Vol.2 Issue-7, MAR 2022 (e-ISSN: 2582-8223)

Heterosis Response in Major Cereal Crops

Neha Rohila, Ankit Kumar and D.K. Janghel

Department of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar

ARTICLE ID: 058

Introduction

Hybrid vigor has been used as a synonym of heterosis. Hybrid vigor describes only the superiority of hybrids over their parents, while heterosis describes other situation as well. A vast majority of the cases of heterosis are cases of superiority of hybrids over their parents. The superiority of an F_1 hybrid may be in terms of increased yield, reproductive ability, increase size and vigor, better quality for ex. hybrids in onion show better keeping quality. The hybrids show earlier flowering and maturity, greater resistance to disease and pests, greater adaptability, faster growth rate and increase in number of plant parts.

Classical genetic concepts and the basis of heterosis:

The dominance model of heterosis is based on the hypothesis that in many genes slightly deleterious recessive alleles are complemented by superior dominant alleles in hybrids. According to this model, heterozygosity per se is not a prerequisite for heterosis. Instead, hybrid vigor is based on the combination of superior alleles at as many loci as possible.

The overdominance model attributes the superiority of hybrids to heterozygosity itself and hence allelic interactions at multiple loci. Several examples of overdominance have been reported in Arabidopsis species (erecta and augustifolia), maize (pl) and tomato (SFT) where a heterotic trait was conditioned by a single gene. In these examples, the trait was superior in its heterozygous over its homozygous state. However, heterozygosity cannot solely explain heterosis. For instance, in some species highly homozygous, modern inbred lines perform better than highly heterozygous hybrids developed some decades ago.

Neither the dominance nor the overdominance model can exclusively explain heterosis. However, they also do not exclude each other. Furthermore, epistatic interactions between different genes are likely to contribute to heterosis.

Heterosis in cross and self pollinated crops : In general cross pollinated crops show hetreosis, particularly when inbred lines are used as parents ex in maize, pearlmillet, sorghum, cotton , sunflower, onion, alfalfa etc. In self pollinated crops the magnitude of heterosis is generally smaller than that in case of cross pollinated species. But in some self pollinated crops heterosis is large enough to be used for production of hybrid varieties, e.g., rice, wheat. The chief drawback in the use of hybrid varieties in self pollinated crops is the difficulty in production of large quantities of hybrid seed.

Heterosis in maize: Heterosis is important in maize breeding and depends up on the level of dominance and diversity in gene frequencies. The manifestation of heterosis depends on genetic divergence of two parental varieties. Maize has great potential for heterotic manifestation and its exploitation. This could be the reason that number of hybrid varieties in maize is much higher than any other varietal types i.e., open pollinated, double cross, synthetics or three way crosses. It is endowed with significant amounts of heterosis for **grain yield** and other **agronomic traits.**

The performance of hybrid depends on the genetic makeup of the parents used. Therefore, selection of appropriate parents is the first step in maize hybrid breeding program. Based on inbred lines abilities to produce superior hybrids, maize parental lines have been grouped into heterotic groups. Further, certain cross combinations produce desirable off springs, whereas, other involving equally promising parents produce poor progeny. Therefore, selection should be based on the sound consideration of combining ability of parents is the most desirable and high yielding cross combinations could be combed out from a large number of combinations. The estimate of heterosis determined by heterosis over mid parent (average heterosis), better parent (heterobeltiosis) and best check hybrid (standard heterosis) for all the characters.

Heterotic response in wheat: Grain yield is clearly the economic trait of interest in hybrid wheat and the desired expression of economic heterosis can be achieved by matching yield and **yield components** from genetically diverse parents. Based on Cytoplasmic Male Sterility (CMS), Nuclear Male Sterility (NMS) as the sterility system for commercial hybrid production and reported maximum better parent heterosis ranging from 3-41% and standard heterosis, the comparison of a hybrid to a commercial cultivar, ranging from -4 to 32%. In a compilation of studies investigating several **yield components**, grain number per spike,

JUST AGRICULTURE
multidisciplinary e-Newsletter

spikes per plant, 1000 grain weight, harvest index, dwarf plant height and spike length were more frequently associated with the significant heterosis for **grain yield**, suggesting that there could be no separate gene system for yield per se as yield is an end product of the multiplicative interactions between its various component characters. This indicated that, on the average, a gene causing an increase in one character will also result in an increase in the other character or vise versa.

Heterotic response in rice: The initial breeding strategy to produce hybrids in rice relied on three breeding lines known as A line (the male sterile line), B line (responsible to maintain the genetic male sterility of the A line) and R line (used to restore the fertility of the A line and to produce the hybrid seed). The ideal system for these and other cross-pollinated crops would be the one-line method utilizing the apomixis system that allows preserving the right cultivar.

In rice breeding, most agronomic and grain quality traits are controlled by many genes each of, which has a relatively small effect on the overall phenotype. Breeders usually overcome this problem by multi environmental evaluation of replicated trials to capture the effect of the environment.

Morphological markers were the first generation of markers to be used for identification and selection for quantitative traits loci. Several efforts have been made to introgress useful genes into elite rice varieties through interspecific hybridization with varying amount of success. Recent breakthroughs in another culture and molecular biology provide greater opportunities for rice breeders to develop a new generation of rice varieties that are better adapted and high yielding. Chromosomal regions controlling various **agronomic traits** have been identified in rice. The QTL have been revealed through their association with molecular markers and by the year 2000, more than 1000 QTL have been documented in rice.

Most cereal crops are cross pollinated, however, the natural out crossing rate of 25% and heterosis yield of 28-47%. Exploitation of heterosis in cereal provides enhancing food security and represents a greatest applied achievement in the discipline of plant breeding.

JUST AGRICULTURE
multidisciplinary e-Newsletter