Heterosis and Combining Ability in Upland Cotton—Effect on Yield

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IN RECENT years the subject of heterosis, or the manifestation of heterosis known as hybrid vigor, has received increased attention from cotton breeders. Heterosis was first utilized in obtaining increased production in asexually propagated plants. Through the use of male-sterility, gametocides, and imperfect-flowered plants, heterosis is now used to advantage in many species.

Considerable evidence exists (4) that heterosis is expressed in crosses between Gossypium hirsutum (Upland cotton) and G. barbadense (extra-long staple cotton). There are indications that heterosis may exist also in crosses among different varieties of Upland cotton and that varieties may vary considerably in combining ability. Data from crosses among three varieties of Upland cotton, in a study begun in 1954 at the Georgia Experiment Station, indicated that appreciable heterosis existed in intervarietal crosses. Because of these favorable results, a larger study designed to obtain further information on heterosis and combining ability of other varieties was begun in 1956. The purpose of this paper is to report the magnitude of the heterotic effect in crosses among four varieties of Upland cotton.

REVIEW OF LITERATURE

Loden and Richmond (4) presented a thorough review of work on heterosis in cotton. One of their conclusions was that the maximum heterotic effect was obtained in the F1 generation and few significant increases in yield occurred in subsequent generations. Ware (8), working with crosses between G. hirsutum and G. barbadense, found that heterosis occurred in the F1 generation of species crosses in cotton but was not expressed for all plant characters.

In discussing heterosis in intraspecific crosses, Kime and Tilley (3) reported that the general assumption had been made that heterosis did not occur in crosses within cotton species. However, Brown (1) reported that F1 hybrids were frequently larger, more vigorous, and more productive than their parents. Loden and Richmond (4) were of the opinion that the list of intraspecific crosses in which a considerable amount of heterosis had been exhibited has been rather extensive if all the cases observed were recorded and published.

Simpson (6) studied 7 varieties of cotton obtained from 2 sources. Seed produced in the field were called inbred, and seed produced in the greenhouse subjected to natural crossing were called crossed. Differences were recorded for various characters and the differences were found to be more for most characters. However, the yield of the crossed seed exceeded that of the inbred in each of the 7 varieties, the range in yield increases being 5.7 to 44%. The individual differences were more and less required for significance. In Simpson's study the crossed seed sources produced an average of 15% more than the inbred seed sources.

Turner (7) reported yield increases of 18% over the best adapted inbred lines and their 45 single crosses. General combining ability was calculated for yield per plot, seed per boll, and lint index. There were 7 hybrid selections grown in 1947. Kime (2) conducted a number of tests involving 10 inbred lines and their 45 single crosses. Specific combining ability was calculated for yield per plot. No important discrepancies were noted between general combining ability, that is, parents high in general combining ability also exhibited high specific combining ability.

EXPERIMENTAL PROCEDURE

The study was begun in 1956 using 4 varieties of cotton ('Empire WR', 'Pope', 'Plains', and 'Stoneville 7') adapted to the Piedmont Area of Georgia as parents. These were chosen because of farmer acceptance and because they represent a range of different genetic groups of American Upland group of cultivated cottons. The study was an attempt to determine the small genetic differences within these varieties grown commercially in this area. Although diversity is limited among these four varieties, there is sufficient genetic variation to make a study of combining ability feasible. Adequate foundation seed of each variety was obtained and stored to provide planting stock for parent entries for the following 3-year period of the study.

Diallel controlled crosses were made in the field with the 4 varieties, making a total of 6 single crosses. Several bolls of each variety were covered with brown kraft paper bags to produce seed of the first selfed generation. The bags were selfed to produce S1 seed for the next generation. Enough crosses were made to produce sufficient seed for each cross for the 3-year experiment. About 100 seeds were planted per plot, giving a total of 600 seed per plot or 6000 seed per treatment with 15 replications per treatment. The treatments were not divided into blocks.