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Hybrid Seed Production Its Methods & benefits

In agriculture and gardening, hybrid seed is seed produced by cross-pollinated plants. Hybrid seed production is predominant in modern agriculture and home gardening. It is one of the main contributors to the dramatic rise in agricultural output during the last half of the 20th century. The alternatives to hybridization are open pollination and clonal propagation.

All of the hybrid seeds planted by the farmer will produce similar plants, while the seeds of the next generation from those hybrids will not consistently have the desired characteristics. Controlled hybrids provide very uniform characteristics because they are produced by crossing two inbred strains. Elite inbred strains are used that express well-documented and consistent phenotypes (such as high crop yield) that are relatively good for inbred plants.

Hybrids are chosen to improve the characteristics of the resulting plants, such as better yield, greater uniformity, improved color, disease resistance. An important factor is the heterosis or combining ability of the parent plants. Crossing any particular pair of inbred strains may or may not result in superior offspring. The parent strains used are therefore carefully chosen so as to achieve the uniformity that comes from the uniformity of the parents, and the superior performance that comes from heterosis. Hybrid is produced by crossing between two genetically dissimilar parents. Pollen from male parent (Pollen parent) will pollinate, fertilize and set seeds in female (seed parent) to produce F1 hybrid seeds. For production of a hybrid CROSSING between two parents is important, the crossing process will results in heterosis. In self pollinated cross it is difficult to cross but in cross pollinated crops it is easier. In nature to create genetic variability and for its wider adaptation in different environmental conditions, flowering plants has adopted many mechanisms for cross pollination. Cross-pollination results in genetic heterogeneity and show wider adaptations. Flowering plants have evolved a number of devises to encourage cross-pollination. Those mechanisms are;

1. **Dicliny:Flowers** are unisexual. In monoecious plants male and female flowers are borne on the same plant eg., cucurbits, maize, castor and coconut. In dioecious plants male flowers are borne on different plants eg., papaya, cannabis, mulberry.

2. **Dichogamy:**Time of anther dehiscence and stigma receptivity are different forcing them for cross-pollination. The time gap between the two may vary from one day to many days. In protoandry anthers dehisce earlier than the stigma receptivity eg; maize, sunflower. In protogyny stigma become recetive earlier than the anther dehisce eg., Pearl millet mirabilis.

3. **Self-incompatibility**:self fertilization in avoided by recognizing the self pollen by the stigma. Eg., Brassica, Petunia, Lilium .

4. **Herkogamy:**there is spatial separation of the anthers and stigma. Their relative position is such that self fertilization cannot occur. The stigma projects beyond the anthers and therefore pollen cannot land on stigma. Eg., Lucerne stigma is covered with a waxy film. The stigma does not become receptive until this waxy membrane is broken by visit of honeybees resulting in cross-pollination.

5. **Male sterility:**Absence or atropy or mis or malformed of male sex organ (functional pollen) in normal bisexual flower. Male sterility is of three types: genetic male sterility, cytoplasm sterility and cytoplasmic- genetic male sterility.

6. A combination of two or more of the above mechanisms may occur in some species. This improves the efficiency of the system in promoting cross-pollination

Method of Hybrid Hybrid

–rice can be produced in the following ways.
1. **Three –line system**. The hybrid seed production involves multiplication of cytoplasmic – genetic male sterile line (A line) , maintainer line (B line) and a restore line (R line) and production of F1 hybrid seed (AXR).
2. **Two-line system.** The hybrid seed production involves the use of photo-period sensitive genetic male sterile (PSMS). Any normal line can serve as a restorer.
3. **By using chemical emasculators**. Chemicals that can sterilize the stamen, with little or no effect on the normal functioning of the pistil, can be used to emasculate female parents for hybrid rice production. The advantages are obvious, no special development of male sterile or restore lines is required and extensive varietal resources are available. Chemical emasculators such as male gametocide 1 (ME1) and male gametocide 2 (MG2) were developed in China and have been successfully used in hybrid rice production. In chemical emasculation, physiological male sterility is artificially created by spraying the rice plant with chemicals to induce stamen sterility without harming the pistil. In hybrid seed production , two – varieties are planted in alternate strips, and one is chemically sterilized and pollinated by the other.

A. Introduction:
1. Definitions
(a) General - a hybrid is the first generation progeny of a cross between two genetically different plants.
(b) Legal - the first generation seed of a cross produced by controlling the pollination and by combining (1) two or more inbred lines (2) one inbred line and/or a single cross with an open pollinated variety (3) two varieties or species, except open pollinated varieties of corn.
(c) Inbred line (pure line) - a genetically homozygous genotype of a species which is developed as the result of self-pollination (inbreeding) and selection for specific characteristics.

(d) Isogenic lines - any two or more inbred or pure lines which are for practical purposes genetically identical except for one characteristic.
(e) Single-cross hybrid - the first generation progney (F1) of a cross between two genetically different inbred or pure lines; not crosses between isogenic lines.
(f) Three-way hybrid - the first generation of a cross between an inbred or pure line and a single cross hybrid.
(g) Double-cross hybrid - the first generation progney of a cross between two single cross hybrids.
2. Hybrid varieties have certain potential not possible to obtain with pure line or open-pollinated varieties.

B. Requisites for hybrid seed production
1. Breeders responsibilities
(a) Develop inbred lines
(b) Indentification of specific parental lines
(c) Develop system for pollen control
2. Major problems for breeders & producers
(a) Maintenance of parental lines
(b) Separation of male and female reproductive organs
(c) Pollen exchange
3. Genetically it makes no difference which parental line is used as the male or female; but seed producers must consider the following characteristics of parental lines.

Female Parent	Male Parent
High seed yield	Good pollen production
Good seed characteristics	Long shedding period
Pest resistance	Plant height
Male sterility	Fertility restoration
Lodging resistant	

C. Basic procedures for hybrid seed production
1. Development and identification for parental lines
2. Multiplication of parental lines
3. Production of single crosses (maize, Figure 1)
(a) Planting ratios
(b) Planting date(s)--"nick"
4. Production of double cross hybrids (maize only, Figure 2)

D. Use of male sterile and restoration factors
1. Male sterility does not occur frequently in natural populations because an isolated male sterile plant can not reproduce itself i.e. male sterility is a dead-end in nature.
2. Male sterility is very useful in both the development of superior genotypes {plant breeding) and seed production of hybrid varieties.
3. Control of male sterility
(a) Genetic
(1) Usually determined by a single gene "Ms" where the homozygous recessive "msms" results in rna l e sterility.
(2) Stability often influenced by environmental conditions and/or modifier genes.
(1) Sterility is determined by the cytoplasm of the female parent. Remember the cytoplasm is derived almost entirely from the female gamete.
(2) Usually more stable under varied environments than genetic sterility.
(3) Cytoplasmic male sterility is most useful when fruit or seed are not desired i.e. flowers, onion, potato. Nonfruiting plants bloom over a longer period of time and the flowers remain 11 fresh 11 longer.
(4) Useful in hybrid seed production only when a source of pollen can be supplied.
(c) Cytoplasmic - genetic
(1) Offspring from male sterile plants are not necessarily sterile although the cytoplasm is sterile. This is due to the presence of genetically controlled restorer factor, 11 Rf 11
•
(2) C-G male sterility permits the same genotype to exist in three different forms: S llf([o s 1 sterile fertile fertile
(d) Problems encountered with use of male sterility in hybrid seed production.
(1) Modifier genes influence the percision of genetic male sterility systems and these modifiers are somtimes lost during the transfer of the 11 MS 11 gene into other lines.
(2) May maintain unwanted genes or cytoplasmic factors. Example Tms and susceptibility to southern corn leaf blight.
(3) Failure to properly identify and/or utilize sterile, normale, restorer or maintainer lines.
E. Use of male sterility in hybrid seed production

1. Keep in mind (1) that cytoplasmic male sterility is carried only through the female parent, therefore, the state of the cytoplasm is immaterial in the immediate cross since it will appear normal (fertile) in the presence of the Rf gene, (2) genetic fertility genes are dominant over all sterility controlling factors.

2. Maize
(a) Plant breeders develop inbreds but seed technologists often must maintain normal, genetic sterile, cytoplasmic sterile, restorer lines.
(b) Normal and restorer lines can be maintained by planting in isolation or by hand pollination.
(c) Sterile lines must be maintained by crossing isogenic male sterile and male fertile lines in isolated crossing blocks.
(1) Seed-s from the female rows of field using cytoplasmic sterility will all produce male sterile plants.
(2) Seeds from the female rows of fields using genetic sterility will produce offspring that are all fertile or 1/2 fertile and 1/2 sterile, unless the fertile plants are removed. For this reason genetic sterility is not of great practical importance in the production of hybrid maize.
(d) Production of single crosses for double-cross hybrid and production.
(1) Single crosses to be used as the female parent of a double cross
- female rows should be male sterile.
- male rows should be male fertile but without restorer.
(2) Single crosses to be used as the male parent of a double cross.
- female rows should be male sterile.
- male rows should be male fertile with restorer.

(e) Double cross production
1/2 of the production must be made without the use of sterility factors and then the fertile seeds blended withn the sterile seeds prior to the time they are distributed.
3. Hybrid seeds of crops with perfect flowers
(a) Most crops species have perfect flowers, therefore, the availability of parental lines - male sterile, maintainers and fertility restorers - are absolutely necessary for hybrid seed production on a commercial scale.
(b) Sorghum
(1) Breeder develops 11A11 lines (Cytoplasmic male sterile) 11B11 lines (maintainer) and 11R11 lines (restorer).
(2) Increase 11A11 line by planting in isolation with 11811 line the same as in maize; 1:2 or 2:4 ratio. 11R11 lines maintained in isolation.
(3) Single cross fields are planted in isolation; 2:6, 2:8 or 4:12, 220 yards from other grain, 320 from forage, 440 from grass sorghums.
(c) Wheat, rice, pearl millet, sunflower, cotton.

(1) The development and testing of the "A" "B" and "R" lines are breeder responsibilities with each species having its unique techniques, although, they are similar to those for maize and sorghum.
(2) Maintanance of parental lines follows the same pattern as
that for hybrid sorghum for example pearl millet .
(3) Specific seed production difficulties
Wheat - low percentage seed set because of difficulties in pollen transfer and lesser expression of hybrid vigor.
Pearl Millet - parental lines have very low seed production potential but millet hybrids have been widely used in India since 1970.
Rice & Cotton - transfer of pollen from male to female parent is essentially a "hand" operation.
Hybrid cotton seed in India is all produced by hand pollination. Hybrid rice produced in China utilizes mechanical shaking of pollen onto rows of female parent. Sunflower - no particular problems. Hybrid seed are widely used in Argentina, Russia and U.S.A.
Horticultural crops - hybrid seeds of tomatoes, onions and many ornamentals are produced but except for onions essentially all this crops require hand pollination and some hand emasculation. Thus, the seed may be very expensive; $200-
$1,000/lb.

Benefits of Hybrid Breeding

Hybrids represent around 60 % of the oilseed rape grown in the United Kingdom today. The area has increased over the last few years as new, improved varieties become available, and farmers realise the real benefits hybrids have to offer. New hybrid breeding techniques allow greater genetic diversity to be introduced to varieties leading to enhanced levels of success in producing desirable agronomic characteristics.

Yield Advantage

In Germany, hybrids account for more than 84% of the oilseed rape area, 77% in France and about 99% in North America. These modern hybrids are helping average yields push upwards to 5t/ha. Farmer surveys have shown that on average, a hybrid can produce around 350-500kg/ha more than a conventional variety.

Oil Content

With bonuses being paid at 1.5% of the contract price for every 1% extra oil over 40% the importance of oil content to the overall profitability of a crop can not be ignored. Oil content is a very stable characteristic and with the increased reliability of seed yield given by a DSV hybrid this added benefit should not be underestimated.

Hybrid Vigour

It is well known that in general hybrids are more vigorous than conventional varieties. This means they are more able to compensate in the field under difficult growing conditions. Autumn vigour helps with establishment as well, closing crop gaps to reduce the number of landing areas for pigeons and recovery from weather damage after the winter. Spring vigour means a fast growth rate therefore the plants are less prone to pest damage. They also recover better from weather damage after the winter. This vigour also helps the plants out compete weeds if herbicide efficacy is poor, a common problem under adverse conditions.

Wider Sowing Window

Hybrids appear to have better establishment across a wide range of drilling dates and conditions compared with conventional varieties. Most hybrids offer the possibility of a later sowing date, which can be very important in a difficult year and in helping to spread the work load after harvest.

Reduced Seed Rates

Hybrids require lower seed rates to get the best performance. They perform best with a density of around 40 established plants/m². This allows the right canopy structure to establish and the lower population helps eliminate any risk of lodging. At the beginning of plant establishment a field of hybrid rape generally doesn't look as dense as a conventional field which is often sown at double the rate.

Reduced Plant Stress

Hybrid oilseed rape plants tend to suffer less from environmental stresses than conventional varieties. Hybrids are particularly useful in less fertile, more challenging situations, as the technology has been used to develop characteristics that help the plant overcome stress such as a lack of water or extreme cold weather, as well as improving yields. They are also more responsive to inputs than conventional varieties.

Drought Resistance and Root Structure

Hybrids have well developed roots which prove to be beneficial in common summer droughts. This extensive root system also improves nutrient uptake. Hybrids generally offer better utilisation of water and nutrients.

Stem Characteristics

Breeders are trying to combine characteristics that reduce the height of hybrids, increase standing power as well as improving genetics. DSV are in the process of breeding hybrids which are shorter and stiffer, for instance, Primus at 155cm is one of the shortest non semi dwarf varieties available. The height of hybrids can easily be controlled with the use of a plant growth regulator which is normally part of every fungicide spray programme. Therefore, in treated trials only very little difference in height is seen between conventional and hybrid varieties.