Maximizing Irrigated Corn Yields in the Great Plains

By W.B. Gordon

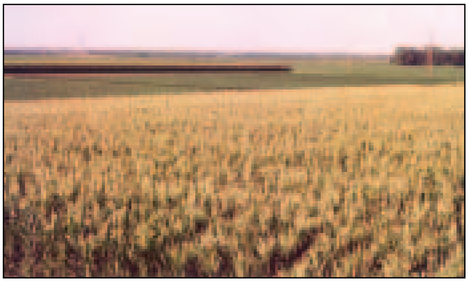
There is a large gap between attainable corn yields and present average yields. The overall objective of this work is to find practical ways of narrowing this gap. Two plant populations and two nutrient input levels were evaluated. With low fertility inputs, yields were decreased when population increased. However, corn produced significantly greater yield at the higher population with additional fertility inputs. One-third of the response to additional nutrient inputs was lost if plant density was not increased. This work further illustrates the importance of using a systems approach when attempting to increase yield levels.

With advances in genetic improvement of corn, yields continue to rise. Modern hybrids suffer less yield reduction under conditions of water and temperature stress. Hybrids no longer suffer major yield loss due to insect, weed, and disease infestations. Furthermore, newer hybrids have the ability to increase yields in response to higher plant populations.

Since 1970, the national average corn yield has increased at a rate of 1.8 bu/A/year. Corn yields reached an all time high of 142 bu/A in 2003, then jumped to a record 160 bu/A in 2004. However, yields obtained in university hybrid performance trials and in state corn grower contests have been even greater. The average corn yield increase during the period 1970-2003 in Republic County, Kansas, was the same as the national average. Meanwhile, yields in the Kansas State University (KSU) Irrigated Corn Hybrid Performance Test increased at the rate of 2.8 bu/A/year. There is a large gap between attainable yields and present average yields. One important aspect of yield advance is that it comes from synergistic interactions between plant breeding efforts and improved agronomic practices. Innovations in each field successively open up opportunities for the other.

The overall objective of this research project is to find practical ways of narrowing the existing gap between average and obtainable yield. This study evaluates more intensive fertility management at standard and high plant populations.

The experiment was conducted in 2000 through 2002 on a producer's field located in the Republican River Valley near the North Central Kansas Experiment Field at Scandia, on a Carr sandy loam soil. In 2003-2004, the study was conducted at the Experiment Field on a Crete silt loam soil. On the Carr sandy loam site, analysis by the KSU Soil Testing Laboratory showed that the initial soil pH was 6.8, organic matter was 2%, Bray-1 P was 20 parts per



More intensive fertility management at higher plant populations may be one approach to narrowing the yield gap between average and obtainable corn yields.

million (ppm [high]), exchangeable K was 240 ppm (very high), and sulfate-sulfur (SO_4-S) was 6 ppm. Soil test values for the Crete silt loam site were: pH, 6.5; organic matter, 2.6%; Bray-1 P, 25 ppm (very high); exchangeable K, 170 ppm (very high); and SO_4-S, 15 ppm. Both sites were in continuous corn and ridge-tilled. The experiment was fully irrigated. Irrigation was scheduled using neutron attenuation methods. Irrigation water was applied when 30% of the available water in the top 36 in. of soil was depleted. Treatments included two plant populations (28,000 and 42,000 plants/A) and nine fertility treatments.

Fertility treatments consisted of three nitrogen (N) rates (160, 230, and 300 lb/A) applied in two split applications (half preplant and half at V4) in combination with 1) current soil test recommendations for P, K, and S (this would consist of 30 lb/A P_2O_5 at these two sites); 2) 100 lb P_2O_5 + 80 lb K_2O + 40 lb SO_4-S/A applied preplant, and the three N rates applied in two split applications (half preplant and half at V4 stage); and 3) 100 lb P_2O_5 + 80 lb K_2O + 40 lb SO_4-S/A applied preplant with N applied in four split applications (preplant, V4, V8, and tassel). In 2001, treatments were included in order to determine which elements were providing yield increases. Additional treatments included an unfertilized check, 300 lb N/A alone, 300 lb N + 100 lb P_2O_5 /A, 300 lb N + 100 lb/ P_2O_5 + 80 lb K_2O/A, and 300 lb N + 100 lb P_2O_5 + 80 lb K_2O + 40 lb SO_4-S/A. Preplant applications were made 14 to 20 days before planting each year. Fertilizer sources were ammonium nitrate, monoammonium phosphate (MAP), ammonium sulfate, and potassium chloride (KCl).

Table 1. Interaction of plant population and fertilizer rates on irrigated corn yield. Carr sandy loam soil, 2000-2002.

Population, plants/A	$P_2O_5 + K_2O$ + S, lb/A[1] 30 + 0 + 0	100 + 80 + 40	Response
	- - - - - Grain yield, bu/A - - - - -		
28,000	162	205	43
42,000	159	223	64
Response	-3	18	

[1]Plus 230 lb N/A (half preplant; half at V4).

The results from the 3-year study on the Carr sandy loam soil clearly illustrate the interaction between plant density and fertility management (**Table 1**). Increasing plant density had no effect on yield unless fertility was increased simultaneously and one-third of the fertility response was lost if plant density was not increased. Fertility levels must be adequate in order to take advantage of the added yield potential of modern hybrids grown at high plant populations. Treatments added in 2001 and 2002 show that all three elements contributed to the yield response (**Table 2**). The addition of P, K, and S increased yield by 88 bu/A over the N alone treatment.

Table 2. Response of irrigated corn yields to application of N, P, K, and S. Carr sandy loam soil, 2001-2002. Rates of fertilization were 300 lb N/A, 100 lb P_2O_5/A, 80 lb K_2O/A, and 40 lb S/A.

Treatment	Grain yield	Response to inputs
	- - - - - bu/A - - - - -	
Unfertilized check	80	—
N	151	71
N + P	179	99
N + P + K	221	141
N + P + K + S	239	159
LSD (p<0.05)	10	

Results from the 2-year study on the Crete silt loam study were similar (**Table 3**). At the low fertility treatment yields were decreased when population was increased. When additional fertility was added, corn yield responded to higher plant populations. As in the experiment on the Carr soil, one-third of the fertility response was lost if plant population was not increased. Addition of P to the N increased yield by 56 bu/A (**Table 4**). Addition of K further increased yield by 13 bu/A, and adding S to the mix further increased yield by 9 bu/A. With both soils, yield increased with increasing N rate up to the 230 lb N/A rate. Increas-

Table 3. Interaction of plant population and fertilizer rates on irrigated corn yields. Crete silt loam soil, 2003-2004.

Population, plants/A	$P_2O_5 + K_2O$ + S, lb/A[1]		
	30 + 0 + 0	100 + 80 + 40	Response
	- - - - - - - - - Grain yield, bu/A - - - - - - - - -		
28,000	202	225	23
42000	196	262	66
Response	-6	37	

[1]Plus 230 lb N/A (half preplant; half at V4)

Table 4. Response of irrigated corn yields to application of N,P, K, and S. Crete silt loam soil, 2003-2004. Rates of fertilization were 300 lb N/A, 100 lb P_2O_5/A, 80 lb K_2O/A, and 40 lb S/A.

Treatment	Grain yield	Response to inputs
	- - - - - - - - - - bu/A - - - - - - - - - -	
Unfertilized check	137	—
N	187	50
N + P	243	106
N + P + K	256	119
N + P + K + S	265	128
LSD (p<0.05)	7	

ing the number of N applications from 2 to 4 did not increase yields on either soil in any year of the experiment.

Results of this experiment have shown a clear interaction between plant density and fertility management, thus illustrating the importance of using a systems approach when attempting to increase yield levels.

This 5-year study also points out the need for soil test calibration and fertility management research that is conducted at high yield levels. Standard soil test recommendations on these two soils would not have produced maximum yield. BC

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