# Maximizing Irrigated Soybean Yields in the Great Plains

By W. B. Gordon

**Several years of irrigated field research in north central Kansas clearly demonstrated the importance of complete and balanced nutrition in the production of high yield corn (Gordon, 2005). However, fertilization of soybeans in a common corn/soybean rotation has traditionally been secondary to corn fertilization, as the crop is usually left to scavenge nutrients remaining after corn. This study was started in 2004 as an expansion of the original corn research to determine the benefit of direct fertilizer application to sprinkler-irrigated soybeans. It has shown that the addition of P and K can have a significant impact on soybean yield, with 4-year average increases due to P and K as high as 34 bu/A. This experiment also demonstrated that Mn can impact soybean production in high yielding environments.**

Analysis of corn yield data from hybrid performance tests in north central Kansas show that corn yields have increased by an average of nearly 2.5 bu/A/year. Nationally, trends are similar. Soybean yield trends have also been on an upward swing, but the rate of increase is less than 1 bu/A/year. This increase can be attributed to genetic advances among other factors. Genes imparting herbicide resistance have been incorporated and many advances in disease resistance have occurred. Effective fungicide and insecticide seed treatments are now available for use in soybeans.

Despite the many advances, soybean yields have not improved as dramatically as corn. Fertility issues could be among the factors limiting yield improvement. Typically in a corn-soybean rotation, fertilizer is only applied during the corn phase of the rotation, despite the fact that on a per bushel basis soybeans remove nearly twice as much P and almost five times as much K as corn. With greater corn yield, more nutrients are removed and less is left over for the following soybean crop. To capitalize on genetic improvements in yield and technical advances in production, levels of plant nutrients must not be limiting. Other production practices such as plant population and row spacing may interact with fertility management to influence crop yields. The objective of this experiment was to develop cropping systems and fertility practices that will maximize yield of irrigated soybeans.

## Procedures

The experiment was conducted on a Crete silt loam soil at the North Central Kansas Experiment Field, located near Scandia. Treatments included soybean planted at two row spacings (30 and 15 in. wide) and two plant populations (150,000 and 225,000 plants/A). Fertility treatments consisted of a low P application (KSU soil test recommendations would consist of 30 lb $P_2O_5$/A at this site), low P-low K, low P-high K, high P-high K, N-P-K, and an unfertilized check plot. Phosphorus application rates were 30 or 80 lb $P_2O_5$/A, and K treatments were 80 or 120 lb $K_2O$/A. The N-P-K treatment consisted of application of 20 lb N, 80 lb $P_2O_5$ and 120 lb $K_2O$/A. A treatment was added in 2005 that included the same rate of N, P, K plus 5 lb/A Mn. Soil test values for the experimental area were: pH, 7.1; Bray-1 P, 12 ppm (low); and exchangeable K, 250 ppm (very high). The K source used was KCl and the P source was triple super phosphate. Fertilizer was broadcast in mid-March each year. The previous crop was corn. Each year, corn received 180 lb N/A and 40 lb $P_2O_5$/A. Whole plant soybean samples were taken at full-bloom for nutrient analysis. Plant heights were taken just before harvest. Whole plants were taken from a 10 ft. (3-meter) length of row at maturity for yield component analysis. Seed weight was determined from seed samples retained at harvest. The soybean variety Asgrow 3305 was planted in mid May each year. Soybeans were sprinkler irrigated, receiving an average of 8 in. of irrigation water during the growing season.

Abbreviations and notes for this article: N = nitrogen; P = phosphorus; K = potassium; Mn = manganese; ppm = parts per million.

**Soybean** yield responded to P and K fertilizer application in irrigated plots.

## Results

In no year of the experiment did increasing plant populations or reducing row spacing result in any increase in yield (**Table 1**). In 2004, increasing plant population in narrow rows

**Table 1.** Soybean yield as affected by row spacing and plant population (average over fertility treatments) 2004-2007.

| Row space | 150,000 plants/A | 255,000 plants/A |
|---|---|---|
| | - - - - - - - - - - - - yield, bu/A - - - - - - - - - - - - | |
| 30 in. | 78.2 | 77.6 |
| 7.5 in. | 78.4 | 76.6 |
| LSD (0.05) =NS* | | |

* Not significant at the 0.05 level of probability.

**Table 2.** Fertility effects on soybean yield, and whole plant tissue P and K concentration at full-bloom, 2004-2007 (average over row spacing and plant population).

| Treatments | Yield, bu/A | Whole plant P | Whole plant K |
|---|---|---|---|
| | | ----------- % ----------- | |
| Check | 50.3 | 0.222 | 2.61 |
| Low P | 68.8 | 0.245 | 2.59 |
| Low P-Low K | 77.8 | 0.248 | 2.99 |
| Low P-High K | 80.4 | 0.246 | 3.41 |
| High P-Low K | 84.7 | 0.292 | 2.97 |
| High P-High K | 84.8 | 0.300 | 3.39 |
| N-P-K | 84.9 | 0.294 | 3.42 |
| LSD (0.05) | 4.1 | 0.019 | 0.13 |
| CV%* | 4.2 | 5.1 | 4.9 |

* Coefficient of variation.

**In** 2 of the 3 years Mn was applied, average yield increase was 4.9 bu/A.

**Table 3.** Fertility effects on soybean yield components and plant height, 2004-2007 (average over row spacing and plant population).

| Treatments | Seed number per ft.$^2$ | Seed per pod, number | Seed size, grams/100 seed | Plant height, in |
|---|---|---|---|---|
| Check | 390 | 1.6 | 10.9 | 23.7 |
| Low P | 485 | 2.2 | 11.4 | 27.2 |
| Low P-Low K | 570 | 2.8 | 12.3 | 28.3 |
| Low P-High K | 614 | 2.9 | 13.5 | 28.4 |
| High P-Low K | 660 | 2.9 | 13.6 | 29.3 |
| High P-High K | 661 | 2.9 | 13.2 | 29.6 |
| N-P-K | 660 | 2.9 | 13.8 | 29.9 |
| LSD (0.05) | 23 | 0.9 | 0.5 | 1.1 |
| CV% | 12 | 8.1 | 4.3 | 2.6 |

* Coefficient of variation.

actually reduced yield. When averaged over all 4 years of the experiment, row spacing or plant population did not affect yield of soybean, nor was there a significant interaction among the three factors in the experiment

Soybean yield did respond to fertilizer application. Addition of 30 lb $P_2O_5$/A resulted in a 4-year average yield increase of over 18 bu/A (**Table 2**). Applying 80 lb $P_2O_5$ with 60 lb/A $K_2O$ increased yield by 34 bu/A over the unfertilized check plot. Applying additional K or adding N to the mix did not increase yields. Addition of P and K fertilizer significantly increased soybean tissue nutrient concentration at the full bloom stage of growth. Addition of fertilizer increased the number of seed, number of seed per pod, and weight of seed as well as plant height (**Table 3**). Direct application of P and K fertilizer is crucial in maximizing performance and yield of irrigated soybean.

In 2 of the 3 years that the Mn treatment was included in the experiment, Mn applied with N, P, and K resulted in an increase in soybean yield over the same treatment without Mn. Average yield increase was 4.9 bu/A in those 2 years. Manganese application can fit in a fertility program designed for maximum soybean yield. BC

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*Dr. Gordon is with the Dept. of Agronomy, Kansas State University, Courtland, KS 66939; e-mail: bgordon@oznet.ksu.edu.*

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## *Delayed-Flood Rice...from page 5*

other crops suggest that lower N rates can be used and still obtain increased early-season vegetative growth and grain yield (Vetsch and Randall, 2000; Kaiser et al., 2005). Finally, the recovery efficiency of starter N in rice is not well understood. Therefore, research is needed to address the dynamics of recovery of starter N applications in a delayed-flood rice production system. BC

*Dr. Walker (e-mail: TWalker@drec.msstate.edu) and Dr. Bond are with Mississippi State University – Delta Research and Extension Center, Stoneville. Dr. Norman is with the University of Arkansas, Fayetteville. Dr. Ottis is with RiceTec, Inc., Sikeston, Missouri.*

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