is irreversible. Hence seeds become practically worthless if they fail to give adequate plant stands in addition to healthy and vigorous plants. Good storage is therefore a basic requirement in seed production.

FACTORS AFFECTING SEED LONGEVITY IN STORAGE

1.Kind (or) variety of seed

2.Initial seed quality

3.Moisture content

4.Relative humidity and temperature during storageProvenance

5.The activity of organisms associated with seeds in storage.

1. Kind or variety of seed

Seed storability is considerably influenced by the kind or variety of seeds. Some seeds areshort lived. E.g.: Onion, Soybean and Groundnut. As a general rule starchy seeds can be stored considerably for a longer period compared to proteinaceous or oily seeds because of their hygroscopic nature.

2. Initial seed quality

Seed lots having plumpy, vigorous undamaged seeds store longer than that of deteriorated.Even seed lots having good germination at the beginning of storage period, may deteriorateata faster rate depending upon the severity of weathering damage, mechanical injury or otherwise in the field. The low quality seeds should invariably be rejected. Even at best storage conditions, the initial quality of the seed cannot be improved (except for the dormant seed) but can only be maintained.

3. Moisture content

The most important factor influencing seed viability during storage is the moisture content and the rate of deterioration increases, as the seed moisture content increases. The drier theseed the higher will be the storage life.

Seed moisture content (%)	Storage life
11-13	1⁄2 year
10-12	1 year
9-11	2 years

it is well known that higher moisture content enhances the biological activity in the seeds and causes excessive heating, besides promoting mould and insect activities. The relationship of moisture content of seeds during post harvest stages furnished below would clearly indicate the role of moisture in the life of seeds in storage.

Relative humidity and temperature during storage

Seeds are hygroscopic. They attain rather specific and characteristic moisture content when subjected to given level of atmospheric humidity at a particular temperature (equilibrium moisture content). The equilibrium moisture content for a particular kind of seed at a given relative humidity tends to increase as temperature decreases and the deterioration starts. Equilibrium moisture content varies among seed kinds. In general, the equilibrium moisture content of “oily” seed is lower than that of “starchy” seed at the same relative humidity and temperature. This phenomenon can be accounted for by the fact that fats and oils do

not mix with water. Thus, in a seed with 50% oil content, the moisture has to be concentrated in half the seed, while in a seed containing 10% oil, the moisture is distributed throughout 90% of the seed. Thus the maintenance of moisture content of seed during storage is a function of RH and to a lesser extent of temperature. At equilibrium moisture content there is no net gain or loss in seed moisture content when seed is placed in a new environment with RH higher or lower than that of the seed, the seed will gain or lose moisture till it reaches a new equilibrium moisture content at this particular new environment.

6. **The activity of organisms associated with seeds in storage:**The bacteria, fungi, mites, insects, rodents and birds may do harm to seeds in storage. The general limits of temperature and relative humidity for the multiplication of the various biological agencies infesting stored seeds are,It is also interesting to note that the favourable limits of temperature and RH for germinationare 16-42oC and 95-100 per cent respectively.

UNIT 2: SEED GERMINATION,TESTING,VIGOUR ANDCERTIFICATION

Seed germination test

Germination is defined as the emergence of essential structure of seedling embryo I.e root system ,shoot axis,cotyledons,terminal bud and coleoptile determine its potentiality to develop in to normal plant under favorable condition or and development from the seed embryo, of those essential structures, for the kind of seed in question, indicates its ability to produce a normal plant under favourable conditions.

Types of germination:

Hypogeal germination: Its the process of germination in which cotyledons stay beneath the soil.The epicotyl expands to raise the first true leaf out of the soil and hypocotyl remains short and compact is known as hypogeal germination.Example chick pea,field pea cereals

Epigeal germination:Its the process of germination in which cotyledons gets raised out of the soil by the extension of hypocotyl and worked as leaf or leave is known epigeal germination example oil seeds,moong,urd and onion

Principles

Germination tests shall be conducted with a pure seed fraction. A minimum of 400 seeds are required in four replicates of 100 seeds each or 8 replicates of 50 seeds each or 16 replicates of 25 seeds each depending on the size of seed and size of containers of substrate.

The test is conducted under favourable conditions of moisture, temperature, suitable substratum and light if necessary. No pretreatment to the seed is given except for those recommended by ISTA.

MaterialsrequiredSubstratum

The substratum serves as moisture reservoir and provides a surface or medium for which the seeds can germinate and the seedlings grow. The commonly used substrate are sand, germination paper and soil.

1. **Sand**

Size of sand particle

Sand particles should not be too large or too small. The sand particles should pass through 0.80 mm sieve and retained by 0.05mm sieve.

Toxicity

Sand should not have any toxic material or any pathogen. If there is presence of any pathogen found then the sand should be sterilized in an autoclave.

Germination tray

When we use the sand, germination trays are used to carry out the test. The normal size of the tray is 22.5 x 22.5 x 4 cm. The tray may either zinc or stainless steel.

Method of seed placement

Seed in sand(S)

Seeds are planted in a uniform layer of moist sand and then covered to a depth of 1 to 2 cm with sand.**Top of sand (TS)**

Seeds are pressed in to the surface of the sand.

Spacing

We must give equal spacing on all sides to facilitate normal growth of seedling and to avoid entangling of seed and spread of disease. Spacing should be 1-5 times the width or diameter of the seed.

Water

The amount of water to be added to the sand will depend on size of the seed. For cereals, except maize, the sand can be moistened to 50% of its water holding capacity. For large seeded legumes and maize sand is moistened to 60% water holding capacity.

2. **Paper**

Most widely used paper substrates are filter paper, blotter or towel (kraft paper). It should have capillary movement of water, at vertical direction (30 mm rise / min.). It should be free from toxic substances and free from fungi or bacteria. It should hold sufficient moisture during the period of test. The texture should be such that the roots of germinating seedlings will grow on and not into the paper.

Methods

Top of paper (TP)

Seeds are placed on one or more layers of moist filter paper or blotter paper in petriplates. These petriplates are covered with lid and placed inside the germination cabinet. This is suitable for those seeds which require light.

Between paper (BP)

The seeds are germinated between two layers of paper. The seeds are placed between two layers of paper and rolled in towels. The rolled towels are placed in the germinator in an upright position.

Germination apparatus

Germination cabinet / Germination room

This is called chamber where in temperature and relative humidity are controlled. We can maintain the temperature, relative humidity and light required for different crops.

Room germinator

It works with same principle as that of germinator. This is a modified chamber of larger one and the worker can enter into it and evaluate the seedlings. Provisions are made to maintain the temperature and relative humidity. This is used widely in practice.

Evaluation of germination test

The germination test is evaluated as

- Normal seedlings
- Abnormal seedlings
- Hard seeds
- Fresh and ungerminated seeds
- Dead seeds

ISTA classified the seedlings into different categories based on the development of essential structures.

Normal seedlings

Seedlings which has the capacity for continued development into normal plant when grown in favourable conditions of soil, water, temperature and light.

Abnormal seedlings

Seedlings which do not show the capacity for continued development into normal plant when grown in favourable condition of soil, water, temperature and light.

Factors affecting seed germination:

Soil:soil is the medium for germination and plant establishment. therefore seed germination is influenced by soil environment viz. Water holding capacity ,aeration,rate of flow of water to seed,soil temp,soil frost,water logging,soil particles size,pH,ions and tillage operation .

Water: Water is the basic requirement for germination.Its essential for enzyme axctivation,breakdown,translocation and use of reserves storage material.In their resting state seeds are characteristically low in moisture and relatively inactive metabolically.That is they are state of quiescence.Thus quiesence seeds are able to maintain a minimum level of metabolic activity that assures their long term survival in the soil and during storage.Seed germination is essentially related to water availblity.seeds of most plant species at maturity usally have moisture content below 15 .the surface properties of macromolecules such protein,starch,and cell wall in seed leads to imbibition of water.when seed get contact with water there in intial in rush which is physical porocess and considered as uncontroolled.seed water up take shows triphasic pattern.the phase 1 is intial rapid up take followedd by plateu phase2 a further increase in water up take during phase 3 rd occurs as the embryo axis elongates and break through covering layer to complete germination.

Temparature:Its most important factor regulating germination of non dormant seed in irrigated annual agroecosystem at the beginning of growth season. The response to temp during germination ids influenced by genotype,seed quality,time from harvest.These three cordinal points of vital activity of germination are min.temp. Below no activity occurs,an optimum at which highest germination occurs and max.temp. below no activity occurs.The optimum temp at which max.germination was reported with in shortest time 15-30 degree celcius**.**The maximum temperature for most of the species is between 30 and 40 degree celcius.Some species will germinate at approaching freezing point I.e alpine and rock garden

Oxygen:"The atmospheric oxygen conc. is about 21% and in the soil it is usually at 19%.However it can reduce 1% at field capacity or flooding. Germination retarded in most of the seeds is retarded if oxygen conc. is reduced substantially below that of air. Respiration increase sharply during germination. Since respiration is essential an oxidative process and adequate supply of oxygen must be available. If the oxygen concentration is reduced substantially below that of air,germination of most of the seeds retarded.

L**ight:**light has inductive effect on germination and in many plant sp is promoted or suppressed by light .seeds of cultivated plant usually germinate both in dark or light condition whereas wild plant have specific requirement of light for poor germination.Seeds germinate in dark are called negatively photoblastic whereas the sp. Which germinate under light are called positively photobastic. Both light

intensity and light quality influence germination.The influence of light intensity on different species varies greatly.Germination of some of the seeds that require light has been reported by moon light.Light intensity of 1800 -2160 lux from direct light in the average seed testing laborartory are probably adequate for germination of most species.Light quality:Influence of light quality on seed germination. The greatest promotion of germination occurs in the red area(600-700nm) with peak at 660nm followed by an inhibition zone in the far-red area above 700nm.

Role of promoters and inhibitors in seed germination

Gibberellins:Since 1955 gibberellins have been known to promote seed germination in a great variety of species. Gibberellines are not used extensively in routine germination testing,but it be useful in certain situation. A number gibberellins promotes germination but most often used GA3. Gibberellines can substitute for light and temperature in promoting germination. They can also promote germination of seeds not having these requirements.

Cytokinins: Another group of endogenous hormone that promote seed germination in some species are the cytokinins.Kinetin is best known of these.While cytokinin can be break primary dormancy of some seeds,they appear to be more effective in overcome secondary dormancy.The mechanism of cytokinin regulation of seed germination not known,but three possibilities have been suggested.

Transcriptional mediation :The binding of cytokinin to ribosomal preparation has been demonstrated in wheat seed embryo. This finding may suggest that cytokinins can regulate gene expression.

Translation mediation: It has been found in association with wheat embryo tRNA and always with tRNA species which recognized uridine as their initial codon letter. Its suggested t the ribosome assumes a specific configuration in response to the uridine codon which controls tRNA species are permitted accesses to codon thus mediating the process to be synthesized.

Membrane permeability mediation. Thoms 1977 showed that cytokinin influence many phytochorome controlled process. Since phytochrome located in cell membrane and can alter membrane permeability through its reorientation,cytokinin may conceivably mediate seed germination through their effect on membrane permeability.

Ethylene: Its known to stimulate seed germination of many species,in addition influence on fruit ripening,bud dormancy,leaf abscission and other growth process. Apparently it is involved in the regulation of seed dormancy,although its effect is not limited to dormant seed. I ts has been shown to enhance germination rate of aged seed as well as immature seed. Ethylene although involved in in regulating auxin level in dormant seed and is known to be released during germination of several species. Its used in breaking dormancy of peanut and sunflower.

Hydrogen peroxide: The stimulating effect of hydrogen peroxide on seed germination and subsequent seedling vigor has been observed in number of species including many conifers, legumes and barely. This chemical act as respiration stimulant that accelerates the breakdown of food reserve substances,thus providing rapid supply of energy and material for synthesis in the growing points.

Auxin: The best known auxin IAA has shown increase lettuce seed germination and to be temperature dependent,the high conc. inhibits germination while low conc. are generally promotive or ineffective. There is also evidence that IAA interacts with light in influencing seed germination.

Potassium nitrate: Its mostly widely used chemical for promoting seed germination. Solution of 0.1 to 0.2 % are common routine germination testing and are recommended by the Association of Official Seed Analyst and the International Seed Testing Association for the germination test of of many species.

Moisture test . So many factors affect the viablity and health of seed and moisture is the most important one. Therefore, the information regarding the moisture content of seed is desired at different stages,such as harvesting,threshing,storage and transporation.If the moisture content of seed is high at the time of harvesting,there shall be more mechnical injury during threshing and seeds are effected by diseases and pest easily and if the seeds are stored at high moisture level rate of deterioration is increased due to high respiration rate and activity of microganism.Seeds which can with stand dehydration with out damage are known as orthodox seed whereas the seed,which can not with stand water loss and are stored at relatively high moisture contant in order to remain viable are known as recalcitrant seed.

Apparatus.Oven, desicator,analytical balance,grinding machine with uniform speed which does not cause heating to grinding material,sieves and glass container having dia 10 cm with tightly fitted cover.
Procedure.
Working sample. Moisture of seed sample submitted in water proof container is estimated by oven dry method.
Preparation of sample:crops of large size are grounded before drying unless its high oil content makes it difficult. After grinding sample is passed through different size of sieves .Pre drying before grinding is recommended for sample with more moisture content than the minimum required percentage of moisture determination. Predried material are exposed 2 hrs before drying.
Moisture determination:Container and its cover are weighed M1.The sample is distributed evenly over the surface of the container and weighed with the cover container M2.This container is placed in oven at temperature of 103 degree Celsius for 17 hours as per crop. The drying period starts when the temp of oven reaches at required point. At the end of Prescribed period container is placed for cooling in a desicator for 30-40 min. After cooling container is weighed with its cover and content M3
Calculation:The moisture content as percentage by weight is culculated to one decimal place by following formula

Moisture%= M2-M3)/M2-M1

T**etrazolium test**:the activity of enzyme dehydrogenase is more vigours seed as compared to less vigrous seed(Lakon 1940) 2-3-5 triphenyl terazolium chloride
Equipments and chemicals: Petri plate, filter-paper,incubator,razor,beaker,spectronic20,distilled water,tetrazolium,and methyl allosolve
Requirements for test
Tetrazolium solution: The chemical used for test is light yellow soluble powder,tetrazolium .Its 1% soln. Of 6.5 to 7.5 Ph used for the whole seeds,but 0.1 to 0.5% concentration is sufficient when seeds are bisected. This solution should be protected from light,so it must be stored in colored bottle Phosphate buffer solution: If the tetrazolium solution is more acidic the colour wouldn't be developed even in living tissue,but if basicity of solution is increased,the tissue is more deeply stained. This cause difficult in evaluation
Principle:The tetrazolium test distinguished between viable and dead tissue of the embryo on the basis of their relative respiration rate in hydrated state. Although many enzymes are active during respiration the test utilized the activity of dehydrogenase enzyme as a index to respiration rate and seed viablity.

Dehydrogenase enzyme reacts with substrate and release hydrogen ions to the oxidized color less teterazolium salt solution which is changed in to red formazan.

Procedure :Usually 200 seeds in replicate of 50 or 100 seeds are taken for the test seeds are placed in petri plate lined with moist blotter paper and placed at 25 degree Celsius for 24 hours. Embryonic axis are excised with the help of sharp razor and placed in a beaker containing 1 ml of 1.5% w/v tetrazolium solution at 30 degree Celsius after 2 hours excess solution is drained out and embryonic axis are washed throughly distill water. The Axes are soaked in 10 ml methyl allosolve for 6 hours with occasion stirring for extraction of red colour (formazan).After complete extraction of formazan ,embryonic axes turn colour less .

Evaluation: Although the living tissue of seed stain red,interpreting these result to estimate viablity requires considerable skill experience. Sound embryo tissue absorb tetrazolium slowly and tend to develop to lighter colour than embryos that are bruised, aged, frozen or capacity to produce normal seedlings and those stain abnormally. The stain pattern reveals the live and dead areas of embryo and enables the analyst to determine if seed have capacity to produce normal seedling

SEED VIGOUR

Seed vigour: Seed vigour: Is the sum of those properties that determine the activity and level performance of seed lots of acceptable germination in wide range of environments. Seed vigour is not single a single measurable property,but its concept describing several characteristics associated with following aspects of seed performance.

1.Rate and uniformity of seed germination and seedling growth.

2.Emergence ability of seed under unfavorable environment condition

3.Performance after storage ,particularity the retention of the ability to germinate

Methods of determination of seed vigour

Stress test

1.**Accelerated ageing test**:For rapid determination of seed vigour and storage potential of the seed lot,the process of ageing is accelerated into weeks or days by increasing the moisture content and temperature.

2.Process of ageing: Solution 200-250 ml of potassium hydroxide prepared for maintaining the the required humidity is placed at dessicator .The dessicator is sealed with the help of grease after keeping moisture metre on the wire mesh.The dessicator is placed at the required temp.in an incubator for 24 hrs to ensure required humidity in dessicator.The seeds are spread over wire mesh in a single layer and placed in desicator.The desicator is made air tight and kept in incubator at required temp. samples are drawn periodically and tested for germination. The day lot reaches 50% initial germination is recorded. The lot took maximum days to reach 50% germination is considered vigour.

3.Brick gravel test: A tray is filled with soil up to 3 cm depth. Seeds are placed on soil surface.After placement of seed the tray is tightly packed with crushed brick gravel of 3 mm in size at the depth of 3.0cm.Brick granules put a stress on the emergence and elongation of seedlings and hinder the emergance of week and injured seedling.

4.Paper piercing test: Seed are planted on layer of 1.25 cm moist sand. Its covered with with specially selected dry filter paper. The filter again covered with 3 cm moist soil sand. The seedling which are able to penetrate the paper are considered vigrous.

Biochemical test

1.T**etrazolium test**:the activity of enzyme dehydrogenase is more vigrous seed as compared to less vigrous seed(Lakon 1940)

seeds are placed in petri plate lined with moist blotter paper and placed at 25 degree Celsius for 24 hours. Embryonic axis are excised with the help of sharp razor and placed in a beaker containing 1 ml of 1.5% w/v tetrazolium solution at 30 degree Celsius after 2 hours excess solution is drained out and embroyonicaxis are washed throughly distill water. The Axes are soaked in 10 ml methyl allosolve for 6 hours with occasion stirring for extraction of red colour(formazan).After complete extraction of formazan ,embryonic axes turn colour less .

Respiration test: Respiration during early hours of imbibition in water is closely associated with seedling growth rate. During the process of respiration seed take oxygen and evolves carbon dioxide. The ratio of volume of oxygen consumed/volume of carbon dioxide evolved / unit time of the volume of oxygen consumed/unit time known as respiratory quotient. This is more related to vigour than oxygen up take alone. One or more than 1.0 RQ Measured in 100% oxygen after 6 hours of planting indicate high vigour

Factors affecting on seed vigour

Seed ageing : Seed ageing is major cause of vigour difference both naturally and artificially .In addition germination after after precise period of deterioration related to seed vigour..However old seed lots would show reduction in germination due to ageing.

Imbibition damage: Imbibition damage is most apparent when seed coat have been removed from dry seeds before imbibition. This is high lighted the role of testa protecting the cotyledon from damaging effect of water uptake. The high leakage of solutes in first few minutes of imbibition that they observed in pea embryos resulted from the membrane of the dry seed being porous hexagonal state.

Seed development:Climate can influence seed vigour. High temperature during seed filled led to production of poor quality seed. ,high temp at the wrinkled pod stage produce seed having highest incidence of hallow heart and hence low vigour.Reduce water availblity may interrupt seed development and tempory draught leads to the production of shrivelled seed .

SEED CERTIFICATION

It is a legally sanctioned system for quality control and seed multiplication and production. It involves field inspection, pre and post control tests and seed quality tests. Purpose of seed certification to maintain and make available to the farmers, through certification, high quality seeds and propagating materials of notified kind and varieties. The seeds are so grown as to ensure genetic identity and genetic purity.

Eligibility for certification of crop varieties

Seeds of only those varieties which are notified under section 5 of the Seeds Act, 1966shall be eligible for Certification.

Breeder seed is exempted from Certification. Foundation and Certified class seeds come under Certification.

Breeder seed is produced by the plant breeder which is inspected by a monitoring team consisting of the breeder,representative of seed certification agency (DDA), representative of NSC (Deputy Manager) & nominee of crop co-ordinator. The crops shall be inspected at appropriate stage.

Phases of seed certification or Seed certification procedures

1. Receipt & Scrutiny of application 2.Verification of seed source 3.Field inspection 4.Post harvest supervision of seed crops 5.Seed sampling & testing 6.Labelling, tagging, sealing and grant of certificate.

Receipt & scrutiny of application

a. Application for registration

Any person, who wants to produce certified seed shall register his name with the concerned Assistant Director (AD) of seed certification by remitting Rs. 25/- per crop, per season. There are 3 seasons under certification viz., kharif (June-Sep), Rabi (Oct. – Jan.) &Summer (Feb-May).

The applicant shall submit two copies of the application to the ADSC 10 days before the commencement of the season or at least at the time of registration of sowing report.

On receipt of the application, the ADSC will verify the time limit, variety eligibility & its source,the class mentioned, remittance of fee etc.

The application, if accepted will be given an application no (e.g. Paddy / k / 01- 05-06, where Paddy refers the crop to be registered, K-the season, 01-the application no & 05-06 -the financial year). The original application is retained and the duplicate is returned to the applicant.

b. Sowing report: (Application for the registration of seed farm)

The seed producer who wants to produce certified seeds shall apply to the ADS.C, in the prescribed sowing report form in quadriplicate with prescribed certification fees along with other documents such as tags to establish the seed source.

Separate sowing reports are required for different crop varieties, different classes, different stages and if the seed farm fields are separated by more than 50 metres.

Separate sowing reports are also required if sowing or planting dates differ by more than 7days and if the seed farm area exceeds 25 acres.

The sowing report shall reach the concerned ADAS.C within 35 days from the date of sowing or 15 days before flowering whichever is earlier. In the case of transplanted crops, the sowing report shall be sent 15 days before flowering.

The producer shall clearly indicate on the reverse of sowing report, the exact location of the seed farm in a rough sketch with direction, distances marked form a permanent mark like milestone, building, bridge,

road, name of the farm if any, crops grown on all four sides of the seed farm etc, to facilitate easy identification of the seed farm by the seed certification officer. The AD S.C, on receipt of the sowing report, scrutinizes & register the seed farm by giving an N.S.C number for each sowing report. Then he will send one copy of the sowing report to the N.S.C officer, one to the D.D.S.C & the third to the producer after retaining the fourth copy.

Verification of seed source During his first inspection of seed farm the S.C officer, will verify whether the seed used to raise the seed crop is from an approved source.

Field Inspection The objective in conducting field inspection is to verify the factors which can cause irreversible damage to the genetic purity or seed health. Inspection Authority. The seed certification officer authorized by the registering authority shall attend to field inspections.

Crop stages for inspection: The number of field inspections and the stages of crop growth at which the field inspections should be conducted vary from crop to crop. It depends upon duration, and nature of pollination of the seed crop. If the crop is grown for hybrid seed production, the no. of field inspections during the flowering stage should be more than in the case of self-pollinated / cross/ often cross pollinated varieties. The hybrid seed production and variety seed production of cross pollinated crops, the inspection during flowering should be made without any prior notice of the seed grower to judge the quality of operation undertaken by him to maintain the genetic purity of the crop. But in the case of self-pollinated crops the seed grower may be informed about the date of introspection the former case if prior notice is given to the seed grower, it may not be possible to detect the damage by the contaminants, whereas in the latter case prior notice will lead to improvement of the quality of the seed production work and thus the quality of seed.

The key points to be observed at each stage of inspection are

Key stages	Key points

I. Pre-flowering stage Vegetative stage) Stages	Verification of seed source
	Confirmation of acreage given in the report
	Land requirement to keep check on genetic as well as physicalcontamination and spread of disease inoculums.
	Planting ratio
	Border rows
	Isolation distance
	Guide the grower in identification of Off-types, pollen shedder,diseased plants, shedding tassels etc.
inspections, When 5% of plants begin to flower)	Confirm the observation of plants inspection were correct.
	Confirm whether grower had continued thorough roguing, afterthe previous inspection.
	shedding tassels, objectionable weed plants & diseased plants.
III. Inspection during post inspections and pre-harvest	Confirm the correctness of observations, made in earlier
	flowering Guide the grower on roguing, based on pods, ear head, seed &stage chaff characters such as colour, shape & size
	Explain to the grower when & how to harvest the crop & process
IV. Inspection during harvest	Verify that male parent rows have been harvested separately
	Ensure complete removal of off-types, other crops, weeds &harvest diseased plants etc.
	Seal properly by the certification agency of the threshed(conducted on a seed crop) produce after initial leaning & drying.

SEEDS ACT AND RULES

Introduction:The seed is an important agricultural input and it plays vital role in increasing production and productivity. There is a need to safeguard the farmers with the supply of genetically pure and quality seeds. Any new variety produced by the Scientist has to be multiplied many times to meet the needs of the farmers. In order to ensure the availability of quality seeds, Government of India have enacted Seeds act, 1966 and Seed rules, 1968. The seed (Control) order, 1983 was promulgated under essential commodities act, 1955 in order to ensure the production,marketing and equal distribution of the seeds.

Seeds Act, 1966

The object of Seed Act is to regulate the quality of certain notified kind / varieties of seeds for sale and for matters connected therewith. The seed act passed by the Indian Parliament in 1966was designed to create a 'Climate' in which the seeds man could operate effectively and to make good quality seed available to cultivators. Seeds rule under the act were notified in September 1968 and the act was implemented entirely in October, 1969. This act extent to the whole of India and it has 25 sections. Seed legislation could broadly be divided into two groups

1. **Sanctioning legislation**

Sanctioning legislation authorizes formation of Advisory bodies, Seed Certification Agencies,Seed Testing laboratories, Foundation and Certified Seed Programmes, Recognition of Seed certification Agencies of Foreign countries Appellate authorities etc.

2. Regulatory legislation

Regulatory Legislation controls the quality of seeds sold in the market including suitable agencies for regulating the seed quality. On quality control basis, the Seeds Act could conveniently be divided into the following:

I. Minimum limit and labeling of the notified kind / varieties of seed

a. Power to notify the kind / variety

b. Labeling provisions

c. Seed testing

d. Seed analyst

e. Seed inspectors

f. Penalty

g. General provisions

II. Seed Certification

III. Restriction of Import and Export of Seeds

I. Minimum limits and labeling

Quality control as envisaged in the Act is to be achieved through pre and post marketing control, voluntary certification and compulsory labeling of the seeds of notified kind /varieties.

II. (a) Power to notify the kind / varieties

.New varieties evolved by the State Agricultural Universities and ICAR institutes are notified and released /notified respectively under section 5 of the seeds act in consultation with the central seed committee and its sub committees constitute under section 3 and 3(5) of the Seeds Act. As on date more than 2500 varieties and 130 varieties were notified and denotified under this section. List of varieties notified and denotified from 1969 to 2005 are compiled and made available in the form of a book called catalogue of varieties notified and denotified under section 5 of the Seeds Act. Functions of the Central Seed Committee and its sub-committee are defined in Clauses 3 and 4 of part II of seed rule.

(b) Labeling provision

Minimum limits for germination, physical purity and genetic purity of varieties / hybrids for crops have been prescribed and notified for labeling seeds of notified kind / varieties under section 6(a) of the Seeds Act. Size of the label, colour of the label and content of the label were also notified under sub clause (b) of Section 6 of Seeds Act. Colour of the label is opel green and size of the label is 10 cm x 15 cm or proportionate thereof. Responsibility for making labeling content of mark or label, manner of marking, false / misleading statement on label etc., are defined under clause 7,8,9,10,11 and 12 of part V of seeds rule.

111.Section 7 of the act regulates the sale of notified kind or varieties. Accordingly no person shall keep for sale, offer to sell, barter or otherwise supply any seed of any notified kind or variety,after the dates recorded on the container mark or label as the date unto which the seed may expected to retain the germination not less than prescribed under clause (a) of section 6 of the Act.

III. (c) Seed Testing There is a provision to set up a central seed laboratory and state seed laboratory to discharge functions under section 4(1) and 4(2) of the Seed Act, In the year 1968 there were 23 state seed testing laboratories in the country. At present there are 86 Seed testing laboratories functioning in the country. During 1995-96 these laboratories tested about 5 lakh samples. Seed testing laboratories have been assigned certain important functions under part III (5) of Seed Rule.

IV. (d) **Seed Analysts**

State Government could appoint the Seed Analysts through notification in the Official Gazette under Section 12 of the Seed Act defining his area and his jurisdiction. Seed Analyst should posses certain minimum qualification as prescribed under clause 20 part IX of Seed Rule.

V. (e)**Seed Inspectors**

The State Government, under section 13 of the Act may appoint such a person as it thinks fit,having prescribed qualification (Clause 22 part IX of Seed Rule) through notification, as a Seed Inspector and define the areas within which he shall exercise jurisdiction for enforcing the seed law. He will be treated as a public servant within a meaning of section 21 of the I.P.C. (45 of1860). He has power to examine records, register document of the seed dealer. He will also exercise such other powers as may be necessary for carrying out the purposes of this Act or rule made there under. Duties of Seed inspectors are defined in clause 23 of part IX of Seed rule

Agencies of seed certification in India.

National Seed Corporation. The NSC was set up March 1963 as an undertaking under the administrative control of Ministry of Agriculture,Government of India with main responsibility of foundation and certified seed production of various crops. It helps the government for developed the certification standard and arranging training programme for the workers who are engaged in seed production. The seed certification work of NSC was later handed over to state seed corporation,but NSC continued the job coordinating the seed certification work carried out by the state corporation and still carried out certification where such corporation were not establish.

Tarai Development Corporation. Its was establish in 1969 with assistance of world bank which was later in 2002 named Uttrakhand seeds and TDC . It did splendid job in seed certification also establish minimum standard for seed certification of various crop.

State Seed Certification Agencies. The function of certification was transfered to state seed certification agencies. The state govt also notified seed inspector to enforce various provision of the seed quality at state level. State seed certification agencies were established under society act 1860.The centre seed certification board was established in 1976 to render the advisory service on scientific and operational matters to centre and state government. The above development gradually leads to setting up of reasonably independent autonomous Seed Certifying Agency in several states like Andra Pradesh, Bihar,Haryana and UP etc In some other states like J&K,Gujarat,Tamil Nadu and Bengal a separate wing of dept of agriculture with varying degree of independence from the dept of agriculture and from seed producer,marketing and law enforcement was authorized to certify seed.

The Seeds Act, 1966

[29th December, 1966

An Act to provide for regulating the quality of certain seeds for sale, and for matters connected

therewith. It is enacted by Parliament in the Seventeenth Year of the Republic of India as follows:

Short Title, Extent and Commencement

(1)This Act may be called the Seeds Act, 1966.

(2)It extends to the whole of India.

(3) It shall come into force on such date as the Central Government may, by notification in the Official Gazette, appoint, and different dates may be appointed for different provisions of this Act, and for different States or for different areas thereof.

Definitions

2. In this Act, unless the context otherwise requires,

1. "Agriculture" includes horticulture;

2. "Central Seed Laboratory" means the Central Seed Laboratory established or declared as such under sub-section (1) of section 4;

3. "Certification agency" means the certification agency established under Section 8or recognized under Section 18;

4. "Committee" means the Central Seed Committee constituted under sub-section(1) of Section

5. "Container" means a box, bottle, casket, tin, barrel, case, receptacle, sack, bag,wrapper or other thing in which any article or thing is placed or packed;

6. "Export" means taking out of India to a place outside India;

7. "Import" means bringing into India from a place outside India;

8. "Kind" means one or more related species or sub-species of crop plants each individually or collectively known by one common name such as cabbage,maize, paddy and wheat;

9. "notified kind or variety" , in relation to any seed, means any kind or variety thereof notified under Section 5;

10. "Prescribed" means prescribed by rules made under this act;

11. "seed" means any of the following classes of seeds used for sowing or planting- seeds of food crops including edible oil seeds and seeds of fruits and vegetables; cotton seeds; seeds of cattle fodder;and includes seedlings, and tubers, bulbs, rhizomes, roots, cuttings, all types of grafts and other vegetatively propagated material, of food crops or cattle fodder;

12. "Seed Analyst" means a Seed Analyst appointed under section 12;

13. "Seed Inspector" means a Seed Inspector appointed under section 13;

14. "State Government", in relation to a Union territory, means the administrator thereof;

15. "State Seed Laboratory", in relation to any State, means the State Seed Laboratory established or declared as such under sub-section (2) of section4 for that State; and

16. "Variety" means a sub-division of a kind identifiable by growth, yield,plant, fruit, seed, or other characteristic.

17.Central Seed Committee

(1)The Central Government shall, as soon as may be after the commencement of this Act, constitute a Committee called the Central Seed Committee to advise the Central Government and the State Governments on matters arising out of the administration of this Act and to carry out the other functions assigned to it by or under this Act.

(2). The Committee shall consist of the following members, namely:- Chairman to be nominated by the Central Government; eight persons to be nominated by the Central Government to represent such interests that Government thinks fit, of whom not less than two persons shall be representatives of growers of seed; One person to be nominated by the Government of each of the States.

(3) The members of the Committee shall, unless their seats become vacant earlier by resignation, death or otherwise, be entitled to hold office for two years and shall be eligible for renomination.

(4) The Committee may, subject to the previous approval of the Central Government,make bye-laws fixing the quorum and regulating its own procedure and the conduct of all business to be transacted by it.

(5) The Committee may appoint one or more sub-committees, consisting wholly of members of the Committee or wholly of other persons or partly of members of the Committee and partly of other persons, as it thinks fit, for the purpose of discharging such of its functions as may be delegated to such sub-committee or sub-committees by the Committee.

(6) The functions of the Committee or any sub-committee thereof may be exercised notwithstanding any vacancy therein.

(7) The Central Government shall appoint a person to be the secretary of the Committee and shall provide the Committee with such clerical and other staff as the Central Government considers necessary. Central Seed Certification Board

"8A. ,(1) The Central Government shall, by notification in the Official Gazette, establish a Central Seed Certification Board (hereinafter referred to as the Board) to advise the Central Government and the State Governments on all matters relating to certification and to co-ordinate he functioning of the agencies established under section 8.

(2) The Board shall consist of the following members, namely:-

(i) a Chairman, to be nominated by the Central Government;

lii) four members, to be nominated by the Central Government from out of the persons employed by th~ State Governments as 'Directors 'of Agriculture;

(iii) three members, to be nominated by the Central Government from out of the persons employed by the Agricultural Universities as Directors of Research;

(iv) thirteen persons, to be nominated by the Central Government to represent such interests as that Government thinks fit, of whom not less than four persons shall be representatives of seed producers or tradesmen.3) A member of the Board shall, unless his s~at becomes vacant earlier by resignation

or otherwise - be entitled to hold office for two years from the date of his nomination:Provided that a person nominated under clause (if) or clause (iii) of sub-section (2) shall hold office only for so long as he holds the appointment by virtue of which hi

nomination was made.

Central Seed Laboratory and State Seed Laboratory

4. (1) The Central Government may, by notification in the Official Gazette, establish aCentral Seed Laboratory or declare any seed laboratory as the Central Seed Laboratoryto carry out the functions entrusted to the Central Seed Laboratory by or under this Act.

(2) The State Government may, by notification in the Official Gazette, establish one or more State Seed Laboratories or declare any seed laboratory as a State Seed Laboratory where analysis of seeds of any notified kind or variety shall be carried out by Seed Analysts under this Act in the prescribed manner. Power to notify kinds or varieties of seeds

(3) If the Central Government, after consultation with the Committee, is of opinion that itis necessary or expedient to regulate the quality of seed of any kind or variety to be soldfor purposes of agriculture, it may, by notification in the Official Gazette, declare such kind or variety to be a notified kind or variety for the purposes of this Act and different kinds or varieties may be notified for different States or for different areas thereof. Power to specify minimum limits of germination and purity, etc.

Power to notify kinds or varieties of seeds

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5.Power to specify minimum limits of germination and purity, etc.

The Central Government may, after consultation with the Committee and by notification in the Official Gazette, specify-

a. the minimum limits of germination and purity with respect to any seed of any notified kind or variety;

b. the mark or label to indicate that such seed conforms to the minimum limits of germination and purity specified under clause (a) and the particulars which such mark or label may contain.

6.Regulation of sale of seeds of notified kinds or varieties

No person shall, himself or by any other person on his behalf, carry on the business of selling, keeping for sale, offering to sell, bartering or otherwise supplying any seed of any notified kind or variety, unless

a. such seed is identifiable as to its kind or variety;

b. such seed conforms to the minimum limits of germination and purity specified under clause (a) of section 6;

c. the container of such seed bears in the prescribed manner, the mark or label containing the correct particulars thereof, specified under clause (b) of section 6;and

D.The complies with such other requirements as may be prescribed. Certification agencyThe State Government or the Central Government in consultation with the State Government may, by notification in the Official Gazette, establish a certification agency for the State to carry out the functions entrusted to the certification agency by or under this Act.

8.Grant of certificate by certification agency

9. (1) Any person selling, keeping for sale, offering to sell, bartering or other wise supplying any seed of any notified kind or variety may, if he desires to have such seed certified by the certification agency, apply to the certification agency for the grant of a certificate for the purpose.

(2) Every application under sub-section (1) shall be made in such form, shall contain such particulars and shall be accompanied by such fees as may be prescribed.

(3) On receipt of any such application for the grant of a certificate, the certification agency may, after such enquiry as it thinks fit and after satisfying itself that the seed to which the application relates conforms to the minimum limits of germination and purity specified for that seed under clause (a) of section 6, grant a certificate in such form and on such conditions as may be prescribed. Revocation of certificate

10. If the certification agency is satisfied, either on a reference made to it in this behalf or otherwise, that-
a. the certificate granted by it under section 9 has been obtained by mis representation as to an essential fact; or b. the holder of the certificate has, without reasonable cause, failed to comply with the conditions subject to which the certificate has been granted or has contravened any of the provisions of this Act or the rules made thereunder;then, without prejudice to any other penalty to which the holder of the certificate maybe liable under this Act, the certification agency may, after giving the holder of the certificate an opportunity of showing cause, revoke the certificate.

Appeal

11. (1) Any person aggrieved by a decision of a certification agency under section 9 or section 10, may, within thirty days from the date on which the decision is communicated to him and on payment of such fees as may be prescribed, prefer an appeal to such authority as may be specified by the State Government in this behalf:Provided that the appellate authority may entertain an appeal after the expiry of the said period of thirty days if it is satisfied that the appellate was prevented by sufficient cause from filing the appeal in time.

(2) On receipt of an appeal under sub-section (1), the appellate authority shall, after giving the appellant an opportunity of being heard, dispose of the appeal as expeditiously as possible.

Every order of the appellate authority under this section shall be final.

3.Seed Analysts

12.The State Government may, by notification in the Official Gazette, appoint such persons as it thinks fit, having the prescribed qualifications, to be Seed Analysts and define the areas within which they shall exercise jurisdiction.

Seed Inspectors

13. (1) The State Government may, by notification in the Official Gazette, appoint such persons as it thinks fit, having the prescribed qualifications, to be Seed Inspectors and define the areas within which they shall exercise jurisdiction.

(2) Every Seed Inspector shall be deemed to be a public servant within the meaning of section 21 of the Indian Penal Code (45 of 1860) and shall be officially subordinate to such authority as the State Government may specify in this behalf.

Powers of Seed Inspector

14. (1) The Seed Inspector may-take samples of any seed of any notified kind or variety from-

.any person selling such seed; or any person who is in the course of conveying, delivering or preparing to deliver such seed to a purchaser or a consignee; or a purchaser or a consignee after delivery of such seed to him;send such sample for analysis to the Seed Analyst for the area within which such sample has been taken; enter and search at all reasonable times, with such assistance, if any, as he considers necessary, any place in which he has reason to believe that an offence under this Act has been or is being committed and order in writing the person in possession of any seed in respect of which the offence has been or is being committed, not to dispose of any stock of such seed for a specific period not exceeding thirty days or, unless the alleged offence is such that the defect may be removed by the possessor of the seed, seize the stock of such seed; examine any record, register, document or any other material object found in anyplace mentioned in clause (c) and seize the same if he has reason to believe that it may furnish evidence of the commission of an offence punishable under this Act;

(2) Where any sample of any seed of any notified kind or variety is taken under clause

(a) of sub-section (1), its cost, calculated at the rate at which such seed is usually sold to the public, shall be paid on demand to the person from whom it is taken.(3) The power conferred by this section includes power to break-open any container in which any seed of any notified kind or variety may be contained or to break-open the door of any premises where any such seed may be kept for sale:Provided that the power to break-open the door shall be exercised only after the owner or any other person in occupation of the premises, if he is present therein, refuses to open the door on being called upon to do so.

(4) Where the Seed Inspector takes any action under clause (a) of sub-section (1), he shall, as far as possible, call not less than two persons to be present at the time when such action is taken and take their signatures on a memorandum to be prepared in the prescribed form and manner.

(5) The provisions of the Code of Criminal Procedure, 1898 (5 of 1898), shall, so far as may be, apply to any search or seizure under this section as they apply to any search or seizure made under the authority of a warrant issued under section 98 of the said Code. Procedure to be followed by Seed Inspectors

15. (1) Whenever a Seed Inspector intends to take sample of any seed of any notified kind or variety for analysis, he shall-give notice in writing, then and there, of such intention to the person from whom he intends to take sample; except in special cases provided by rules made under this Act, take three representative samples in the prescribed manner and mark and seal or fasten up each sample in such manner as its nature permits.

16. When samples of any seed of any notified kind or variety are taken under sub-section , the Seed Inspector shall-deliver one sample to the person from whom it has been taken;send in the prescribed manner another sample for analysis to the Seed Analyst for the area within which such sample has been taken; and retain the remaining sample in the prescribed manner for production in case any legal proceedings are taken or for analysis by the Central Seed Laboratory under sub-section (2) of section 16, as the case may be.

Report of Seed Analyst

16.(1) The Seed Analyst shall, as soon as may be after the receipt of the sample under sub-section (2) of section 15, analyses the sample at the State Seed Laboratory and deliver, in such form as may be prescribed,

one copy of the report of the result of the analysis to the Seed Inspector and another copy thereof to the person from whom the sample has been taken.

(2) After the institution of a prosecution under this Act, the accused vendor or the complainant may, on payment of the prescribed fee, make an application to the court for sending any of the samples mentioned in clause (a) or clause (c) of sub-section (2) of section 15 to the Central Seed Laboratory for its report and on receipt of the application,the court shall first ascertain that the mark and the seal or fastening as provided inclause (b) of sub-section (1) of section 15 are intact and may then despatch the sampleunder its own seal to the Central Seed Laboratory which shall thereupon send its reportto the court in the prescribed form within one month from the date of receipt of the sample, specifying the result of the analysis.

(3) The report sent by the Central Seed Laboratory under sub-section (2) shall supersede

the report given by the Seed Analyst under sub-section (1).Restriction on export and import of seeds of notified kinds or varieties

17. No person shall, for the purpose of sowing or planting by any person (including himself), export or import or cause to be exported or imported any seed of any notified kind or variety, unless-

a. it conforms to the minimum limits of germination and purity specified for thatseed under clause (a) of section 6; and

b. its container bears, in the prescribed manner, the mark or label with the correct particulars thereof specified for that seed under clause (b) of section

6.Recognition of seed certification agencies of foreign countries The Central Govt. may, on the recommendation of the Committee and by notification in the Official Gazette, recognize any seed certification agency established in any foreign country,

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3. for the purposes of this Act.

If any person-

4. contravenes any provision of this Act or any rule made thereunder; or

5. prevents a Seed Inspector from taking sample under this Act;or

6. prevents a Seed Inspector from exercising any other power conferred on him byor under this Act;he shall, on conviction, be punishable-

7.for the first offence with fine which may extend to five hundred rupees, and

8. in the event of such person having been previously convicted of an offence under this section, with imprisonment for a term which may extend to six months, orwith fine which may extend to one thousand rupees, or with both.

9.Forfeiture of property.

When any person has been convicted under this Act for the contravention of any of the provisions of this Act or the rules made thereunder, the seed in respect of which the contravention has been committed may be forfeited to the Government. Offences by companies

21. (1) Where an offense under this Act has been committed by a company, every person who at the time the of fence was committed was in charge of, and was responsible to the company for the conduct of the business of the company, as well as the company, shall be deemed to be guilty of the offence and shall be liable to be proceeded against and punished accordingly:Provided that nothing contained in this sub-section shall render any such person liable to any punishment under this Act if he proves that the offence was committed without his knowledge and that he exercised all due diligence to prevent the commission of such offence.

(2) Notwithstanding anything contained in sub-section (1), where an offence under thisAct has been committed by a company and it is proved that the offence has been committed with the consent or connivance of, or is attributable to any neglect on thepart of, any director, manager, secretary or other officer of the company, such director,manager, secretary or other officer shall also be deemed to be guilty of that offence and shall be liable to be proceeded against and punished accordingly. Explanation. – For the purpose of this section,

Protection of action taken in good faith

22. No suit, prosecution or other legal proceeding shall lie against the Government orany officer of the Government for anything which is in good faith done or intended to be done under this Act.

Power to give directions

23. The Central Government may give such directions to any State Government as mayappear to the Central Government to be necessary for carrying into execution in theState any of the provisions of this Act or of any rule made there under.

Exemption

24. Nothing in this Act shall apply to any seed of any notified kind or variety grown by a person and sold or delivered by him on his own premises direct to another person for being used by that person for the purpose of sowing or planting.

Power to make rules

25. (1) The Central Government may, by notification in the Official Gazette, make rules to carry out the purpose of this Act.

(2) In particular and without prejudice to the generality of the fore-going power, such rules may provide, for-

Seed law Enforcement. With the systematic application of science in agriculture and technological advancement in seed tech. It became imperative to regulate the quality of seed through legislation and its subsequent enforcement to ensure that seed buyers are not made to run undue risk.

Regulatory Legislation. The government of India has promulgated several legislation from time to time such as seed act 1966 ,the seed rule 1968 the seed control order 1983,Plant varieties and farmers right protection act 2001 and patent act 2002 and framed seed policies to regulate quality of seed .The seed act provides for notification of variety to be brought under purview of the act,regulation regarding the sale of the seed and establishment of suitable seed law enforcement machinery. Under the act the centre government is empowered to make rules to carry out provision of the act and to give direction to the state government./

Agencies for Enforcing the Regulation. The responsibility of enforcing various provision regarding the sale of seed of notified variety with seed inspector in their respective area. The seed Inspector has given certain powers .The inspector will take samples of any seed of a notified variety being sold and send to seed testing laboratory where these samples were analysed by analyst.

Procedure of Seed Law Enforcement. Seed inspector should strictly follow the prescribed standard prescribed in hand book for seeds. They should carry necessary equipments and materials with them while on duty

Seed Testing The Seed Testing Laboratory is the hub of seed quality control. Seed testing services are required from time to time to gain information regarding planting value of seed lots. Seed testing is possible for all those who produce, sell and use seeds.

Objective & Importance of Seed Testing

Seed testing is required to achieve the following objectives for minimising the risks of planting low quality seeds.

1. To identify the quality problem and their probable cause
2. To determine their quality, that is, their suitability for planting
3. To determine the need for drying and processing and specific procedures that should be used
4. To determine if seed meets established quality standards or labelling specifications.
5. To establish quality and provide a basis for price and consumer discrimination among lots in the market. The primary aim of the seed testing is to obtain accurate and reproducible results regarding the quality status of the seed samples submitted to the Seed Testing Laboratories.

Importance

- The importance of seed testing was realized more than 100 years ago for assured planting values. The adulteration of vegetable seeds by stone dust which was packed in some parts of the world particularly in Europe.
- Seed testing has been developed to aid agriculture to avoid some of the hazards of crop production by furnishing the needed information about different quality attributes *viz.,* purity, moisture, germination, vigour and health.
- Quality control of seed depends on the different seed testing protocols which determine the genuineness of the cultivar.
- Testing of seed to evaluate the planting value and the authenticity of the certified lot.

- Seed testing is required to assess the seed quality attributes of the seed lots which have to be offered for sale.
- These quality attributes are seed moisture content, germination and vigour, physical and genetic purity, freedom from seed borne diseases and insect infestation. In India, seed testing is done mainly for moisture, germination and physical purity of seeds.
- Standard seed testing procedures for the evaluation of the seeds were developed by ISTA. It is obligatory on the part of the seed analyst to follow rules prescribed by 1STA (1STA, 1985) if the seed is moving to the International trade.
- The seed testing procedures which are described below are based mostly on the international rules because most of our rules (Chalam et *al.*. 1967) are based on, 1STA, 1996. Economic yield of a crop depends on the quality of seeds which can be evaluated by seed testing (1STA, 1996).
- The testing of seed quality is carried out on seed samples drawn from seed lot to be used for cultivation. The quantity of seed sample taken for testing in laboratory is minute compared to that of seed lot it represents.

Endosperm Development: Endosperm serves as the principle nutritive support for embryo of many species especially monocotyledons during seed development and germination.In angiosperms ,the endosperm normally originate from triple fusion of a sperm cell nucleus from the pollen tube with diploid polar nucleus(following fusion of the two polar nuclei) of the embryo sac there fore its nuclear complement is triploid(3N).In gymnosperm the endosperm is normally haploid(N)since it develops from one cell of the female gametophyte. In seeds of many species especially dicotyledons the endosperm develop only few cells while in others it may be highly modified and hardly recognized. In Orchadiaceae its completely suppressed.

The **function of endosperm** is to provide nutrition for the development of embryo,therefore,its composition is compatible with embryo's needs. But the endosperm must also draw its nutritive support from embryo sac and surrounding tissues. The net effect is to surrounded the embryo with a rich nutritive tissue from which it can draw for development and growth.

Types of Endosperm Development: Division of the primary endosperm nucleus yields micropylar and chalazal chambers,one or both of which may contribute to mature endosperm. When only one develops,the other is crushed and soon degerate. Endosperm development may be one of three types,depending up on sequence of nuclear division and cell wall formation

Cellular Endosperm. In this type of endosperm,each nuclear division is accompanied by cell wall formation.

Nuclear Endosperm. This endosperm type is characterized by nuclear division un accompanied by cell wall formation .The nuclei may remain free or may later be separated by cell walls that form in one of three ways:1.one to three layers of cell wall may from around the periphery,with free nuclei inside.(2) a cell wall may form in micropylar area with the rest remaining in a free cell state(3) the entire endosperm may be filled with walled cells. All the endosperm conditionmay exist in the same family.

Helobial Endosperm. The helobial endosperm is intermediate between nuclear and celluar types. Free nuclear division occur,but cell wall formation accompanies nuclear division in some parts of the endosperm as well.