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Bioactive Gibberellins as Heterosis and Overdominance Regulators in Maize: A Genetic Test (Zea mays)

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SUMMARY

Gibberellin levels were to blame for hybrids' superior growth habits (i.e., heterosis). If this is the case, plants with a lower capacity for producing gibberellin, such as maize homozygous for dwarf1 (d1), should have a lower heterotic response. For seven generations, the d1 mutation was introduced into two inbred maize lines, B73 and Mo17. Plants segregating for the dwarf phenotype were created by self-fertilizing introgressed inbred lines and making reciprocal crossings to produce hybrids. Several physical characteristics were measured. The hybrid dwarf plants showed no reduction of heterosis when compared to their regular siblings, according to the findings. These findings rule out the possibility that bioactive gibberellin modulation is a major underlying cause of the heterotic response.

INTRODUCTION

Heterosis, also known as hybrid vigour, is the improved performance of a hybrid plant when compared to the better of the two parents. Heterosis has traditionally been considered in terms of genetic principles like as dominance and overdominance (Birchler et al. 2003). Finally, it is necessary to comprehend the molecular foundation of heterosis. Gibberellin levels have been proposed as the reason of robust plant development associated with heterosis (Paleg 1965; Sarkissian et al. 1964). Exogenous gibberellin A3 (GA3), a synthetic analogue of gibberellin A1 (GA1), was found to be more responsive in inbred maize plants than in hybrids (Nickerson 1959; Rood et al. 1983, 1990).

A dwarf is a maize mutant that lacks the ability to produce bioactive GAs or is unresponsive to their presence. The dwarf 1 (d1) gene encodes a factor that is involved in the conversion of GA20 to GA1 as well as GA20 to GA5 and GA5 to GA3. The homozygous recessive d1 mutants are unable to synthesise any bioactive version of GA and have a phenotype that indicates a reduction in bioactive GA levels (Spray et al. 1996). Short, compact plants with shorter internodes, short broad leaves, and short erect tassels, the d1 mutants have trouble extruding anthers (Neuffer et al. 1997). The notion that genetic manipulation of GA levels influences heterosis was tested in this study. We created near-isogenic lines that segregated for d1 and subsequently hybrids that segregated for d1 as well. If the fundamental basis of heterosis is modification of the GA level, then d1/d1 hybrids should have little or no heterotic response compared to d1/d1 inbreds.

The heterotic response seen in hybrid dwarves suggests that heterosis is unrestricted by decreasing levels of bioactive GA. The hypothesis that GA modulation is a governing factor in maize heterotic response is not supported by this finding. If modulation of bioactive GAs constituted the basis of heterosis, the dwarves' heterotic reaction would have been severely limited. Another study found that GAs are not responsible for interspecific heterosis in poplars (Pearce et al. 2004). Even though *Populus trichocarpa* has greater GA concentrations than *Populus deltoides* due to faster elongating shoots, the hybrids had GA levels equivalent to the slower growing species while having heterosis for shoot elongation.

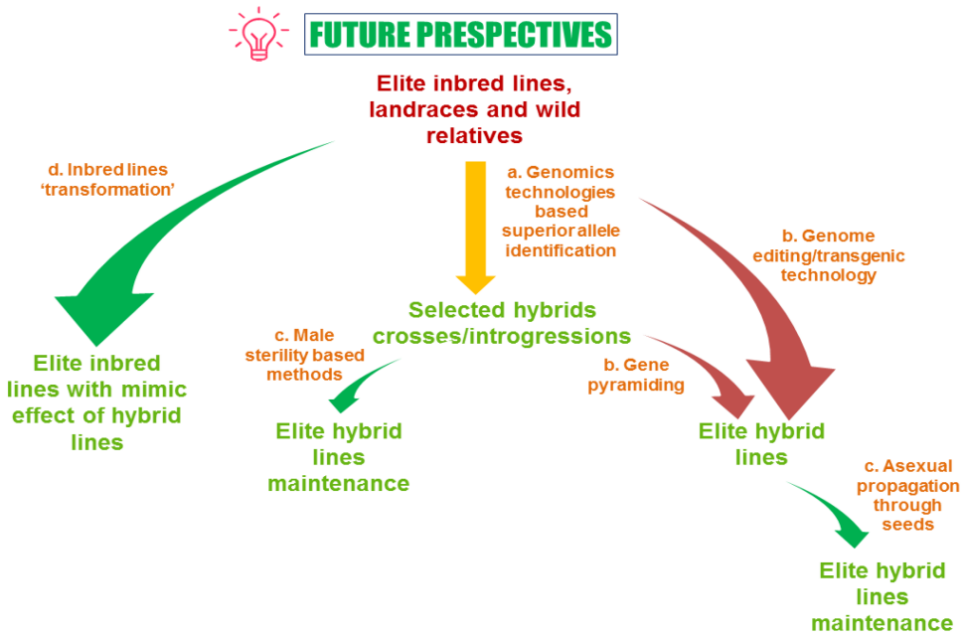

Fig 1. Heterosis breeding in egg plant

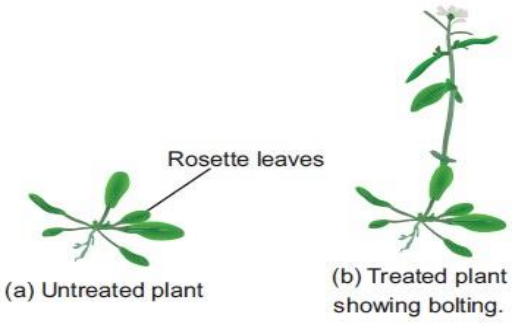

Fig 2: GA impact on physiological growth

Internode length and GA level had a negative connection among F2 descendents, which was surprising. Previous research in maize (Paleg 1965; Rood et al. 1988, 1990; Sarkissian et al. 1964) suggests that GAs could be a target of the heterotic response, if not the underlying mechanism. When considering heterosis at the cellular level, rate-limiting factors affect growth potential in terms of cell size and cell division rate. Clearly, the ultimate restrictions are the availability of resources such as energy, water, and necessary nutrients, but the ability to collect and absorb these resources efficiently comes in second. GAs have the ability to induce more efficient metabolism of these resources, making them heterosis targets. If all of the physiological systems are running at maximum capacity, exogenous GAs should have little stimulatory effect. Exogenous GA will stimulate those processes if GA metabolism is decreased to the point where it becomes rate limiting for the processes it regulates. When compared to maize hybrids, exogenous GA had a significant effect on inbreds, demonstrating that it was a rate-limiting factor in inbreds but not in hybrids. 's findings could be explained by this hypothesis.

CONCLUSION

The fact that hybrid poplars grew faster with lower GA levels than the faster growing parental genotype suggests that factors other than GA were rate limiting and were influenced by heterosis. It's likely that GA levels in hybrid poplars have been reduced to get the best stimulatory signal. The current research suggests that GA modulation is not the primary underlying cause of heterosis. The basis of hybrid vigor requires more investigation.

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