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Fall Surface-Applied Fluid P Movement Into Soil Limits Potential Loss to Erosion

Two years of measurements show that fall-applied fluid P moves into the soil, limiting losses and maintaining relatively higher levels of bioavailable P in top six inches of soil.

SUMMARY

Soil analyses in the spring of 2004, 20 and 23 weeks after band application of fluid P sources the preceding fall, showed that relatively higher levels of bioavailable phosphorus (P) were present up to five inches below the soil surface. In the spring of 2005, however, we could detect fewer differences in relative amounts of bioavailable P from measurements made 15 to 19 weeks after application. Low levels of soil water at the time of the measurements probably limited P diffusion. Nevertheless, the results of these two years of measurements suggest that banded fluid P applied to the soil surface after crop harvest will move into the soil profile where it will be less subject to loss in runoff or by erosion during the winter months, and yet be available to plants the following growing season. These studies are being repeated in 2006.

In previous studies, we used exchange resin membranes to evaluate the distribution of bioavailable P in the soil profile after a surface dribble application (P_2O_5 at 30 lbs/A) of ammonium polyphosphate (APP) starter fertilizer. Forty-three days after application in 2002, the highest concentration of bioavailable P was found more that four inches below the surface for a 15+30+10 starter treatment. At 68 days after application, higher P concentrations were measured at a depth of less than two inches below the surface for the 15+30+10 treatment, and more than three inches below the surface for a 60+30+10 treatment. The research was expanded in 2003 to include an orthophosphate (0+30+0) treatment and three sampling dates. Higher concentrations of bioavailable P were measured near the soil surface for all three of the starter treatments 23 days after application. By 42 days after application, the highest concentration of P was found one to two inches below the surface for both the 15+30+10 and 60+30+10 starter treatments. At 63 days after application, the highest concentration of bioavailable P was measured at a depth of more than three inches below the surface for the 15+30+10 starter treatment. In contrast, no measurable differences in bioavailable P distribution were found in plots in which 0+30+0 or 60+30+10 was dribbled on the soil surface.

Although the results of these previous studies were not consistent among treatments, they do present convincing evidence that surface dribble applications of P fertilizer increase P bioavailability below the soil surface for several weeks after application. Given that P diffusion in the soil is a relatively slow process, P source, volume of material (30 gal/A), and porosity of the soil probably played a role in P movement. In any case, increased levels of bioavailable P in the root zone would potentially benefit the plant throughout the growing season. This leads to the question of what happens to P bioavailability when a

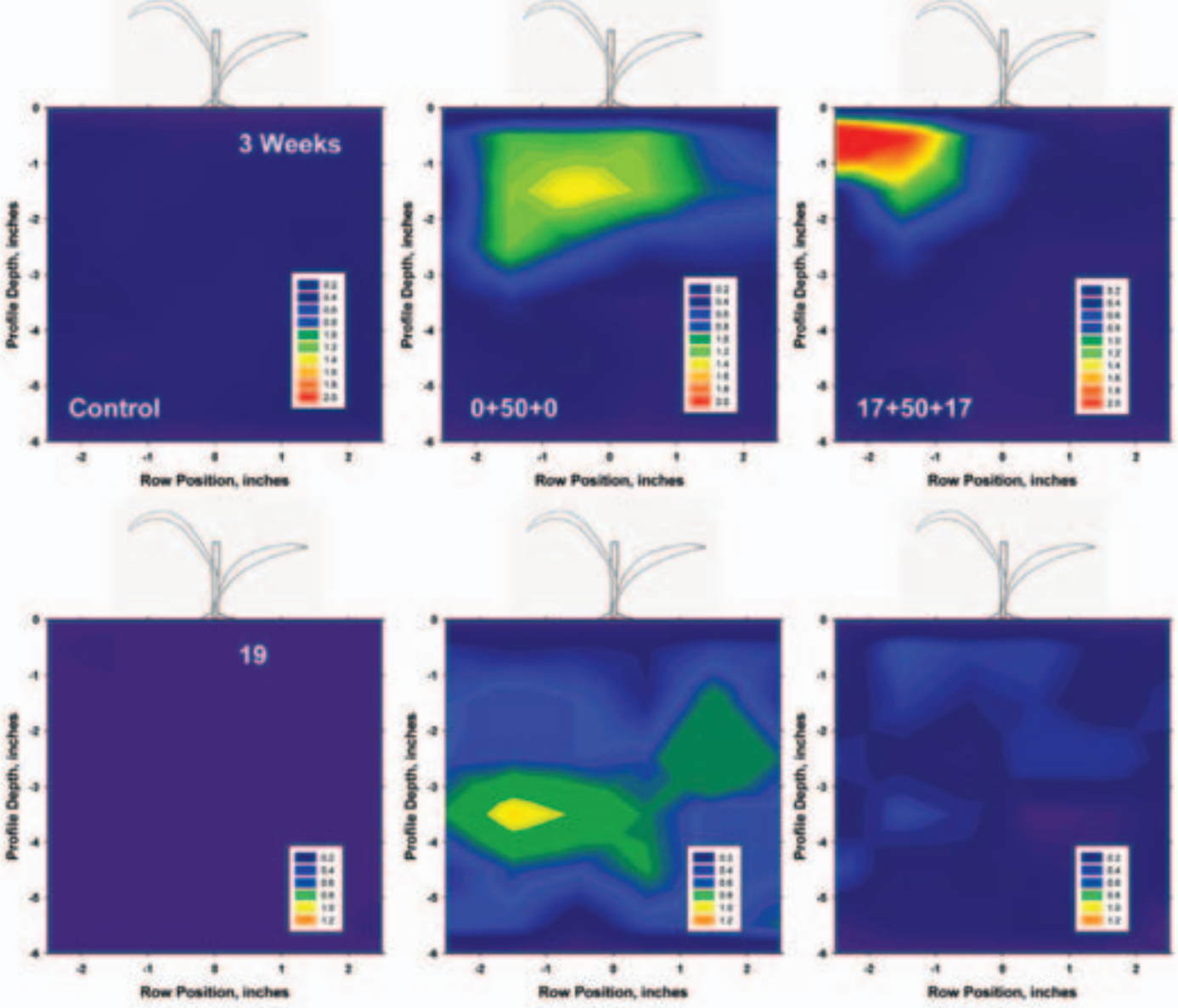

Figure 1. Profile distribution of bioavailable P[(x10-8^{-8}) lb. actual P/inch^2] 3 and 19 weeks after surface band application of 0+50+0 (middle column) and 17+50+17 (right column) on the soil surface approximately two inches to the side of the previous soybean row in the fall of 2004.

liquid P fertilizer is surface applied in the fall of the year. To answer this question, we evaluated the positional and temporal availability of P from surface dribble bands following fall application. Our intent was to improve our understanding of soil P dynamics during the months between application and spring planting.

2004 field trials

Three weeks after fluid fertilizer (P_2O_5 at 50 lbs/A) was applied in the fall of 2003, higher concentrations of bioavailable P were measured at a depth of less than one inch to a depth nearly four inches below the soil surface for the 0+50+0 (ortho-P source) and 17+50+17 (APP source) fluid materials, respectively. Concentrations of bioavailable P were uniformly low in the control plots. Measurements made in the spring of 2004 at 20 weeks after application indicated that higher concentrations of bioavailable P still were present up to five inches below the soil surface for both treatments.

Final measurements were made 23 weeks after application just prior to planting the 2004 corn crop. Higher levels of bioavailable P still could be measured in treated plots that received fertilizer, but the P was not concentrated in any position relative to the row. Spatial variability probably played a role in what was measured with the exchange membranes.

2005 field trials

Following a surface band application of the two P fluid sources in the fall of 2004, higher concentrations of bioavailable P were measured three weeks after application (Figure 1, top row). Highest concentration of bioavailable P was measured at a depth of more

than one inch below the surface for the 0+50+0 treatment, and at approximately one-half inch for the 17+50+17 treatment (Figure 1).

In the spring of 2005, little P was extracted by the exchange membranes placed in the soil 15 weeks after application (data not shown). When the measurements were made, soil water content ranged from less than 8 percent to about 10 percent, which is well below the estimated field capacity (measured at –33kPa) water content of 27.4 percent. With such low soil water content, P diffusion to the exchange membrane would be limited.

The final 2005 measurements were made 19 weeks after application, when soil water content was somewhat higher. Higher concentrations of bioavailable P were measured, mainly in plots that received the dribble band application of 0+50+0 (Figure 1, bottom row).

Even with three replications, and a relatively uniform fertilizer band, additional measurements may be necessary to identify areas with more bioavailable P, especially when measurements are made several months after the fluid fertilizer is applied.

Based on the data collected thus far, the movement of P into the soil profile should be similar for both the ortho- and polyphosphate materials. The precipitation reactions of ortho-P, which occur more slowly when APP fertilizer sources are used, had little effect on the mobility of the P applied to this central Iowa soil.

Summary

Both ortho- and polyphosphate fluid sources increased soil concentrations of bioavailable P with depth. The highest levels were found three weeks after fall application, but could be detected the following spring. Soil water content plays a significant role in the ability of exchange resin membranes to capture P and reveal soil P distribution. These results emphasize the agronomic acceptability of both surface starter P applications close to the row and fall applications of P after harvest.

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