Chapter 7

Inbreeding and Heterosis

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INTRODUCTION

The inbred-hybrid system outlined by Shull (1908, 1909) and East (1908) still remains as the most important breeding scheme for the commercial production of hybrid seeds. To accomplish the purpose of hybrid seed production two phenomena are inevitably involved as the genetic framework toward the exploitation of genetic effects: inbreeding and heterosis. The inevitable consequence of inbreeding is the increase in the level of homozygosity that leads to a depressive effect in the expression of traits, known as inbreeding depression. Heterosis refers to the increase in the expression of quantitative traits in the cross between divergent parents, so that different alleles existing separately in the parents appear in the hybrid in heterozygous condition; the high proportion of heterozygosity in the hybrid is then a natural consequence of hybridization and the basis for heterosis expression. Despite the magnificence of the inbred-hybrid system in the context of grain production all over the world, as evidenced by the hundreds of thousands of new inbred lines and hybrids produced and tested each year, the genetic, physiological, and biochemical bases of inbreeding and heterosis still remain largely unexplained (see Stuber, 1994). Also, despite the multitude of investigations for detecting and quantifying inbreeding and heterosis effects, consistent results attached to strong scientific arguments are not available at the desired levels. A review on inbreeding and heterosis concepts and their values for a better understanding of the inbred–hybrid system for hybrid seed production are the objectives of this work.

INBREEDING

Inbreeding is a mating system in which matings occur between relatives (consanguineous mating). The negative effect of inbreeding, inbreeding depression, has been known since ancient civilizations and is due to recessive deleterious alleles in the homozygous state. In quantitative genetics inbreeding depression is quantified by the reduction in the mean that occurs only under nonadditive genetic effects. The increase of homozygosity or the decrease in the frequency of heterozygous genotypes is a natural consequence of inbreeding and reaches its maximum rate through selfing, the most extreme form of inbreeding. Other less severe forms of inbreeding lead to slower increases in homozygosity and the rate of increase depends on the degree of relationship between the mating parents. The inbreeding coefficient \( F \) is the probability of randomly uniting gametes having alleles identical by descent. So \( F \) is the probability of homozygosis where the homo-