Differential Response of Corn Hybrids to Shade

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An earlier brief paper pointed out a striking parallel between the grain yield of 11 corn hybrids in shade and in dense plantings. Hybrids tolerant of thick planting were also tolerant of shade, and hybrids less tolerant of thick plantings were less tolerant of shade. It is thus apparent that differential yield response of various hybrids at high planting rates is in part a differential response to shading. Further tests have confirmed the previous results and have provided additional information on the nature of the differential response to shade.

Materials and Methods

In 1960 four hybrids were chosen from those used in the previous work: 2 were tolerant and 2 were intolerant of dense planting. All were single-cross hybrids having the inbred C103 in common (Table 1). Tests were planted at the Lockwood Experimental Farm, M. Carmel, Conn., in a cloth shade tent in randomized blocks with five replications. Rows were 3 feet apart with plants thinned to 1 foot apart in the row. Each plot contained 10 plants. The same design was duplicated in the open.

The tent was covered with 2 layers of shade cloth; these reduced the light intensity 45%. Sixteen hundred pounds of 5-10-10 fertilizer were applied before planting and 200 pounds of 16-0-0 fertilizer were applied later as sidressing. Moisture was plentiful throughout the season.

Each plant was tagged and individual records made of grain and stover yields, height, stalk diameter, dates of tasseling and of silking, and the length of silk growth beyond the husk. For supplementary studies, 2 additional replicates consisting of 16 plants per plot were included. On these plots photosynthesis was estimated by measuring carbon dioxide absorption, stalk rot was evaluated, and sugar was determined in the stalks.

The corn was planted May 23 and harvested September 13 after a hurricane caused severe lodging in the tent. At harvest the ears in the tent contained 60% and ears in the open 55% moisture.

Results and Discussion

Grain yields—Table 1 lists the grain yields obtained. The data were analyzed by an analysis of covariance procedure, the total weight of the plant taken as a covariate with grain yield.

In the open the yields of three hybrids were identical. One tolerant hybrid, P334×C103, yielded significantly more. The yields of all hybrids were significantly reduced in the shade, but the tolerant and intolerant hybrids did not respond alike in this respect (Figure 1). Yields of the tolerant varieties were reduced 50%, compared to an average reduction of 86% in the intolerant hybrids. This difference in response to shade was highly significant.

In our earlier experiment both reduction in average ear weight and increase in ear barrenness contributed to the reduced grain yields in shade, with barrenness exerting the more important effect. The effect of barren ears is even more dramatically revealed in the 1960 results. In the tolerant hybrids barren ears increased from 1% in the open to 15% in the shade. Barrenness in the intolerant varieties, on the other hand, increased from 5% in the open to 76% in the shade.

Growth—Since the yield results were anticipated, an attempt was made during the season to determine the cause of the barrenness of intolerant hybrids in a shade environment. As shown in Table 1, there were no detectable differences in the size of the tolerant and intolerant shoots. All hybrids were 15% taller in the shade. The stalk diameters were reduced 12 to 19%. All of the hybrids in the shade lodged in the hurricane whereas very few of the plants in the open lodged. Few plants were broken in either the shade or the open. Thus general growth and appearance did not suggest any reason for the differential response of the hybrids.

Photosynthesis—The differential response in shade is a response to a changed light condition. Therefore, differences in the photosynthetic mechanisms of the hybrids could conceivably account for the differences in yield. Photosynthesis was determined by comparisons of fodder weights and by direct measurements in the field. If root weights of the plants are proportional to shoot weights, the fodder weights in Table 1 give an integrated measure of the net photosynthesis for the season. Although grain yields in the shade were markedly different, the weight of the total shoot or the fodder of tolerant and intolerant hybrids were equal in shade but significantly less than the dry weights in the open. However, in the open the intolerant hybrids produced more fodder, the difference being significant at the 5% level of probability. Thus, the intolerant hybrid fodder yields were reduced relatively more than the tolerant hybrid yields, 41% compared to 34%. This difference was also significant.

The direct photosynthesis measurements were made in the open and shade by enclosing 8 plants in portable plastic chambers and determining the difference in CO₂ concen-

Figure 1—Yield in sun and shade, a—Intolerant hybrid (P158×C103) in the open; b—Tolerant hybrid (P334×C103) in the open; c—Intolerant hybrid in shade; d—Tolerant hybrid in shade.