

⑥ Ganga hybrid Makka No 1 :- originated as (CM 100 × CM 100) × (CM 101 × CM 102) - double crossed, Resistant to lodging & Downy mildew. small round hard and yellow grains.
75% increased yield maturing in 80-90 days.

④ HYBRID BAJRA - Plants of hybrid Bajra much taller and show increased vigour. The no. of seeds per ear is increased at many places. Bajra is used as fodder & therefore its luxuriant growth of hybrid is very useful.

Hybrid Bajra No. 1 released by IARI in 1965 developed from male sterile Melon RB 1MS × B 2L-3B, yield 110% more than standard variety like 155.

3) HYBRID SORGHUM - Heterosis & cytoplasmic sterility has been found in sorghum hybrid show luxuriant growth good tillering and bear many more healthy seeds per year. Some varieties are - CSH No. 1, CSH No. 5, yield is 60-80% drought resistance.

4) HYBRID FODDER CROP - crop like pseudo Giant Napier grass is a African Napier grass (Rn = RB) & cultivated Bajra (Rn = 14) being are interspecific hybrid it show abnormal increase and high sterility.

5) HYBRID COTTON :- Hybrid cotton plant show better growth, larger cotton fibre and increase size and no. of bolls. But we do not have a means to ensure cross pollination in nature therefore on a large scale utilization of the hybrid vigour in cotton is not possible at the moment.

In more complicated forms, the heterozygous gene combination $a_1 a_2$ is superior to either of the homozygous gene combinations $a_1 a_1$ or $a_2 a_2$. The $a_1 a_2$ perform different functions and the product produced by their combination is more vigorous than the single product produced by either allele in the homozygous condition.

This theory then suggests that there is something inherent in the heterozygous condition that brings about hybrid vigour and that the greater the no. of heterozygous alleles, the greater will be the hybrid vigour in the organism.

The relative ^{importance of these} mechanisms of heterosis is dominance & overdominance remains yet to be determined. In most of the cases both the hypotheses lead to the same plant.

ROLE IN CROP IMPROVEMENT

Hybrid vigour or Heterosis is expressed in plant as increased height, vegetative growth & reproductive yield. This results in an increase in size of cells, leaves, flowers, seeds etc. In most of the cases the hybrid become resistant to most of the diseases & in some instances even the longevity of plant is increased.

Heterosis has been widely & successfully utilized in breeding.

1) HYBRID CORN At present hybrid Maize accounts for 90% of corn planting of the world. Hybrid corn plants bear longer ears, the no. of ears per plant is more, each ear has many more rows of larger and hard their seeds and the plants are disease & pest resistant.

2) Deccan hybrid Makka :- originated as $(CM 104 \times CM 105) \times (CM 202 \times CM 201)$. Double crossed resistant to lodging downy mildew produce bold bright yellow green high yielding variety 145% more than local maize in 100-110 days.

may have another set of dominant genes.
 The crossing may bring all these dominant genes together into one hybrid
 rise to a hybrid vigour.

example - Let us suppose two inbreds A & B are crossed to produce F₁ hybrids where A has got the genotype AAbbCCDDEE & B has got genotype aaBBccdd ee in which A, B, C, D & E are dominant genes each contributing some towards the height of hybrid. In the absence of dominance each Recessive gene contribute 1 cm towards the height.

Inbreed A	x	Inbreed B
AA bb cc DD EE		aa BB CC dd ee
Dominant genes = A + D + E		Dominant gene = B + C
= 3 x 5 = 15 cm		2 x 5 = 10 cm
Recessive gene = b + c		Recessive gene = a + d + e
= 2 x 1 = 2 cm		3 x 1 = 3 cm
Total height = 15 + 2 = 17 cm		Total height = 10 + 3 = 13 cm
F ₁ hybrid		
Aa Bb Cc Dd Ee		
Dominant genes = A + B + C + D + E		
5 x 5 = 25 cm		

In the above cross the height of two inbreds are 17 cm & 13 cm respectively while that of hybrid vigour from them is 25 cm. This illustrates that the hybrid has got more favourable dominant genes and for this reason it contains more vigour greater size and increased yield than either of its parents.

2) OVER DOMINANCE HYPOTHESIS :- The concept of this hypothesis was given independently by Shull & East (1908). On supposition that - Heterozygote is superior to either homozygote and hybrid vigour increases in proportion to the amount of heterozygosity.

What is Heterosis? Enumerate the theories of Heterosis and discuss its role in crop improvement.

The term Heterosis for the first time used by Dr. G.H. Shull coined and proposed in the year 1914. This term is derived from the Greek words heteros means 'different' & osis means 'condition'. Heterosis therefore literally means a different condition is different from their parents. When two homogeneous plants of genetically unlike constitutions are crossed together the resulting hybrids obtained from the crossed seeds are usually vigorous & productive, sturdier & taller than either parents. This increased productivity of the hybrids over the parents is known as Heterosis. Heterosis or hybrid vigour is the increased vigour growth or function of a hybrid over the parents resulting from the crossing of genetically unlike organisms.

Usually the term heterosis & hybrid vigour are used synonymously. But according to Pawar (1942-45) Heterosis & hybrid vigour refers to only the increased vigour & size while heterosis to both increased vigour or weakness of hybrids. Heterosis therefore of 2 types is Beneficial & Nonbeneficial Heterosis.

THEORIES OF HETEROSIS There are two genetic theories who explain the heterosis -

1) DOMINANCE HYPOTHESIS D.F. Jones (1917) proposed this hypothesis which based on the assumption that hybrid vigour results from bringing together the maximum no. of dominant favourable genes in F₁ hybrids. According to this concept the heterosis is conditioned by a large no. of hereditary factors in which favourable genes are dominant and unfavourable genes are recessive. The parents differ genetically from each other and therefore one inbred may have a certain set of dominant genes and another