2002

# Plant Population and Nitrogen Fertility Management of Dryland Corn

J. M. Blumenthal
*University of Nebraska-Lincoln*, jblumenthal1@unl.edu

Drew J. Lyon
*University of Nebraska-Lincoln*, dlyon1@unl.edu

Proceedings of the Great Plains Soil Fertility Conference,
Denver, Colorado, March 5-6, 2002, ed. Alan J. Schlegel.

# PLANT POPULATION AND NITROGEN FERTILITY MANAGEMENT OF DRYLAND CORN

J.M. Blumenthal and D.J. Lyon
University of Nebraska, Scottsbluff, Nebraska
jblumenthal1@unl.edu, (308) 632-1372

## ABSTRACT

Dryland corn (Zea mays L.) hectarage 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. In 1999 and 2000, experiments were conducted each year at four sites in western Nebraska. Experimental treatments were plant populations (17 300, 27 200, 37 100, 46 900, and 56 800 plants $ha^{-1}$) and N fertilizer rates (0, 34, 67, 101, and 134 kg N $ha^{-1}$) arranged in a randomized complete block with five replicate blocks. Corn grain yield varied from 300 kg $ha^{-1}$ to 5620 kg $ha^{-1}$. Optimal plant populations ranged from 17 300 to more than 56 800 plants $ha^{-1}$. To achieve maximum yield, total N supply from soil and fertilizer of 188 kg N $ha^{-1}$ was necessary. To optimize yield (95% of maximum) a total N supply of 125 kg N $ha^{-1}$ was needed. The amount of N supply required for optimal corn yields was not related to the yields obtained, and so fertilizer N needs of the crop can be estimated based on preplant soil samples.

## MATERIALS AND METHODS

Field studies were conducted in 1999 and 2000 at four Nebraska Panhandle locations in each year. The 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 corn plant populations and five N fertilizer rates. Corn, 'Pioneer 3893', was no-till seeded into winter wheat or proso millet (*Panicum miliaceum* L.) stubble at a rate of 103 000 seed $ha^{-1}$, and about three weeks after emergence plants were thinned by hand to final stands of 17 300, 27 200, 37 100, 46 900, and 56 800 plants $ha^{-1}$. Ammonium nitrate was applied broadcast after corn planting, but before emergence, at rates of 0, 34, 67, 101, and 134 kg N $ha^{-1}$.

Gravimetric soil water content was determined just prior to planting in 0.3-m increments to a depth of 1.2 m. Prior to planting, soil samples were taken in depth increments of 0- to 20-cm for determination of organic matter, pH, Bray-P1 phosphorus, and residual soil $NO_3$-N content, and of 20- to 122-cm for determination of residual soil $NO_3$-N content.

Grain was harvested from the middle two rows of each 4-row plot by combine. Grain test weight and moisture were determined along with sample weight. Sample weights were adjusted to a 130 g $kg^{-1}$ moisture content basis.

The data were analyzed using GLM procedures of the Statistical Analysis System (SAS Inst., 1999). Environments were analyzed separately due to significant site x year x treatment interactions. Regression analysis was used to determine the response functions for grain yield to corn plant populations and N fertilizer rate.

## RESULTS AND DISCUSSION

Dryland corn production was exceptional throughout much of western Nebraska in 1999. The relative abundance of water (Figure 1) also was reflected in the average yield for these sites. The Cheyenne Co. site yielded, on average, 5620 kg $ha^{-1}$, the Banner Co. site 4810 kg $ha^{-1}$, the Box Butte Co. site 2950 kg $ha^{-1}$, and the Kimball Co. site 1660 kg $ha^{-1}$.

Dryland corn production in 2000 was more challenging than in 1999. Seasonal precipitation was scarce. The Banner, Cheyenne, and Kimball Co. sites received the lowest amount of seasonal precipitation within the last 50 years. Consequently, in 2000 average corn yields in Banner (113 kg $ha^{-1}$) and Cheyenne Co. (2130 kg $ha^{-1}$) were much lower than in 1999. Yields in Box Butte (3140 kg $ha^{-1}$) and in Kimball Co. (1220 kg $ha^{-1}$) were similar to 1999 yields.

In 1999, we observed linear increases in yield with increasing plant populations at the Banner, Cheyenne, and Box Butte Co. sites (Fig. 2). Apparently, the three sites could have supported plant populations exceeding 56 800 plants $ha^{-1}$ to maximize yield. At the Kimball Co. site, the lowest population of 17 300 plants ha-1 resulted in lower yields than the other population levels ($P<0.05$). Raising population above 27 180 plants $ha^{-1}$ did not result in greater yields at that site.

In 2000, the relationships between plant population densities and yield were quite different than in 1999 (Fig. 3). At the Banner and Kimball Co. sites we observed a negative linear relationship between plant populations and corn yield. At the Box Butte and Cheyenne Co. sites the relationship between plant populations and corn yield was a quadratic function. The population to maximize yield in Box Butte Co. was 39 100 plants $ha^{-1}$ and in Cheyenne Co. 29 200 plants $ha^{-1}$. We did not observe an interaction between plant populations and nitrogen fertilization at any of the sites in either year ($P>0.1$).

Favorable growing conditions and vigorous plant growth resulted in a response to applied fertilizer N at all sites in 1999 (Fig. 4). Fertilizer rates to maximize yield were 169 kg N $ha^{-1}$ in Cheyenne Co., 131 kg N $ha^{-1}$ in Box Butte Co., 122 kg N $ha^{-1}$ in Kimball Co., and 85 Kg N $ha^{-1}$ in Banner Co.. In 2000, we observed linear relationships between fertilizer N and corn yield in Box Butte and Kimball Co., whereas fertilizer N had no impact on corn yield in Banner and Cheyenne Co. (Fig. 5). At the latter two sites, corn growth apparently was impacted by the unfavorable growing conditions to a degree that residual N, and N from mineralization, were sufficient to supply adequate N.

Because yields varied greatly among sites in the two years, data were expressed on a relative yield 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 (Fig. 6). Data from the Banner Co. site in 2000 was excluded, because at this site essentially no crop was produced. Relative yields at greater N levels than to produce maximum yield are not shown. There was a strong relationship between N supply and relative yield ($P<0.05$). To achieve maximum yield a N supply of 188 kg N $ha^{-1}$ was necessary. To optimize yield (95% of maximum) a total N supply of 125 kg N $ha^{-1}$ was needed.

## Figure 1: Total stored water plus growing season precipitation

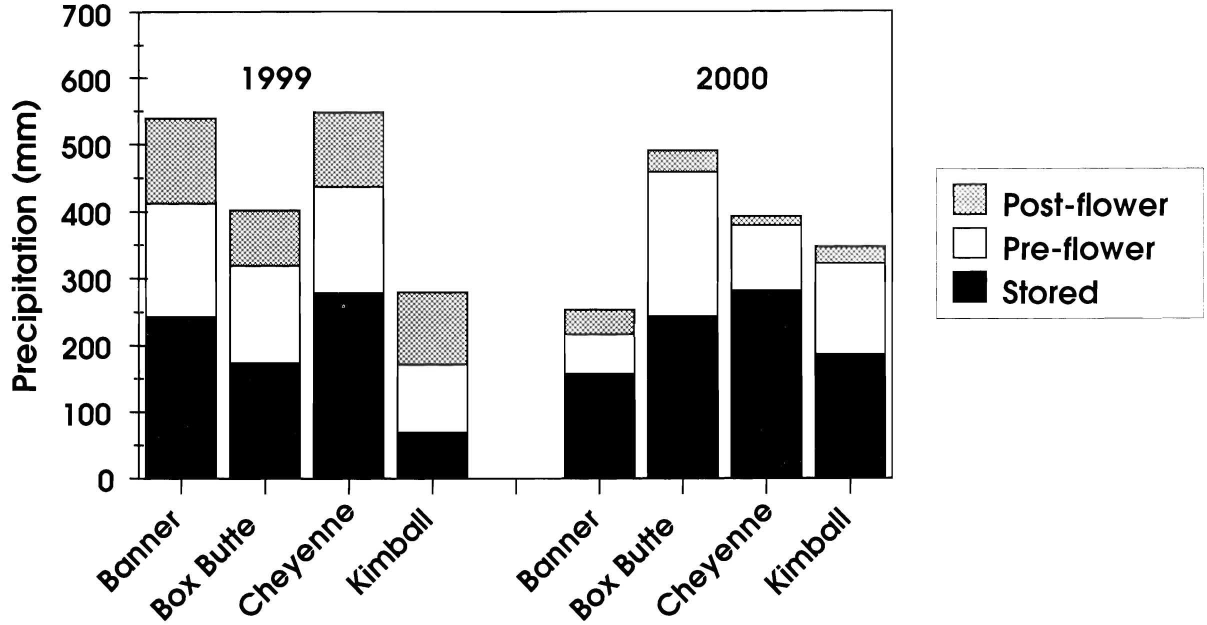


**Figure 2: Effect of plant population in 1999**

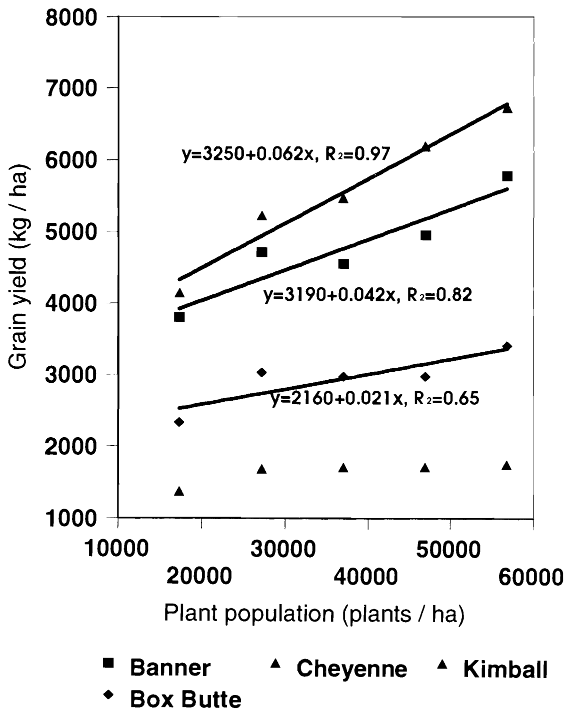


**Figure 3: Effect of plant population in 2000**

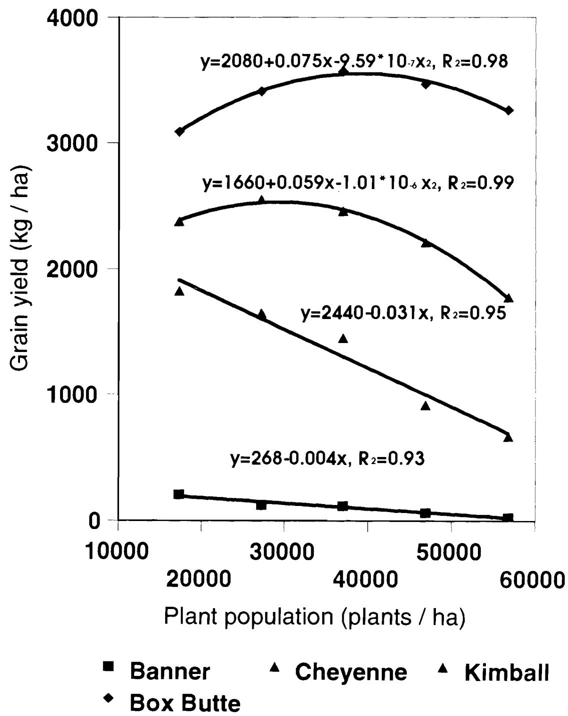

**Figure 4: Effect of nitrogen fertilizer in 1999**

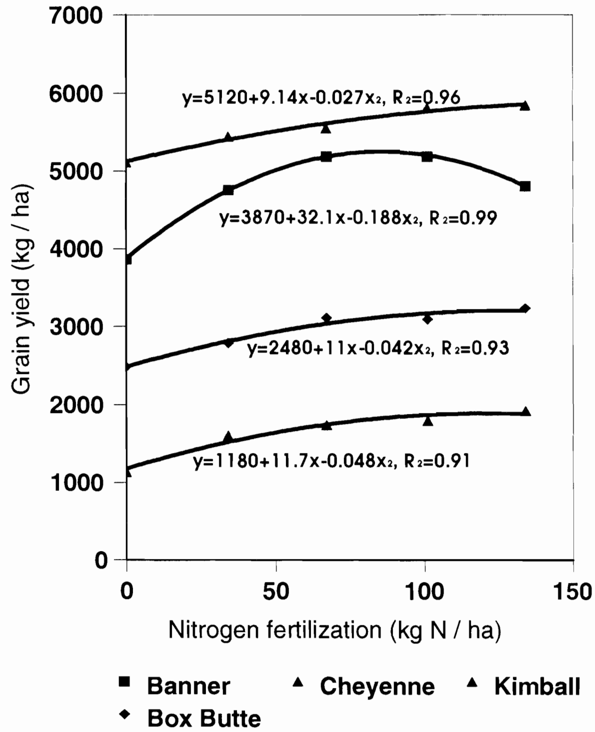


**Figure 5: Effect of nitrogen fertilizer in 2000**

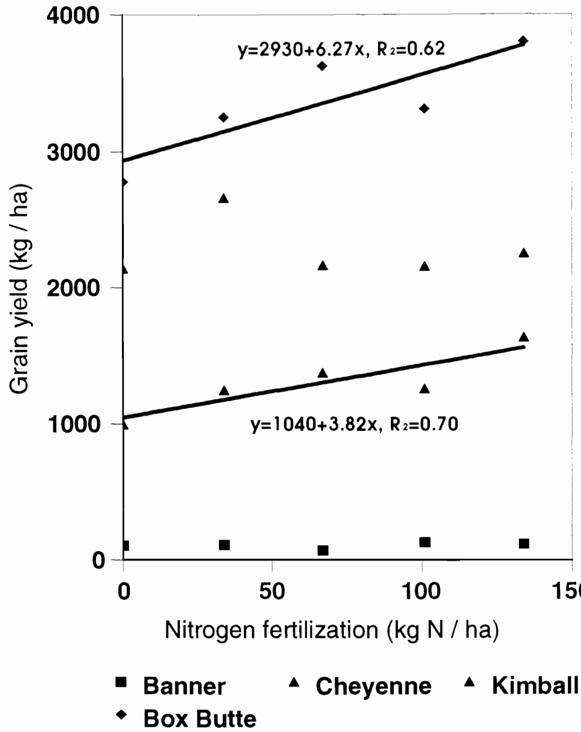


**Figure 6. Relative corn grain yield as affected by nitrogen supply from the soil and fertilizer**