by Drs. J. M. Blumenthal and D. J. Lyon

Searching for a Right Balance in Plant Population and Nitrogen Fertility

Nebraska studies on dryland corn show interesting correlations between yields and management of plant populations and nitrogen fertility.

Summary: *Under favorable weather conditions we observed linear increases in yield with increasing plant populations. We observed similar responses with nitrogen (N) fertility where the weather conditions were favorable. At no site did we observe an interaction between plant populations and N fertilization. Optimal plant populations ranged from 7,000 to more than 23,000 plants/A. To maximize yields, a total N supply from soil and fertilizer of 210 lbs/A was required. To optimize yield, a total N supply of 140 lbs/A was needed.*

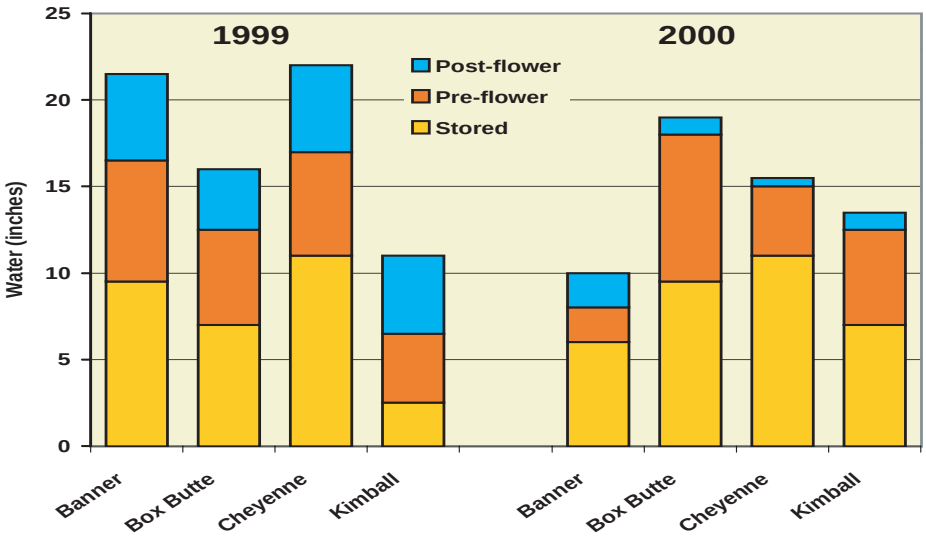

Figure 1. Total water stored plus growing season precipitation.

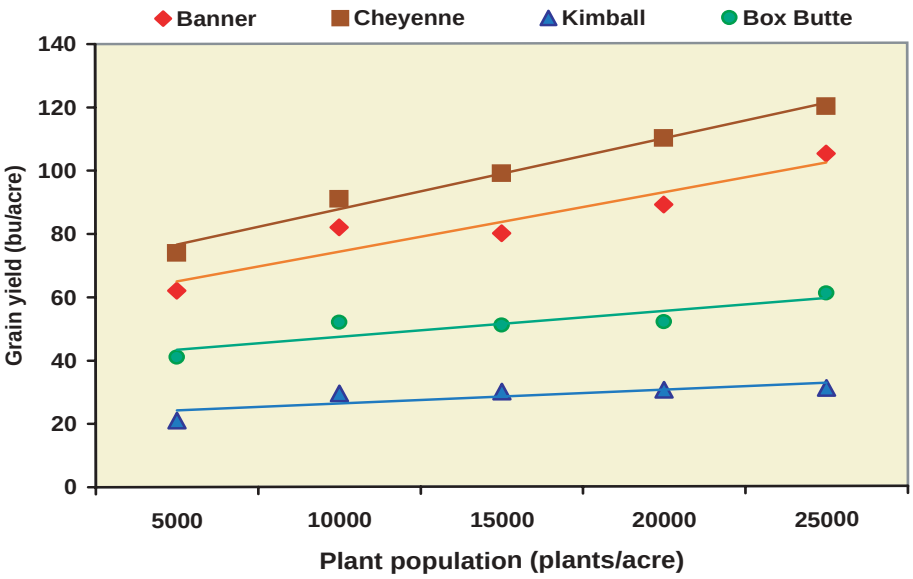

Figure 2. Effect of plant population on corn yield, 1999.

Although corn acreage increased more than seven-fold from 1995 through 1999 in semiarid western Nebraska, corn management recommendations are lacking for this area. The objectives of this study were to determine proper management practices for dryland corn relative to plant population and N fertility.

Weather

Dryland corn production, considering this is a relatively dry area with yields limited by rainfall, was exceptional throughout much of western Nebraska in 1999. The relative abundance of water (Figure 1) also was reflected in the grain yields for the sites. The Cheyenne County site yielded an average of 90 bu/A, the Banner County site 76 bu/A, the Box Butte County site 47 bu/A, and the Kimball County site 26 bu/A.

Dryland corn production in 2000, however, was more challenging. Seasonal precipitation was scarce. The Banner, Cheyenne, and Kimball sites received the lowest seasonal precipitation within the last 50 years. Cheyenne County yielded an average of

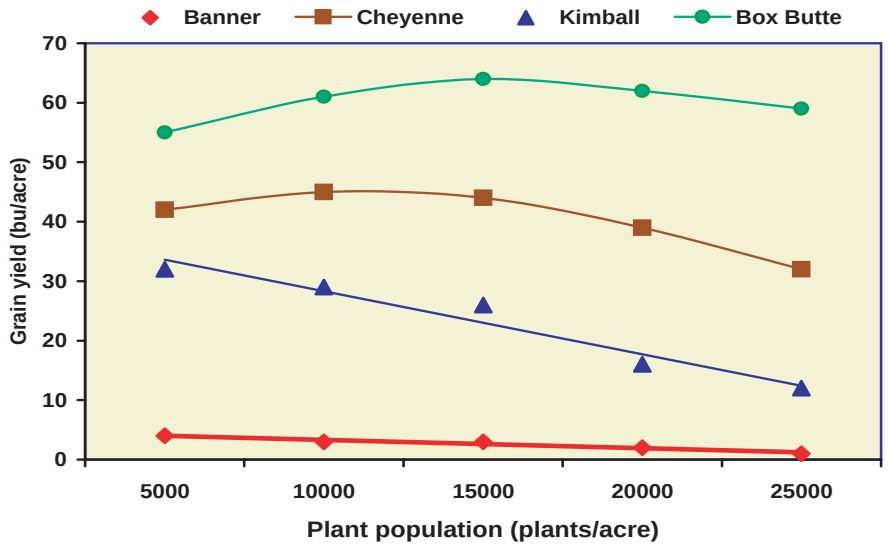

Figure 3. Effect of plant population on corn yield, 2000.

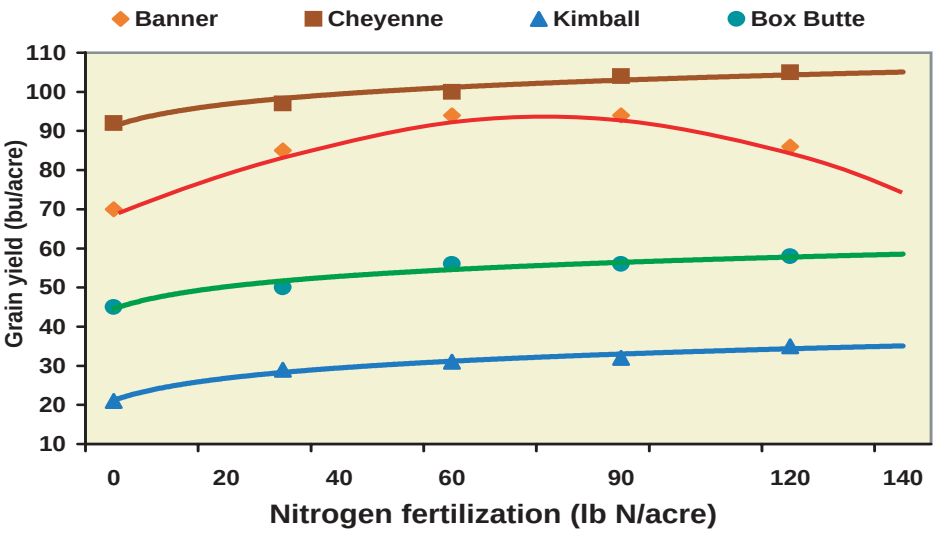

Figure 4. Effect of N fertilizer on corn yield, 1999.

34 bu/A and Banner County 2 bu/A. At the Box Butte and Kimball sites, yields were 50 and 20 bu/A, respectively.

Methodology

Sites. Field studies were conducted at four Nebraska Panhandle locations.

Experimental Design was a randomized complete block with a factorial treatment arrangement and five replicate blocks per site.

Treatments consisted of all combinations of five plant populations and five N fertilizer rates.

Hybrid. Pioneer 3893 was no-till seeded into winter wheat or proso millet (Panicum miliceum L.) stubble at a rate of 41,000 seeds/A.

Population. About three weeks after emergence, plants were thinned by hand to final stands of 7,000, 11,000, 15,000, 19,000, and 23,000 plants/A.

N rates. N was broadcast after corn planting but before emergence at rates of 0, 30, 60, 90, and 120 lbs/A.

Yields and population

1999. We observed linear increases in corn yield with increasing plant populations at the Banner, Cheyenne, and Box Butte county sites (Figure 2). Apparently, the three sites could have supported plant populations exceeding 23,000 plants/A to maximize yield. At the Kimball site, the lowest populations of 7,000 plants/A resulted in lower yields than the other population levels. Raising populations above 11,000 plants/A did not result in greater yields at that site.

2000. The relationships between plant population densities and yield were quite different from 1999. At the Banner and Kimball sites we observed a negative relationship between plant populations and corn yield (Figure 3). At the Box Butte and Cheyenne sites the relationship between plant populations and corn yield was a quadratic function. The plant population to maximize yield at Box Butte was 15,800 plants/A and at Cheyenne 11,800 plants/A. We did not observe an interaction between plant populations and nitrogen fertilization at any of the sites in either year. Developing a population recommendation based on the data collected in the two very different years has been difficult. However, using crop simulation modeling and nearly 50 years of historical climate data to supplement these data has provided a means for making a corn population recommendation for western Nebraska. Median corn yield was maximized at a plant population between 12,000 and 16,000 plants/A. As soil moisture prior to planting in the top 5 feet of soil increased from 6 to 9.5 inches, optimal population increased from 12,000 to 16,000 plants/A.

Yields and nitrogen

1999. Favorable growing conditions and vigorous plant growth resulted in a response to applied fertilizer N at all

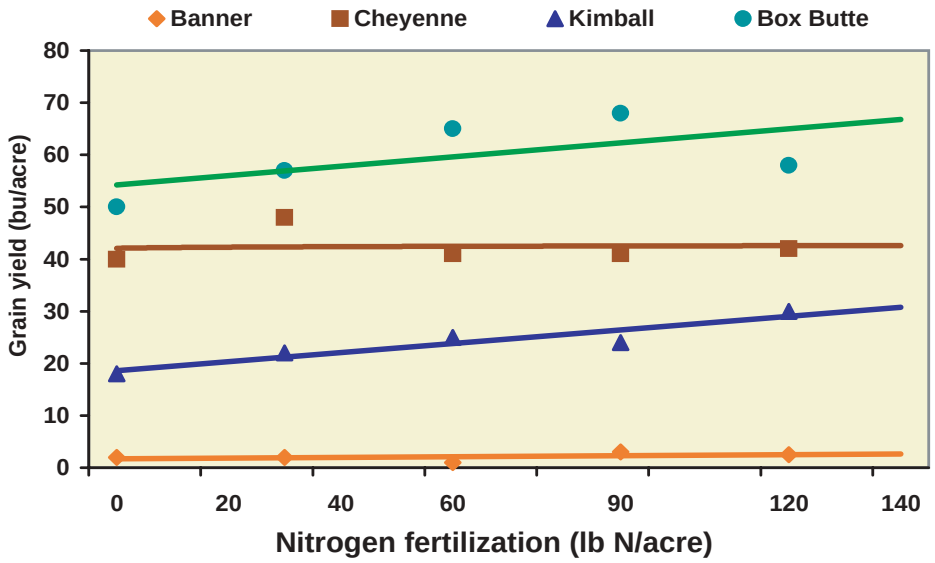

Figure 5. Effect of N fertilizer on corn yield, 2000.

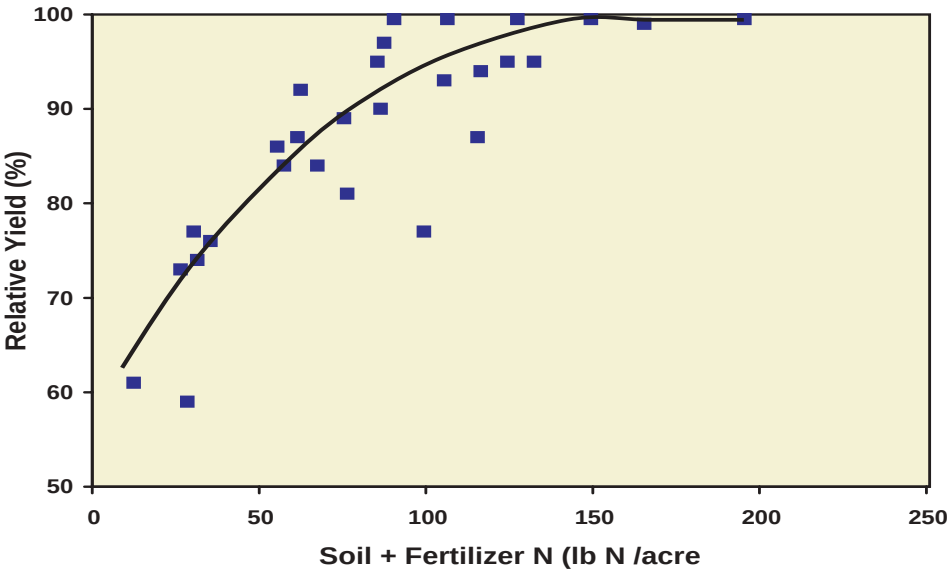

Figure 6. Relative corn yield as affected by N supply from the soil and fertilizer.

sites (Figure 4). N fertilizer rates to maximize yield were 150 lbs/A at Cheyenne, 117 lbs/A at Box Butte, 109 lbs/A at Kimball, and 75 lbs/A at Banner.

2000. We observed linear relationships between fertilizer N and corn yield at the Box Butte and Kimball sites, whereas fertilizer N had no impact on corn yield at Banner and Cheyenne (Figure 5). At the latter two sites, corn growth apparently was impacted by the unfavorable growing conditions to such a degree that residual N and N from mineralization were sufficient to supply adequate N.

Because yields varied greatly among sites during the two years, data were expressed on a relative basis (i.e., all yields expressed as a percentage of the N treatment with the highest yield at a given site and year) to normalize the response to N supply (Figure 6). Data from the Banner site in 2000 were excluded because at this site essentially no crop was produced. There was a strong relationship between N supply and relative yield. To achieve maximum yield, an N supply of 168 lbs/A was necessary. To optimize yield an N supply of 112 lbs/A was needed.

Dr. Blumenthal is assistant professor and Dr. Lyon is professor, Department of Agronomy, University of Nebraska.