Dr. G.W. Rehm

Annual/Biennial Applications of P Compared in No-till and Chisel Plow

Researcher finds variance between tillage systems in corn yield response to biennial applications.

Summary: *Although corn planting was delayed by wet weather and yields were not as good as anticipated, the results of this study show the positive effect of phosphate fertilization on corn yields. Biennial applications beginning every other year in 1994 at varying rates twice the annual rate produced a corn yield increase curve on no-till that was consistently lower than that for chisel plow By contrast, annual applications at lower rates produced matching yield increase curves between the two tillage systems. Corn yield increases resulting from biennial applications used at twice the annual rate were equivalent to annual applications. Phosphorus concentration in the ear leaf tissue was affected by the same factors that had a significant effect on grain yield. Soil samples collected from 0-6 inches showed that phosphate fertilization produced positive changes in soil test values for phosphorus. The sampling scheme used could identify the location of a band applied on an annual basis. The presence of a single band applied in the fall of 1994 (biennial application) was less obvious.*

Very little research has focused on the various management options that might be appropriate for the most efficient use of phosphate fertilizer in the total corn/ soybean rotation. In developing the appropriate phosphate management system, it is essential that annual and biennial applications be compared. A management system that would allow for the application of phosphate fertilizer to the rotation on a biennial basis without reducing crop yields would be preferred by many growers. This approach to phosphate management would save time and fuel because each acre would not need to be fertilized each year. Previously, residual effects of phosphate fertilization were measured when phosphate was applied in the corn production year.

Although many farmers are interested in no-till production systems, conventional tillage systems will continue to be used on large acreages in Minnesota and the northern Corn Belt. The no-till planting system presents a special challenge for management of phosphate fertilizer. Phosphorus is not mobile in soils and, if broadcast on the soil surface, will remain there in a no-till planting system. Therefore, banded applications of phosphate are the only practical alternative if soil test results show that phosphate fertilizer is needed for optimum no-till corn and soybean production. The impact of annual or biennial applications of phosphate in a band have not been evaluated in both no-till and fall chisel planting systems.

Objectives of our study were several:

- evaluate two contrasting tillage systems suitable for corn/soybean rotation, using up-to-date management practices for each tillage system and crop
- develop a system for management of phosphate fertilizer so that phosphorus efficiency is maximized for both crops in the rotation
- evaluate corn/soybean production in two tillage systems when planted in row spacings of either 7 or 30 inches; optimum rates of fertilizer and other appropriate inputs will be used
- monitor the effect of rate and placement of phosphate fertilizer on soil test values for P in each tillage system.

Yield effects

Corn grain yields in both tillage systems increased as the rate of applied phosphate increased. When annual applications were used, the response for both tillage systems was essentially the same (Figure 1). However, with biennial applications beginning in 1994, the yield curve was consistently lower in the no-till planting system (Figure 2). The yields shown in both figures were averaged over placement and row spacing treatments. Not incorporating phosphate broadcast in the no-till system may help explain the lower yields.

In 1996, phosphate placement had no significant effect on grain yield. There

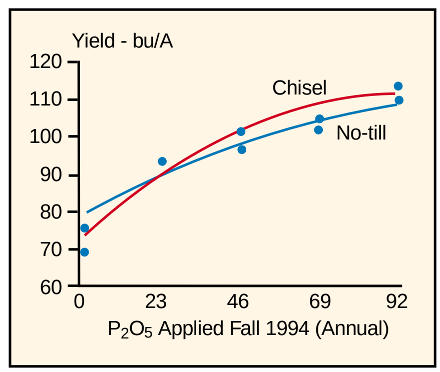

Figure 1. Corn yield as affected by phosphate applied on an annual basis for two tillage systems. Rehm, University of Minnesota, 1996.

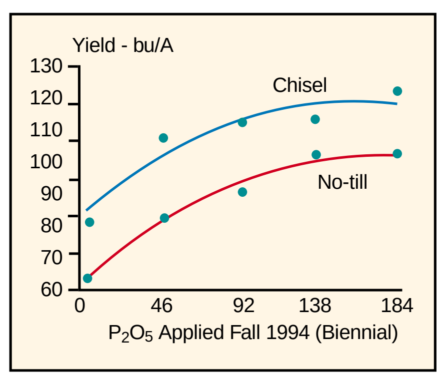

Figure 2. Corn yield as affected by phosphate applied on a biennual basis for two tillage systems, Rehm, University of Minnesota, 1996.

was no significant interaction between tillage system and fertilizer placement. There was also no significant interaction between placement and rate. The yield effects of placement on corn, row spacing used for 1995 soybean production, frequency of application, and tillage system are shown in Figure 3. These yields were typical of corn yields throughout west-central Minnesota. When averaged over all other factors, fall chisel system yields were 109 bu/A while the no-till system produced an average yield of 98 bu/A. This yield difference, however, was not statistically significant.

P concentration

Ear leaf samples were collected at silking to monitor treatment effect on corn uptake of P. In 1996, when averaged over all other factors, P concentration in corn planted in the chisel plow system was .202 percent. When tile no-till planting system was used, P concentration was . 191 percent. This was not a statistically significant difference.

Phosphate placement had no significant effect on ear leaf P concentration. When averaged over other factors studied, P concentration was . 194 percent when the phosphate was applied in a band and .200 percent when phosphate was broadcast.

Ear leaf P concentration increased with applied phosphate rate. There was no significant interaction between rate applied and frequency of application (annual, biennial). There also was no significant interaction between tillage system and applied phosphate rate. The effects of the various treatments on ear leaf P concentration were similar to the effects of these treatments on grain yield.

Soil test values

Soil samples (0 to 6 inches) were collected from selected treatments in the fall of 1996 to measure changes in soil test P values. Samples were analyzed by both the Bray and Kurtz #1, and the sodium bicarbonate (Olsen test) procedures.

Because of high pH values (range 7.5 to 8.0), soil test values measured by the Bray and Kurtz procedure were low and did not provide a good measure of the effect of treatment on soil test values. The bicarbonate extractions provided a better indication of changes.

In general, soil test values were increased by phosphate fertilization. Considering the broadcast application, two annual applications of either 23 or 46 lbs/A of P_2O_5 produced extractable P levels higher than a single application of either 46 or 92 lbs/A of P_2O_5, respectively.

For treatments where phosphate fertilizer was applied in a band, samples were collected from directly beneath the row. Corn was planted over the band in the no-till planting system. For the fall chisel system, this subsurface band could have been disturbed by the chisel operation. The sampling scheme used was successful in detecting the presence of the band in both tillage systems. The chisel operation apparently did not disturb the band. Presence of the band was not obvious when phosphate was applied biennially.

Methodology

Site. This study was conducted at the West-Central Experiment Station at Morris, Minnesota.

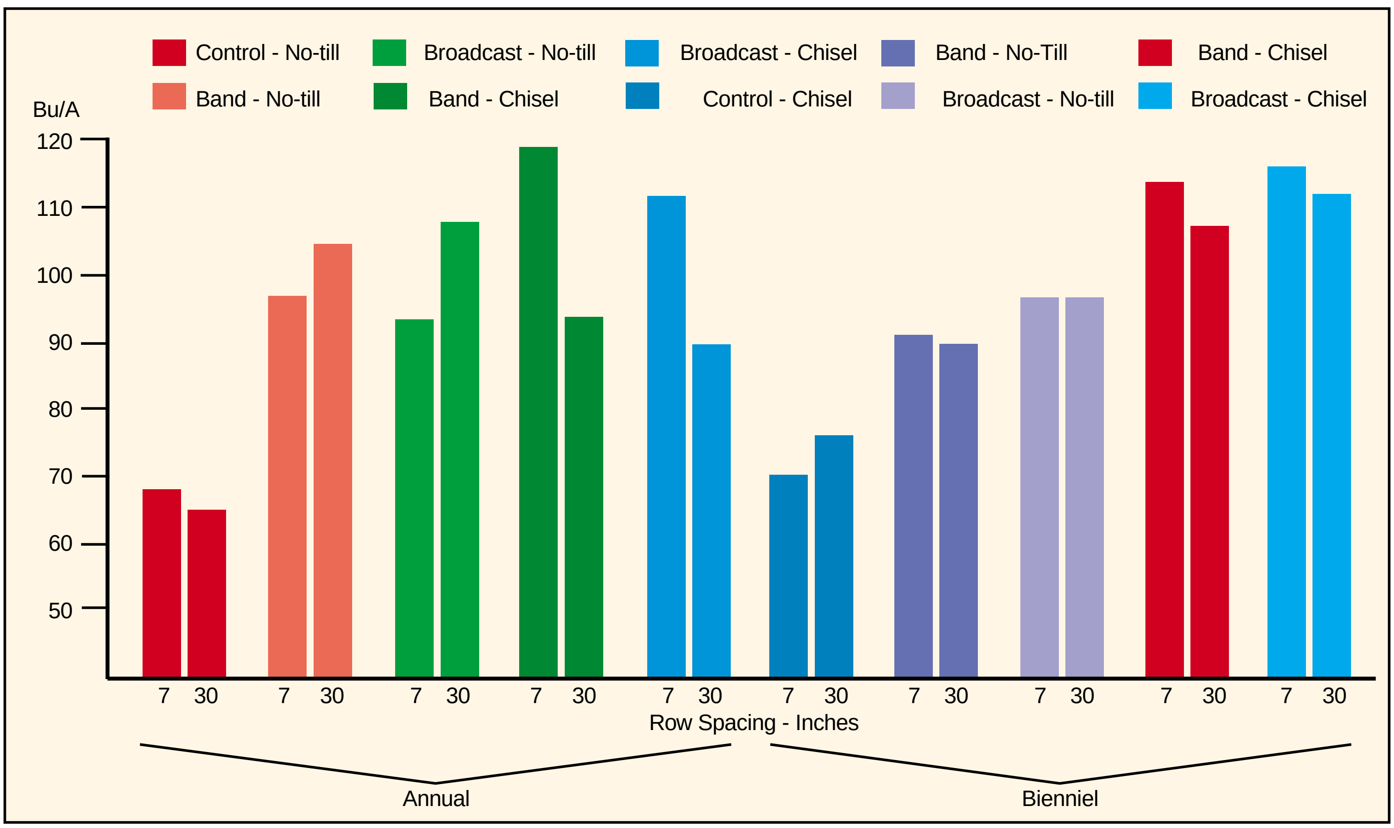

Figure 3. Corn grain yield as affected by tillage system, placement of phosphate, row spacing for previous soybean crop, and frequency of phosphate application, Rehm, University of Minnesota, 1996.

Soil samples (0 to 6 inches) were collected at the initiation of the study and showed: pH 7.8, phosphorus (Bray/Kurtz #1) 2.3 ppm, phosphorus (Olsen) 4.3 ppm, and potassium 166 ppm.

Plot design. Four factors (tillage system, row spacing for soybeans, frequency of phosphate application, and phosphate rate) were combined in a complete factorial design with three replications. Tillage systems (fall chisel, no-till) were the main plots. Soybean row spacings (7, 30 inches) were the sub plots. Frequency, placement, and rate of phosphate applications were the sub-sub plots.

Application rate. Biennial applications of phosphate were first applied in the fall of 1994 and repeated in the fall of 1996. For these applications, phosphate rates were 46, 92, 138, and 184 lbs/A of P_2O_5. Annual phosphate applications were made in late fall of 1994, 1995, and 1996. For these applications, phosphate rates were 23, 46, 69, and 92 lbs/A of P_2O_5. Appropriate zero phosphate controls were used for each frequency of application. Adequate N, supplied as 82-0-0, was applied on June 11 when the corn was in the two-leaf stage of development.

Placement. A coulter and knife assembly was used to band phosphate at a depth of approximately 4 inches below the soil surface. The bands (both biennia and annual) were placed on 15-inch centers for the narrow row soybean treatments. Bands were on 30-inch centers for the 30-inch row spacings. Phosphate applications (both band and broadcast) were completed before the chisel plow tillage operation each fall. There was no incorporation of broadcast phosphate in the no-till planting system.

Planting. Corn planting in 1996 was delayed by frequent rains. DeKalb (DK-442) was planted at a density of 30,100 seeds/A on May 24. Row spacing was 30 inches.

Weed control was achieved with a preemergence application of *Dual*, followed by a postemergence application of *Permit* and *Accent*.

Rotation. Corn was grown in 1994 and 1996. Soybeans were grown in 1995.

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