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Chapter 19

Potential Heterosis Associated with Developmental and Metabolic Processes in Sorghum and Maize

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INTRODUCTION

Organizers of this symposium recognized the enormous value of heterosis or hybrid vigor in increasing world wide production of sorghum [*Sorghum bicolor* (L.) Moench], maize (*Zea mays* L.), and other crops along with the need for further increasing the rate of production improvement in view of our rapidly expanding population. They further recognize that our knowledge about the genetics, physiology, biochemistry or molecular bases of hybrid vigor is meager. Expanding such knowledge should enhance our ability to better use hybrid vigor if we are able to successfully discover the approximate limiting order of yield dependent traits for which useful heterotic responses can be found. This may be especially true in applying newer biotechnology techniques if we can characterize the limiting functional traits in question in sufficient biochemical detail and if the corresponding working genes can be cloned.

Definitions of heterosis vary somewhat but usually have general commonality with the definition given by Brewbaker (1964) "Heterosis is a genetic expression of the beneficial effects of hybridization." Again, increased use of heterosis to achieve yield gains will likely depend considerably on advancing our understanding of heterosis developmentally and metabolically in a sizable proportion of the individual yield limiting processes that contribute to Brewbaker's total "beneficial effects of hybridization". How do we go about developing this understanding to better use heterosis?

Development of grain is complex involving many essential processes over a long period of time. One cannot hope to investigate all processes and must, therefore, narrow the research focus first by determining critical growth stages and then estimating the yield limiting order of major contributing developmental process and their controlling metabolic (biochemical) processes within stages. Determining critical developmental stages is difficult but has been achieved to reasonable degrees for a number of crops; however, characterization of controlling biochemical processes is sparingly addressed. Discerning any biochemically limiting factors requires finding or often developing contrasting genotypes or germplasm pools for the character(s) in question. Developing appropriate germplasm is often a productive practical exercise in itself. Even without knowing controling biochemical process details, excellent screening progress can be made on things like abiotic stresses simply by knowing the sensitive developmental stages and pressuring the germplasm with the abiotic stresses desired. Useful commercial germplasm can emerge from screenings set up to study biochemical contrasts.