

by J.S. Reiter and Dr. D. R. Krieg

# Cotton Yields Respond To Phosphorus Fertigation

Texas research shows fertigation is a viable option to save cotton growers both time and money on fertilizer inputs.

*Summary: Multiple phosphorus applications in a complete nutrient mixture, including nitrogen (N) and sulfur (S) applied through center pivots using the LEPA mode, resulted in greater cotton yields than a single preplant application or split applications using sidedressing. The yield increase was due to a combination of greater fruit production and retention and larger fruit size (lint per boll). The 5:1 N:P<sub>2</sub>O<sub>5</sub> ratio optimized lint yields while using less P fertilizer. Increasing N:P<sub>2</sub>O<sub>5</sub> ratios from 5:1 to 5:3 resulted in a linear increase in lint per boll due to increased fiber mass per unit length (micronaire). Fertigation of complete N:P:S nutrient blends offers the irrigated cotton producer the flexibility to apply fertilizer based on yield potential and crop development stage.*

Increasing use of conservation tillage has resulted in greater usage of granular P-based fertilizer broadcast several months prior to planting cotton. The calcareous nature of Southern High Plains soils presents a major problem with P availability due to high pH (7.4 to 8.0) and the abundance of CaCO<sub>3</sub>, often at the soil surface. Under these conditions, Ca-P complexes rapidly form, reducing the availability of soluble P for plant use.

Cotton yields on the Texas High Plains are limited first by water supply. The seasonal rainfall provides only 50

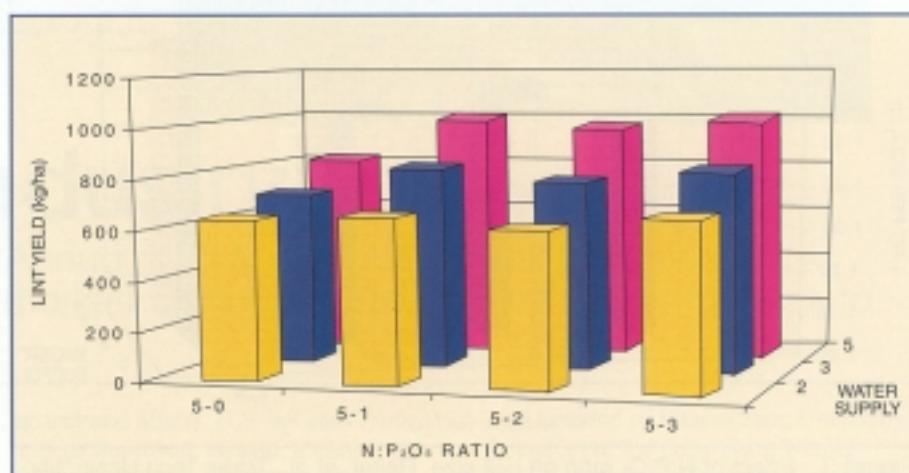


Figure 1. Effect of N:P<sub>2</sub>O<sub>5</sub> ratio on lint yield, Reiter, et al., Texas Tech University, 1999.

percent or less of the crop water requirement for maximum yield within the constraints of the growing season. When irrigation is used to supplement rainfall, nutrient supply becomes the next limiting factor, with N supply being of major importance. Previous research sponsored by the FFF has demonstrated the optimum water-to-nitrogen ratio for maximizing yields and maintaining lint quality. For each

inch of total water available during the growing season, 5 lbs. of N are required to maximize water-use efficiency. Applying N through irrigation water at the rate of 10 lbs. of N per inch of irrigation water to account for rainfall (50% of available water) is the ideal approach and offers flexibility in management based on crop yield potential. Yield potential is largely a function of growing season length

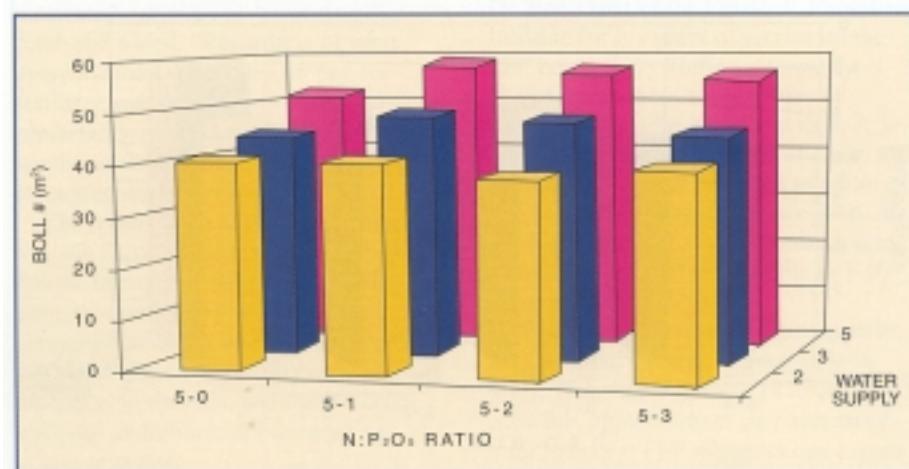


Figure 2. Effect of N:P<sub>2</sub>O<sub>5</sub> ratio on boll number Reiter, et al., Texas Tech University, 1999.

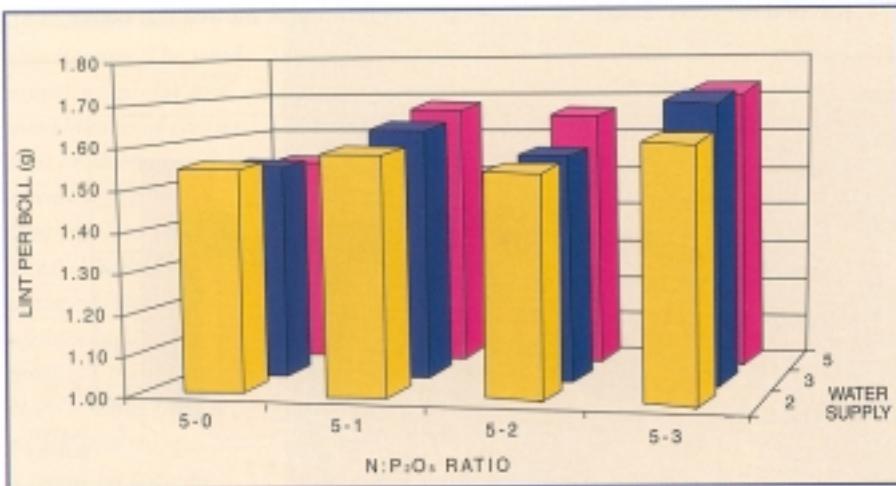


Figure 3. Effect of N:P<sub>2</sub>O<sub>5</sub> ratio on boll size, Reiter, et al., Texas Tech University, 1999.

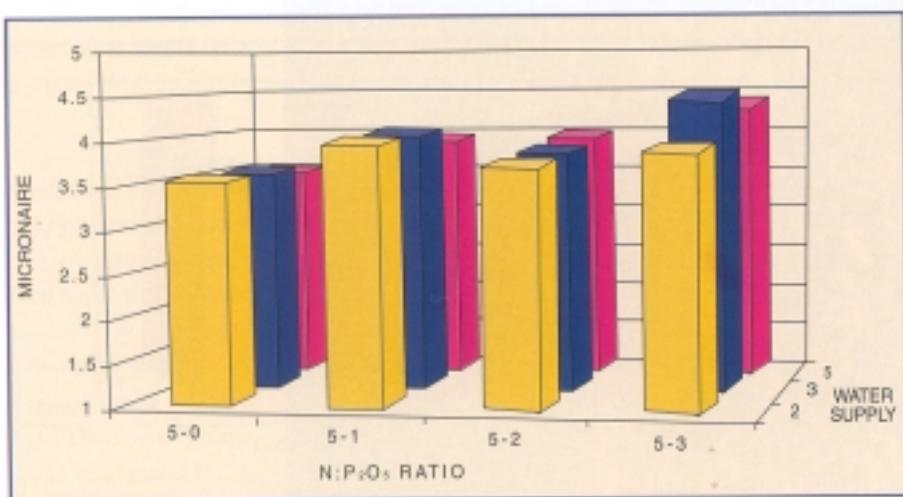


Figure 4. Effect of N:P<sub>2</sub>O<sub>5</sub> ratio on micronaire, Reiter, et al., Texas Tech University, 1999.

measured in heat unit accumulation. The long-term average for the Lubbock area is 2,300 heat units (°F), which is sufficient to produce 1,000 to 1,200 pounds per acre yield if water supply is adequate. However, disturbance in the spring (such as hail storms) can cause replanting, shortening the season length by 15 to 20 percent.

Over 85 percent of the yield variability in cotton is due to the boll number component. Boll size (lint and seed weight per boll) has a strong genetic influence but contributes only 10-12 percent to total lint yield variation across environments. Boll number is a function of plant density, fruiting sites per plant, and fruit

retention. Plant density is largely controlled by the producer. Previous research (also funded by the FFF) has clearly defined the optimum plant density for cotton production on the Texas High Plains. Optimum density varies based upon the water supply and ranges from 2 plants per foot of row under limited water conditions to 4 plants per foot of row under optimum water supplies.

Water supply has the major influence on production of fruiting sites on a cotton plant. Fruit retention is strongly dependent on the supply of reduced C and N to the developing fruit. Fruit size is largely controlled by the number of developing embryos in the fruit, which

is dependent upon the food supply to the developing embryo during the first 10 days after pollination. North Carolina research has indicated that P fertilization influences boll size but not fruit numbers. Studies in Mississippi have suggested that cotton responds to P only when adequate N is available.

The purpose of this research was to first determine whether P fertilizer can be effectively applied through irrigation water in combination with N and S and, secondly, to determine the optimum N:P<sub>2</sub>O<sub>5</sub> ratio for cotton production using fertigation.

#### Effect of Application Method

Although soil test P levels were in the 25-30 ppm range for the Olsen bicarbonate test, which is considered medium to medium-high, lint yield responses were observed every year for the fertigation treatment. The preplant banded P provided a response over no P in two of three years. Sidedress application resulted in sufficient root pruning to negate the effect of multiple P applications. Sidedressing at first flower pruned sufficient roots to interfere with water and nutrient uptake, which decreased boll numbers. A 50-lb/A yield increase was observed by simply using fertigation rather than preplant P applications.

Lint yield increases were due to increased boll numbers and increased boll size. Boll numbers were related to an increase in bolls found on the 6th to 10th fruiting branches, whereas boll size was a function of increased micronaire (more mature fibers).

#### Water is critical

N:P<sub>2</sub>O<sub>5</sub> ratios showed that cotton response to P is largely determined by water supply. At 2 gallons per minute per acre (GPM/A), plants did not respond to added P as water was the most limiting factor.

At 3 and 5 GPM/A, lint yield responded to added P but increasing P rates did not significantly increase lint yields (Figure 1). The 5:1 ratio provided the largest yield increases and used less P fertilizer. Lack of a yield response at the higher N:P<sub>2</sub>O<sub>5</sub> ratios was likely due to the number of boils (Figure 2).

Increasing the N:P<sub>2</sub>O<sub>5</sub> ratios did increase boll size (Figure 3). Increased boll size was a function of higher micronaire, owing to more mature fibers in the bolls (Figure 4).

### Methodology

**Location.** The study was conducted at the Crop Production Research Lab in Terry County, TX on an Amarillo loamy fine sand (fine-loamy, mixed, superactive, thermic Aridic Paleustalf).

**Irrigation.** The center pivot was equipped with LEPA application technology and nozzled to apply 2, 3 and 5 GPM/A, which corresponds with 33, 50, and 90 percent PET

replacement, respectively. These water supplies represent the irrigation capabilities found throughout the Southern High Plains region. Irrigation was on a five-day schedule and adjustments were made according to rainfall to meet the crop water requirements.

**Application method.** The four application methods used included a no P control, preplant, sidedress, and fertigation. Preplant N:P<sub>2</sub>O<sub>5</sub> was banded with a sweep rig four weeks prior to planting. The sidedress N:P<sub>2</sub>O<sub>5</sub> was banded with a sweep rig and split into three equal applications at preplant, first square, and first flower. Fertigation was applied at least four times starting at first square and continuing through peak bloom. All treatments received 100 lbs/A N through the irrigation water. The preplant, sidedress, and fertigation plots received 40 lbs/A P<sub>2</sub>O<sub>5</sub>.

N:P<sub>2</sub>O<sub>5</sub> ratios. The N:P<sub>2</sub>O<sub>5</sub> ratios were 5:0, 5:1, 5:2, and 5:3 (lbs of N:lbs P<sub>2</sub>O<sub>5</sub>)

per inch of total water. The 5:0 received only N. The 5:2 ratio supplied 40 lbs/A P<sub>2</sub>O<sub>5</sub> in the 5 GPM/A water supply, which is the standard recommendation in the area. Each water supply received a different amount of N and P based on total water applied throughout the season.

**Yield determination.** Cotton development and boll distribution was monitored during the season by plant mapping at first flower, peak bloom, and at harvest. Yields were determined by hand harvesting samples and ginned in a plot gin. Lint weight, seed weight, and lint percent were measured and used to calculate yield. Fiber samples were taken for fiber quality measurements at the International Textile Center in Lubbock, TX.

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