Density Response of Corn to Shading

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Yield of corn per unit area can be increased by increasing plant densities, through maximizing total light interception by the canopy. The response of grain yield to density increase however, is parabolic. In other words the grain yield would decline if the corn population exceeds an optimum density. This varies with genotype and environmental factors. Reduction in grain yield at high densities is mostly due to an increase in ear barrenness and/or a decrease in number of kernels per ear. Artificial shading has similar effects as high densities.

A 2 year field study was conducted 1987 and 1988 at the Agricultural Experiment Station Farm in South Deerfield, Massachusetts. A single-ear late maturity corn hybrid (Agway 584S) was planted on 7th and 4th of May in 1987 and 1988 respectively. Three densities of 3(low), 7.5(medium), and 12(high) plants m^{-2} together with two light levels (ambient light intensity and shade) were used in this study. Shade was provided using black polypropylene fabric with 50% light reduction. Shade cloths were put above the plants 44 days after emergence, and were adjusted weekly to keep them approximately one meter above the plants.

All plants in all treatments completed their tasseling 86 days after planting(DAP)(Fig.1). Plants at low densities in shade and full light reached 100% silking 2 days after 100% tassel emergence. However, time for 100 percent silking in the full light level was delayed by 5 days as the density increased from 3 to 7.5 plants m^{-2} (Fig.2.). In high density about 10% of the plants did not show any silk even 9 days after tassel emergence. An interaction existed between shading and density. With shade, 9 days after 100% tassel emergence, 25% and 50% of plants in medium and high densities respectively had no silk. Even if these plants were to produce silk later, they would remain barren due to desynchronization between pollen shed and silking. These results can be related to decreased kernel number per ear, number of barren plants, and therefore to the total grain yield in response to increasing density and shading.

In full sun light, biological yield showed a typical asymptotic response leveling off at medium density. With shade no response to density was found(Fig.3a). Response of total grain yield in full light to increasing density was parabolic (Fig.3b). However, when light intensity was decreased by 50%, grain yield decreased with increasing density. The reduction in grain yield with increased density was primarily due to an increase in barrenness.

At low density there was not an earless stalk even with shading. However, the number of barren stalks increased linearly as the density increased. Shading intensified this effect. In full light at high density 15% of the plants were barren compared to 50% in reduced light, high density plots. These effects can be related to the desynchronization of pollen shedding and silking.

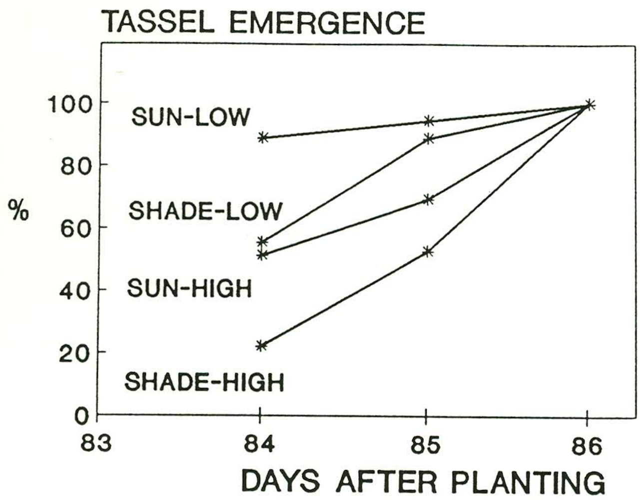

Figure 1. Density and shade effect on tasselling.

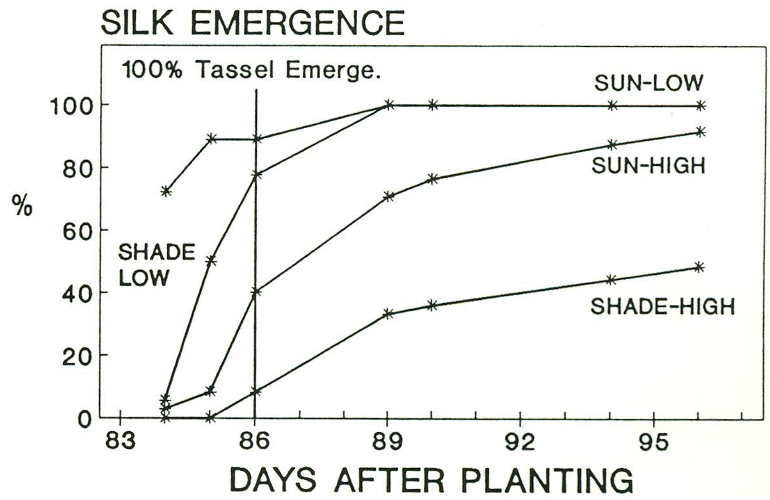

Figure 2. Density and shade effect on silking.

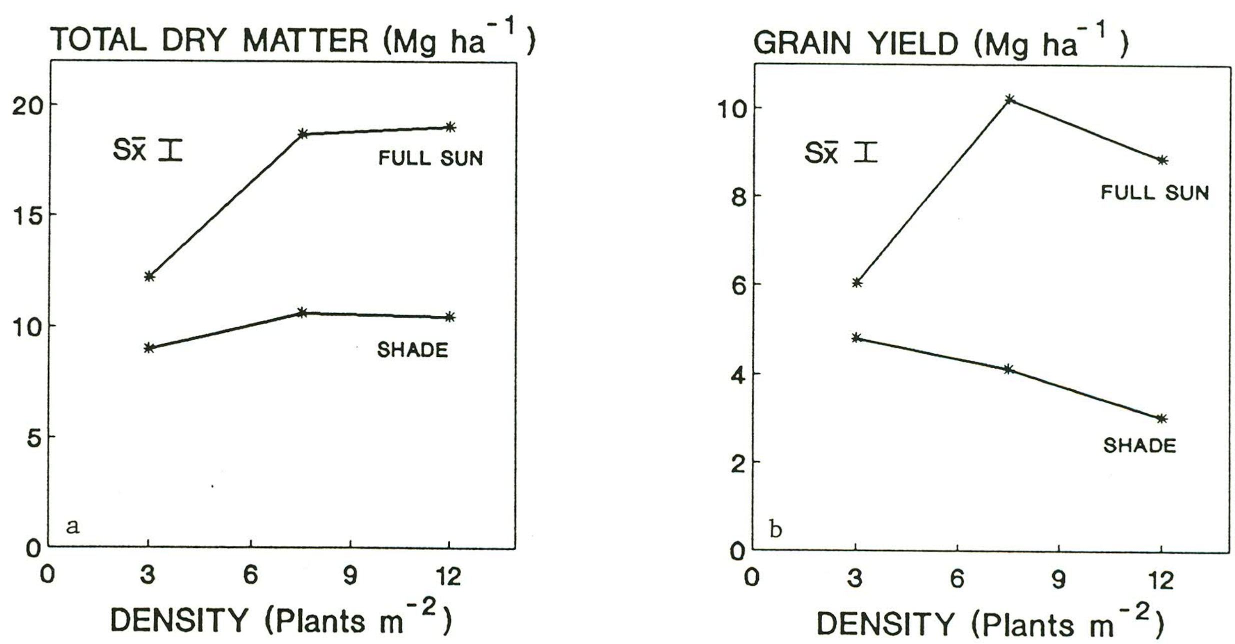

Figure 3. Effect of density and shading on (a) biological yield and (b) grain yield.

Among the other yield components, kernel number per row was greatly reduced with increased density and was intensified with shading. High density plants in full light had 45% fewer kernels per row compared to low density plants. In reduced light this reduction was 77%. The most probable causes of the reduction in kernel number are poor pollination due to the increased interval between pollen shed and silking and also reduced assimilate supply due to reduced light caused by increased density and the shade cloth.

Kernel size was also significantly decreased by density, more so than row number per ear but less than kernel number per row and ear per plant. Kernel size reductions in full light were 23 and 28% in medium and high densities respectively. Shading caused a 13% reduction in kernel size at low density. However, it did not cause further reduction in kernel size in medium and high densities when compared with kernel size in these densities in the full light condition. Adjustments in kernel number per row perhaps compensated for the light reduction allowing remaining kernels to fill to a similar size to those in the full light condition.

Number of rows per ear showed the least effect under either shading or high density. Shading had no significant effect on row number per ear and the amount of reduction in high density, though significant, was less than 10% compared to low density.

In summary, the effects of high density and shading on yield and yield components were similar. Shading intensified the density effect. The primary effect of reduction of available light is reduced photosynthesis. However, reduction in light level also decreased the yield by postponing silk emergence which in turn caused the reduction in kernel number and the increase in barrenness.