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Genetic Basis Modification in Heterosis for Develop Synthetic Variety

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SUMMARY

Scientists are required to meet the food needs of the era's rapidly growing population. As a result, introducing synthetic cultivars in the agriculture industry is one means of improving productivity. Plant breeding efforts in a wide range of cross-pollinated species produce synthetics and the specialised populations produced from them-known synthetic varieties that are considered totally equivalent to synthetic cultivars. Through the intercrossing of various genotypes with known superior combining capacity, a synthetic variety is created. To employ synthetic varieties in breeding methods, precise information about their selection method, development, application, source, and population formed from them must be available. As a result, the creation and usage of synthetic varieties in crop enhancement are discussed in this work...

INTRODUCTION

Heterosis and inbreeding depression are closely related phenomena. In fact, they may be regarded as the opposite sides of the same coin. Therefore, genetic theories that explain heterosis also explain inbreeding depression. There are three main theories to explain heterosis and, consequently, in breedings depression: (1) dominance, (2) over dominance, and (3) epistatis hypotheses.

Dominance Hypothesis

The dominance hypothesis was first proposed by Davenport. It was later expanded by Bruce, and by Keeble and Pellew. In simplest terms, this hypothesis suggests that at each locus the dominant allele has a favourable effect, while the recessive allele has an unfavourable effect. In heterozygous state, the deleterious effects of recessive alleles are masked by their dominant alleles. Thus heterosis results from the masking of harmful effects of recessive alleles by their dominant alleles. Inbreeding depression, on the other hand, is produced by the harmful effects of recessive alleles, which become homozygous due to inbreeding.

1. **Failure in the Isolation of Inbreds as Vigorous as Hybrids.** According to the dominance hypothesis, it should be possible to isolate inbreds with all the dominant genes. Such inbreds would be as vigorous as the F_x hybrids. However, such inbreds have not been isolated in many studies. But in some studies, it has been possible to recombine genes so that inbred lines as good as or superior to the heterotic hybrids were isolated.
2. **Symmetrical Distribution in F_2.** In F_2, dominant and recessive characters segregate in the ratio of 3 : 1. According to the dominance hypothesis, quantitative characters, therefore, should not show a symmetrical distribution in F 2. This is because dominant and recessive phenotypes would segregate in the proportion (3/4 + 1/4)", where n is the number of genes segregating. However, F_2's nearly always show a symmetrical distribution.

Overdominance Hypothesis

This hypothesis was independently proposed by **East and Shull** in 1908. This is sometimes known as single gene heterosis, superdominance, cumulative action of divergent alleles, and stimulation of divergent alleles. The idea of superdominance, i.e., heterozygote superiority, was initially put forth by Fisher in 1903; it was elaborated by East and Shull in 1908 to explain heterosis. According to overdominanc e hypothesis, heterozygotes at atleast some of the loci are superior to both the relevant homozygotes. Thus heterozygote Aa would be superior to both the homozygotes AA and aa. Consequently, heterozygosity is essential for and is the cause of heterosis, while homozygosity resulting from inbreeding produces inbreeding depression. It would, therefore, be impossible to isolate inbreds as vigorous as F_x hybrids if heterosis were the consequence of overdominance.

Evidence for Overdominance. There are not many clear-cut cases where the heterozygote is superior to the two homozygotes; in fact, overdominance has not been demonstrated unequivocally for any polygomic trait (see, Banga and Banga, 1998). This has been the biggest objection to the general acceptance of overdominance hypothesis. But there is no doubt that in the case of some oligogenes, heterozygotes are superior to the homozygotes. In case of maize, gene ma affects maturity. The heterozygote Ma ma is more vigorous and later in anthesis and maturity than the homozygotes Ma Ma and ma ma. Gustafsson has reported two chlorophyll mutants in barley that produce larger and more number of seeds in the heterozygous state than do their normal homozygotes. Simila rly, heterozygotes for the hooded gene in barley show a higher rate of photosynthesis than the two homozygotes.

In human beings *(Homo sapiens),* sickle cell anaemia is produced by a recessive genes which is lethal in the homozygous state. In Africa, the heterozygotes active advantage over the normal SS individuals because they are more resistant to malaria. Other case of heterozygote advantage is reported in Neurospora crassa (bread mold). Gene pab is concerned with the synthesis of/7-aminobenzoic acid. The heterozygote pab^+ pab is more vigorous and shows a faster growth rate than the two homozygotes pab pab and pab^+pab^+.

But the number of such genes where heterozygote superiority has been established beyond doubt is limited. There is a large number of cases, however, where heterozygotes for chromosome segments, e.g., inversions, etc., or complex loci are known to be superior to the homozygotes, However, the superiority of heterozygotes need not be a result of overdominance.

Comparison between Dominance and Overdominance Hypotheses

The two hypotheses lead to similar expectations, but they do differ from each other with respect to some expectations. The similarities and differences between them are listed below.

Similarities. The two hypotheses have the following similarities.

- Inbreeding would produce inbreeding depression.
- Outcrossing would restore vigour and fertility.
- The degree of heterosis would depend upon the genotypes of the two parents. In general, the greater the genetic diversity between the parents, the higher the magnitude of heterosis.

Differences.

The chief differences between the two hypotheses are

- Heterozygotes are superior to the two homozygotes according to the overdominance hypothesis, while according to the dominance hypothesis they are as good as the dominant homozygote.
- Inbreds as vigorous as the F, hybrid can be isolated according to the dominance hypothesis, but it will be impossible according to the overdominance hypothesis.

Synthetics and Composites Varieties

The possibility of commercial utilization of synthetic varieties in maize was first suggested by Hayes and Garber in 1919. synthetic varieties have been of great value in the breeding for those cross-pollinated crops where pollination control is difficult, e.g., forage crop species, many clonal crops like cacao, alfalfa (M.Sativa), clovers (Trifoulim sp.) etc. The maize improvement programme in India now places a considerable emphasis on synthetic varieties. The maize programme of CIMMYT. Mexico, is based on population improvement; the end-product of such a programme is usually a synthetic variety.

A synthetic variety is produced by crossing in all combinations a number of lines that combine well with each other. Once synthesized, a synthetic is maintained by open- pollination in isolation. Some breeders use the terms synthetic variety in a restricted sense : a synthetic variety is regularly reconstructed from the parental lines and is not maintained by open-pollination. A composite variety is produced by mixing the seeds of several phenotypically outstanding lines and encouraging open-pollination to produce crosses in all combinations among the mixed lines. The lines used to produce a composite variety are rarely tested for combining ability with each other. Consequently, the yields of composite varieties cannot be predicted in advance for the obvious reason that the yields of all the F_1's among the component lines are not available. Like synthetics, composites are commercial varieties and are maintained by open-pollination in isolation.

Germplasm complexes are produced by mixing seeds from several lines or populations of diverse genetic origin. The objective of germplasm complexes is to serve as reservoirs of germplasm. Germplasm complexes are experimental populations and they are not commercial varieties.

Operations in Producing A Synthetic Variety

Evaluation of Lines for GCA

GCA of the lines to be used as the parents of synthetic varieties is generally estimated by topcross or polycross test. The lines are evaluated for GCA because synthetic varieties exploit that portion of heterosis, which is produced by GCA. Polycross refers to the progeny of a line produced by pollination with a random sample pollen from a number of selected lines. Polycross test is the most commonly used test in forage crops. Polycross progeny are generally produced by open-pollination in isolation among the selected lines. The lines that have high GCA are selected as parents of a synthetic variety.

Production of A Synthetic variety

A synthetic variety may be produced in one of the following two ways.

1. Equal amounts of seeds from the parental lines are mixed and planted in isolation. Open-pollination is allowed and is expected to produce crosses in all combinations. The seed from this population is harvested in bulk; the population raised from this seed is the Syn_1 generation.
2. All possible crosses among the selected lines are made in isolation. Equal amounts of seed from each cross is composited to produce the synthetic variety. The population derived from this composited seed is known as the syn_1 generation.

Multiplication of Synthetic Varieties

After a synthetic variety has been synthesized, it is generally multiplied in isolation for one or more generations before its distribution for cultivation. This is done to produce commercial quantities of seed, and is a common practice in most of the crops, e.g., grasses, clovers, maize etc. But in some crops, e.g., sugarbeets, the synthetic varieties are distributed without seed increase, i.e., in the Syn1 generation. The open-pollinated progeny from the Syn_1 generation is termed as Syn_2, that from Syn_2 as syn_3 etc. The performance of Syn_2 is expected to be lower than that of syn_1 due to the production of new genotypes and a decrease in the level of heterozygosity as a consequence of random mating. However, there would not be a noticeable decline in the subsequent generations produced by open-pollination since the zygotic equilibrium for any gene is reached after one generation of random mating. The synthetic varieties are usually maintained by open-pollinated, and may be further improved through population improvement schemes, particularly through recurrent selection.

Factors determining performance of synthetic varieties

The yield of syn_2 would be less than that of syn_1 due to loss in heterozygocity as a result of random mating. The decrease in yield ability of syn_2 would depend on

1. The number of inbred lines and
2. On the difference in the yielding abilities of syn_1 and syn_0 generations.

By increasing the number of lines. By increasing the performance of syn1 By improving the performance of parental lines

Synthetic Varieties Development

The primary goal in developing synthetic varieties is to raise the gene frequency for specified characteristics (Hallauer and Eberhart, 2000). (1966). The primary notion in the construction of synthetic varieties is to take advantage of heterosis or hybrid vigour, as varieties are made up of inbreds with general combining capacity. Synthetic varieties, on the other hand, exploit heterosis to some extent because some inbreeding occurs to allow for open pollination in subsequent generations. Synthetic gene action is more additive, whereas hybrid gene action is more non additive (over dominance and epistatic) (Mohammed, 2013).

A synthetic variety is a variety created by crossing a number of inbred lines (with high GCA that mix well together) in any combination, and a synthetic variety is a variety created by crossing a number of inbred lines (with high GCA that mix well together) and a synthetic variety is a variety created by crossing a number of inbred lines.

CONCLUSION

In this century scientist are challenged in fulfilling the demand of the population with rapid increment. In addition the global warming is also increasing from day to day which leads like ELINO. In a consequence of this many farmers are suffering at this time in Africa. Synthetic varieties may take the vital role for doing so. As different varieties use this method of improvement for diseases resistance, as a method of multiplication and for conserving in germplasm for a long period of time it will be a suited choice of breeding for the future.

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