FACULTY OF AGRICULTURAL SCIENCES

AND ALLIED INDUSTRIES

CAUSES FOR VARIETAL DETERIORATION

Deterioration of 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.

1. Developmental variations
2. Mechanical mixtures
3. Mutations
4. Natural crossing
5. Minor genetic variations
6. Selected influence of pest and diseases
7. The technique of the plant breeder

1. Developmental Variations

When seed crops are grown under environments with differing soil, fertility, climate photoperiods, or at different elevations for several consecutive generation's developmental variations may set in as differential growth responses. It is therefor, preferred to grow the varieties of crops in the areas of their natural adaptation to minimize developmental shifts.

2. Mechanical Mixtures

Mechanical mixtures, the most important reason for varietal deterioration, often take place at the time of sowing if more than one variety is sown with the same seed drill, through volunteer plants of the same crop in the seed field, or through different varieties grown in adjacent fields. Two varieties growing next to each other field is usually mixed during harvesting and threshing operations. The threshing equipment is often contaminated with seeds of other varieties. Similarly, the gunny bags, seed bins and elevators are also often contaminate, adding to the mechanical mixtures of varieties. Roguing the seed fields critically and using utmost care during seed production and processing are necessary to avoid such mechanical contamination.

3. Mutations

Mutations do not seriously deteriorate varieties. It is often difficult to identify or detect minor mutations occurring naturally. Mutants such as 'fatuoids' in oats or 'rabbit ear' in peas may be removed by roguing from seed plots to purify the seeds.

4. Natural Crossing

Natural crossing can be an important source of varietal deterioration in sexually propagated crops. The extent of contamination depends upon the magnitude of natural cross-fertilization. The deterioration sets in due to natural crossing with undesirable types, diseased plants, or off types. In self-fertilized crops, natural crossing is not a serious source of contamination unless variety is male sterile and is grown in close proximity with other varieties. The natural crossing, however, can be major source of contamination due to natural crossing are the breeding system of the species, isolation distance, varietal mass

and pollinating agent. The isolation of seed crops is the most important factor in avoiding contamination of the cross-fertilized crops. The direction of prevailing winds, the number of insects present and their activity, and mass of varieties are also important considerations is contamination by natural crossing.

5. Minor Genetic Variations

Minor genetic variations can occur even in varieties appearing phenotypically uniform and homogenous when released. The variations may lost during later production cycles owing to selective elimination by the nature. The yield trials of lines propagated from plants of breeder's seed to maintain the purity of self-pollinated crop varieties can overcome these minor variations. Due care during the maintenance of nucleus and breeder's seed of cross-fertilized varieties of crop is necessary.

6. Selected Influence of Pest and Diseases

New crop varieties often are susceptible to newer races of pests and diseases caused by obligate parasites and thus selectively influence deterioration. The vegetatively propagated stock also can deteriorate quickly if infected by virus, fungi or bacteria. Seed production under strict disease free conditions is therefore essential.

7. The Techniques of the Plant Breeder

Serious instabilities may occur in varieties owing to cytogenetic irregularities in the form of improper assessments in the release of new varieties. Premature release of varieties, still segregating for resistance and susceptibility to diseases or other factors can cause significant deterioration of varieties. This failure can be attributed to the variety-testing programme.

In addition to these factors, other heritable variations due to recombination's and polyploidization may also take place in varieties during seed production, which can be avoided by periodical selection during maintenance of the seed stock.

MAINTENANCE OF VARIETAL PURITY

Agroclimate and Location

1. The crop variety to be grown for seed production must have a suitable Agroclimate, adapted to the photoperiodic and temperature conditions prevailing in that location
2. Specific selected locations would be needed to economically grow crop varieties sensitive to photoperiodism (short days viz., long days) and temperatures
3. The regions with moderate rainfall, humidity and extreme temperatures
4. Most agronomic crops require a dry sunny period and moderate temperatures for flowering and pollination
5. Excessive dew and rains affect normal pollination , resulting in poor seed set
6. Extreme temperatures may cause desiccation of pollen and poor seed set.
7. Very hot and dry weather conditions adversely affect the flowering of several crops, especially vegetables, legumes and fruit crops, which fail to set seed. These crops invariably require cooler climates with low atmospheric humidity to flower and pollinate normally.
8. Oil seed crops may tolerate hot weather during flowering, but very high temperatures can result in premature flowering and the production of poor quality seeds.
9. Extreme cold temperatures also damage seed quality in the early phases of seed maturation. Thus, locations with extreme agroclimate (summer hot and cold winters) are generally not suitable for seed production.
10. Excessive rainfall conditions normally result in a higher incidence of pest and diseases making the harvesting and other operations of seed production extremely difficult. They may also cause delayed maturity and pregermination of seed in many standing crops.
11. A mature seed crop becomes increasingly susceptible to shattering, strong winds, and heavy rainfall.
12. Ample sunshine, moderate rainfall, climate and absence of strong winds are ideal for the production of high quality seed.

Agarwal (1980) lists the following desirable characteristics of land selected for seed crops:

1. The seed plot should have soil texture (light, well drained) and fertility characteristics as required by the crop.
2. The plot should be free from volunteer plants and seeds of weeds and other crop plants.
3. The soil of the selected plot should be comparatively free from soil borne diseases and pests.
4. The same crop or variety thereof should not have been cultivated during the previous season on the plot selected for seed production.
5. The plot must be levelled and feasible for isolation as per the requirement of certification standards.

Isolation

1. The seed crop must be sufficiently isolated from nearby fields of the same or other contaminating crops as per the requirements of certification standards.
2. The seed crop should be isolated by providing enough distance between seed plots and contaminating fields.
3. In the case of hybrid maize seed production, time isolation can be followed if distance isolation is not feasible.
4. On a small scale in nucleus / breeder's seed production, isolation may be achieved by enclosing individual flowers or by removing male flower parts and employing artificial pollination.
5. Even after the seed crop is harvested, effective isolation of seed from different varieties is essential to avoid mechanical contamination.
6. Bags and other equipment must be thoroughly clean to maintain seed purity.

Variety

1. After the land is prepared for improving germination, including freedom from weeds and uniform irrigation, the selected crop variety is carefully planted.
2. The variety selected should suit the prevailing agroclimatic conditions, high-yielding and possessing desirable attributes such as disease resistance, earliness and grain quality. Similarly the seed should be known purity, appropriate class, and obtained from an authorized official agency.
3. The seed may require treatment before sowing, if not treated already. Seed treatment may be given with appropriate fungicides or involve bacterial inoculation for legumes or for breaking dormancy.
4. Seeds having hard seed coats may require soaking in water overnight to facilitate germination.
5. The seed must be planted at its normal planting time in soil having adequate moisture content for germination. Lower than usual seed rates of commercial crops will facilitate the roguing and inspection of seed crops.

Sowing

1. The seed crop is generally sown in rows by mechanical drillers, which allow the desired quantity of seeds to be planted at uniform depth.

2. The sowing equipment must be thoroughly clean to avoid any contamination.
3. Sowing in rows facilitates effective plant protection measures, roguing operations, and field inspection.
4. Adequate spacing within rows and distance between rows are given as per the plant bases.
5. For hybrids, female and male parent lines are planted in 4:2 or 6:2 proportions to ensure that the seeds of the male and female parent lines are not mixed while planting.
6. Small seed is generally sown shallow and large seed a little deeper to secure good planting.
7. Seed emergence is better from greater depths in sandy soils than in clayey soils and as well as from warmer soil.

Roguing

1. Adequate and timely roguing constitutes the single most important operation in seed production. Rogues differing from normal (weak or sickly plants, bolters

and off types) are pulled out and discarded at the earliest possible phases, before flowering, especially in cross pollinated crops to avoid genetic contamination.

2. Plants obviously differing in height, colour of vegetation, leaf size, shape, and orientation, or any other morphological characteristic as well as malformed and diseased plants should be removed completely.
3. In some crops roguing at the early vegetative stage may be necessary to remove virus affected plants.
4. Undesirable plants not distinguishable earlier should be removed soon after emergence of the earhead / tassel.
5. In hybrids, where male sterility is employed, special care is required to remove pollen shedders.
6. While removing the plants with earheads infested by seed borne diseases or loose smut, precautions must be taken to ensure that spores are not spread to healthy plants.
7. Roguing at maturity is also necessary to remove off types not distinguishable earlier and contaminants affecting the physical purity of seed.
8. Roguing and sorting of harvested earheads may be necessary in some crops to remove off textured, off coloured, diseased, or malformed earheads. In root and vegetable crops, roguing at harvest time may be needed to confirm the fruit, tuber, or root quality of the crop.

Pollination and Weeding

1. Supplementary pollination provided by honey bees in hives in close proximity to seed crops that are cross pollinated by insects may be necessary to ensure good seed set and thereby increase seed yield.
2. Production of high quality seed requires through control of weeds on the seed plot.
3. In addition to reduction in seed yield, weeds are often a source of contamination by way of mixing at the time of harvest.
4. Weeds in the seed plot or nearby areas may also harbor a number of pests and diseases
5. Effective control of weeds at all the phases of crop growth is essential and they must not be allowed to flower or set seed in any case.

6. Planting seed crops on clean, fallow land or following crop rotations is generally recommended to keep at a minimum. Hand weeding, intercultural operations or chemical weed control may be necessary.

Irrigation

1. Because drier climates are more suitable for producing high quality disease free seeds, irrigation is essential to obtain good seed yields.
2. Irrigation may be required before planting and at suitable intervals up to flowering.
3. One or two irrigation's may be desirable for many seed crops.
4. The frequency of irrigation and amount of water supplied depend upon the physical texture of the soil and crop requirements.
5. Maximum benefits from irrigation's can be derived only with adequate crop nutrition in the form of organic manure and fertilization, especially readily available sources of nitrogen and phosphorus.
6. Seed crop is rather sensitive to moisture stress at the vegetative, flowering and maturity stages. Adequate soil moisture is also necessary for uniform seed germination necessary to further crops stand and good seed yields.

7. Both excessive moisture conditions and prolonged drought will adversely affect germination, growth and development of the seed crop.
8. Water may be applied by surface irrigation, sprinkler, drip or overhead irrigation or subsurface irrigation.
9. The irrigation should be stopped 2-3 weeks before seed maturity to ensure the dried conditions needed for harvesting.

Plant Nutrition

1. Adequate amounts of nitrogen, phosphorus, potassium and other essential minerals are crucial for the proper growth and development of the seed crop. It is, therefore necessary to know the nutritional requirements of any individual seed crop and to ensure proper nutrition at all the stages of crop growth.
2. Split applications of nitrogen are generally advocated to avoid lodging of a crop due to excessive vegetative growth.
3. Application of nitrogen at the time of flowering leads to an increase in yield and quality of the seed of most crops.
4. In some early crops nitrogen dressing at flowering may tend to delay ripening.
5. While most grasses and peas are benefited by early applications of nitrogen, lettuce crops respond well to nitrogen application at the time of flowering.
6. Phosphorus and potassium favour root growth, increased strength of straw fruiting and seed development. They also hasten plant maturity and increase disease resistance.
7. Potassium improves the photosynthetic efficiency of plants and favours both protein and lipid metabolism in oil seeds.
8. Deficiencies of other essential secondary and micronutrients also need to be monitored carefully using soil test measures.

Plant Protection

1. Effective control of all pests, including diseases and insects, is essential to produce a healthy seed crop. In addition to heavy reductions in seed yields, diseases and pests damage the quality of the produce.

2. Planting seed chemically treated with the appropriate fungicides effectively checks the seedling and many of seed borne diseases.
3. Applying the appropriate fungicides and insecticides in proper quantities and at the right time can effectively control most seed crop pests.
4. Adoption of appropriate schedules of plant protection and roguing of diseased plants and earheads from time to time will further check the spread of disease and insects.

Harvesting

1. After completion of essential cultural operations and approval of seed fields for certification, the crop is ready for harvest. The appropriate time of harvest to ensure maximum seed yield and quality is of great significance.
2. Fully matured seed is easily harvested and cleaned with minimal harvest losses. While early harvests may make combining difficult, with increased losses in threshing and cleaning, harvesting at later stages may result in increased losses due to weather, lodging, seed shattering and pest and dieseas.
3. Seed moisture content is a good indication of the optimum time of harvest. Combines do not normally operate well above 15% seed moisture. While soybeans

may be harvested best at a seed moisture content of 13% for wheat the best moisture content varies from 15 to 17%. Harvesting of seed crops at seed moisture contents of less than 20% minimizes mechanical damage to seed. If maize ears are picked and dried moisture content of less than 20% minimizes mechanical damage to seed. If maize ears are picked and dried , they may be harvested at 30-35% seed moisture content.

4. A seed crop may be harvested manually or mechanically, taking care to avoid mechanical injury to seeds during harvesting and threshing operations. Care must also be taken to avoid any chance of mechanical mixing of seeds and maintain lot identity.

Drying

1. Cemented threshing floors or use of tarpaulins is preferred to maintain the quality of seeds. A crop may be harvested by directly combining in the field using mechanical combines. Sun drying of seeds on threshing floors, spreading the seeds in thin layers, may be necessary to reduce its moisture content and improve the storage quality.
2. Drying of a seed crop to its safe moisture limit to preserve its viability and vigour must be carried out rather quickly. If the seed is to be dehydrated mechanically, it should be taken to the processing plant soon after harvesting.
3. Care must be taken at all stages to avoid mechanical mixing and to minimum the identity of seed lots.

Seed Storage

1. Seed may be stored in sacks or bags for short periods. Bags may need to be disinfected with DDT solutions, dried and cleaned before use.
2. They should be labelled properly and stacked on wooden pallets.
3. Storage facilities should be dry, cool, and clean disinfected with malathion, and fumigated if necessary.

GENETIC PURITY MAINTENANCE

Agarwal (1980) described the following steps to maintain the genetic purity of variety during seed production

1. Use of only approved class of seed in seed multiplication
2. Inspection and approval of seed plots prior to planting
3. Field inspection and approval of growing crops at all critical growth phases for verification of genetic purity, detection of admixtures, weeds and for freedom from noxious weeds, and seed borne diseases.
4. Sampling and sealing of cleaned lots, and
5. Growing of samples of potentially approved stocks for comparison with authentic stocks.

Hartmann and Kester (1968) recommended the following steps for maintaining the genetic purity of cultivars.

1. Provision of adequate isolation to prevent contamination by natural crossing or mechanical mixtures.
2. Roguing of seed plots prior to growth phases at which seed crop gets contaminated,

3. Periodic testing of varieties for genetic purity,
4. Growing crops only in areas of their adaptation to avoid genetic shifts,
5. Certification of seed crops to maintain genetic purity and quality of seed, and
6. Adoption of generation system.

In the generation system, seed production is restricted to four generations, i.e., starting from the breeder's seed, the seeds can be multiplied up to three more generations, namely, foundations, registered and certified seed.

The following measures have been suggested to safeguard the genetic purity:

1. Use of seed of an appropriate class from an approved source to raise the seed crop.
2. Preceding crop requirements as have been fixed to avoid contamination due to volunteer plants.
3. Isolation of seed crops from various sources of contamination by natural crossing with other varieties grown along side and off types present in the field by wind and insects.
4. Avoiding contamination due to mechanical mixtures at the time of sowing, harvesting, threshing, processing and handling of seeds, and contamination due to seed borne diseases.
5. Roguing of off types differing in characteristics from those of the seed variety. The off types may arise due to presence of the some recessive genes in heterozygous conditions, arising from mutations. The heterozygous plants segregate for the characters affected by the particular gene(s) in later production cycles to give rise to off types. Volunteers plants may arise from accidentally planted seed or from seed produced by earlier crops contributing to off types.
6. The genetic purity of seed under commercial seed production can be maintained through a system of seed certification to distribute crop seeds, tubers, or bulbs of true to type and high genetic quality. Qualified and experienced personnel of seed certification agency should inspect seed crops at all appropriate stages of growth and verify seed lots or purity and quality.
7. Periodic testing of genetic purity of seeds, by growing the crop to ensure maintenance of quality.