Heterosis and Combining Ability for Plant Height and Developmental Data in a Diallel Cross of Two Species of Cotton

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RESULTS for yield and components of yield in intraspecific and interspecific crosses of *Gossypium hirsutum* L. and *G. barbadense* L. have been reported in a previous paper (6). It was found that the main factor for heterosis in yield in both types of crosses was the increase in the number of bolls produced. This trait is a product of the number of flowers produced by the plant, and the percentage of these flowers that are retained as mature bolls. The number of bolls produced might also be influenced by the time of flowering, time of maturity, vegetative height of plants, and their tendency to lodge. These traits will be discussed in the present paper.

Loden and Richmond (5) reviewed some of the early papers dealing with these traits in cotton hybrids. Ware (7) studied the interspecific cross 'Pima' (*G. barbadense* L.) × 'Upright' (*G. hirsutum* L.) and found that it was much higher than the parent varieties. Heterosis for height was mainly caused by heterosis for node length, while the number of nodes was similar to that of the Pima parent.

Data for flowering and earliness in cotton hybrids have been reported by very few workers. Kime and Tilley (4) found that interspecific *G. hirsutum* L. hybrids produced more flowers at the beginning of the flowering period, and matured their bolls somewhat earlier than the parents. Jones and Loden (2) also reported that interspecific *G. hirsutum* L. crosses matured earlier than the parent varieties. Worley found that the interspecific hybrid 'Pima 32' × 'Acaca 44' flowered earlier than its parents and produced more flowers. White and Richmond (8) did not find heterosis for plant height, days to anthesis of first flower, or earliness in a diallel cross among five primitive and foreign *G. hirsutum* L. varieties. They reported that variance for general combining ability was significant for these traits, while variance for specific combining ability was not significant.

Kearney and Peebles (3) reported that *F*₁ progenies of an 'Acaca' × Pima cross shed 24% of their bolls, as compared to 67–81% and 9–19% of the Acaca and Pima parent varieties, respectively.

### MATERIALS AND METHODS

Two diallel cross experiments, involving varieties of *G. hirsutum* L. and *G. barbadense* L. were carried out in 1959 and 1960. These experiments have been described and results for yield and its components were given in a previous paper (6).

The *G. hirsutum* L. varieties were: (1) 'Acaca 4–42'; (2) 'Coker 100 W'; (3) 'Empire'. The *G. barbadense* L. varieties were: (4) 'Pima 32'; (5) 'Pima S-1'; (6) 'Ashilma'. The 15 crosses and the 6 parents were planted in 1959 at Rehovot, Israel. There were 5 replications in a Youden-Square design. In 1960 a second experiment was planted from which Pima S-1 and its crosses were excluded. The *F*₁ single crosses were made reciprocally in the preceding year. The 20 reciprocal crosses and the 5 parents were planted at the same location in 6 replications of a 5 × 5 lattice square design.

Both experiments were on fertile sandy loam, under irrigation. Each plot consisted of a single row, 3 m. long, with 1.50 m. spacing between rows. Planting was in hills spaced 25 cm., and seedlings thinned to 2 plants per hill.

The date of flower initiation was recorded when at least two open flowers per plant had appeared. Seed cotton was harvested at frequent intervals (10 harvests in 1959, 8 in 1960). The mean date of maturity was calculated by the method of Christidis and Harrison (1) as the mean, weighted by the yields of seed cotton at each harvest, of the maturity date of all the harvests. Height of plants was measured for three random plants in each plot. One height measurement was taken in July, when the plants started to flower, and a second measurement at the end of the season.

Flowers were counted once a week, interpolated for the week, and their total number for all the season estimated on this basis. The data for the number of bolls produced (6) were used to calculate the percentage of bolls retained. Lodging was scored 5 times during September, using the following 'lodging index': 0—no lodging, 1—slight lodging, 2—medium lodging, 3—severe lodging, 4—complete lodging. Average results of all five observations are given. Data for flowering, percentage bolls retained, and lodging index were available only for 1959.

There were no significant differences between the reciprocals of any cross in 1960. Therefore only the averages of these reciprocal crosses will be presented in the results.

Analysis of variance was computed for each year separately. The crosses were subdivided into 3 groups: *G. hirsutum* L. × *G. hirsutum* L., *G. barbadense* L. × *G. barbadense* L., and *G. hirsutum* L. × *G. barbadense* L. Variances among the groups and within each group were calculated. The variance within the *G. hirsutum* L. × *G. barbadense* L. group was subdivided to general and specific combining ability effects, as in a factorial design. In estimating the components of variance, varieties were assumed to be fixed effects.

**RESULTS**

The Expression of Heterosis

Heterosis, expressed as percent increase of hybrid performance above the average of the parents is given in Table 1.

Most of the hybrids started to flower earlier than the average of their parents. The interspecific crosses flowered earlier than the earliest parents in 1959, and almost as early as them in 1960.

There were no significant heterotic effects for mean date of maturity in 1959, but in 1960 the interspecific crosses matured later than the average of the parents, though not as late as the *G. barbadense* L. parents.

Significant heterosis for plant height was found in 1959 for the *G. hirsutum* L. intraspecific crosses, and in both years for the interspecific crosses. Environmental conditions in 1960 were not as suitable for vegetative development of *G. hirsutum* L. varieties as in 1959. This was probably the reason that no heterosis for the intraspecific crosses of these varieties was evident in 1960.

Heterosis for the number of flowers produced was significant for the *G. barbadense* L. intraspecific crosses and for the interspecific crosses. A smaller and non-significant heterosis for this trait was observed in the *G. hirsutum* L. intraspecific crosses.

The cumulative number of flowers for 1959 is presented in Figure 1. Flowering of *G. hirsutum* L. varieties and their