Above-Soil Environment Limits Yields of Semiprolific Corn as Plant Population Increases

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The grain yield of individual corn plants is greatly influenced by the number of plants per unit of land area. Usually as the plant population is increased, the grain yield of individual plants is reduced. However, the total grain yield per unit may increase because the small decrease in yield per plant is offset by the increase in plant numbers. The reduced production of individual corn plants with increasing population is due to increased environmental stress resulting from greater competition among plants. This is a report of an experiment designed to study the effect on corn of above-soil environmental stress at different plant populations by providing a similar below-soil environment at all populations.

MATERIALS AND METHODS

Florida experimental semiprolific (2-eared) hybrid corn, Zea mays L. (F44 X F6) X (4B281), was planted on plots through the center of a larger corn field on Arredondo fine sand. Plots were separated from outside of the field by 8 or more rows of corn. Plots were 8 rows wide and 18 feet long. Plants were spaced equidistant in the drill on the 38-inch-wide rows at populations of 6,000, 12,000, and 18,000 plants per acre. Nearly perfect stands were obtained by seeding 2 to 3 kernels per hill and thinning to 1 plant when seedlings were at 5-leaf stage. Seeding date each year was March 30. Population treatments were replicated 3 times in a completely randomized block design. The same field location on the Agronomy Farm, Gainesville, Florida, was used in both experimental years, 1961 and 1962.

Two open-topped steel drums 15.4 inches in diameter and 20 inches deep were buried in the soil of each plot until 1 1/2 inches of drum protruded above the surface. The center of each drum corresponded to the normal location of a hill of corn within a plot. The bottoms of all drums were filled with a 3-inch layer of washed unsorted gravel. Two drums in plots having 6,000 plants per acre population were built in lysimeters, so that water percolating through drums could be collected and measured. The other drums had perforated bottoms covered with fine plastic screens which allowed excess water to pass into the natural subsoil. The drums were filled to outside soil level with the Arredondo fine sand. Per-acre rates of 3 tons of dolomitic limestone, 1 1/2 tons of 0–10–20 fertilizer, 100 pounds of ammonium nitrate, and 30 pounds of a complete fritted minor element mixture (FTE 501) were mixed with soil each season on the basis of surface area of the drum. Beginning 6 weeks after seeding, a complete nutrient solution was applied weekly to plants in drums and continued until plants were mature. Water and nutrient solutions were applied so as not to disturb the plants in drum row and adjacent rows. All drums received the same treatment and management so that plants growing in drums would have similar soil conditions regardless of the surrounding plant population.

The corn rows without drums were cultivated twice with a tractor. At the same time the drum row was cultivated by hand with push plows and hoes. Sprinkler irrigation was used to bring soil in plot area to field capacity when a 1.25-inch soil moisture deficit occurred. Soil moisture levels were estimated by the bookkeeping method, using a daily evapotranspiration rate of 0.25 inch. The corn plants in drums received additional uniform applications of water to the surface. The amount of additional water applied was enough to saturate the soil in drums and cause a little leachate to drain from lysimeter drums. Extra irrigation to drums increased with age of plants until it was applied daily when plants were above 4 feet in height.

Fertilizer application per acre to plots outside the drums totaled 335 pounds N, 80 pounds P, 265 pounds K, 10 pounds Mg, 3 pounds Zn, 25 pounds fritted complete minor element mixture (FTE 501), and 350 pounds dolomitic limestone in 1961. In 1962 the plot area received per acre rates of 1 ton of Fairfield basic slag, 260 pounds N, 44 pounds P, 100 pounds K, 3 pounds Zn, and 25 pounds complete minor element mixture (FTE 501). The nutrients supplied were considered to be satisfactory to fulfill the requirements of the corn plants at all populations used.

Grain yields were determined for each individual plant in the drums. Grain yields of normal field plots were determined from 13.7-feet row lengths on the 2 rows adjacent to the row containing drums. Harvested ears were dried to uniform moisture at 130°F.

RESULTS AND DISCUSSION

The average yield of ear corn per plant when grown in drums and normal soil at 3 populations is shown in Figure 1. The yield per plant in drums was reduced 22 and 21%, respectively, as the population was increased from 6,000 to 12,000 and 12,000 to 18,000 plants per acre in 1961. Corresponding decreases in plant yield were 17 and 19% in 1962. There was a highly significant decrease in plant yield as the population increased from 6,000 to 18,000 plants per acre in both seasons. The decreased yield of plants in drums as the population increased was attributed to the above-soil environment because the soil in drums was managed the same at all populations.

The average yield of ear corn per plant under field conditions also decreased with increasing population in a similar manner to that of plants grown in drums in both seasons. This suggests that the above-soil environment was also a principal causal factor under field conditions. Because of the heavy fertilization and supplemental irrigation, soil nutrients and water, the most common soil factors

Figure 1. Yield of corn per plant grown in drums and under field conditions at three plant populations in 1961 and 1962. The LSD at .05 level between population values for drums is .10 pound in both 1961 and 1962 and between population values for field is .13 pound in 1961 and .08 pound in 1962.

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