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Does Pattern of Root Development Explain Variances in Crop Response?

Minnesota ridge-till studies suggest corn hybrids with shallower root system patterns may respond better to potash applications in early growth stages.

Summary: *Research conducted on ridge-till systems in 1991-92 seems to point to differences in development of corn root systems as an explanation for differing responses of young corn plants to potassium applications. In the early growth stages, hybrids with shallower root development patterns are better able to tap potassium close to the soil surface. However, differences in root development between hybrids seem to disappear as corn grows throughout the season. Other factors, such as changes in bulk density of soil, and changes in potassium chemistry as affected by moisture and temperature, may also be involved. More research is needed.*

Before 1988, several farmers who used the ridge-till planting system suspected that corn yields were declining in comparison to the yields of neighbors who used conventional planting systems. The decline was noted more frequently after the ridge-till system had been used for three or four years. There were theories for this decline, but no easy explanations.

In 1988, potassium deficiency symptoms appeared on corn grown in many ridge-till fields. These symptoms appeared even though soil tests for potassium were in the high or very high range. The severity of the symptoms also varied with hybrid.

Thinking that reduced uptake of potassium resulting in visual deficiency symptoms could be the cause of the declining yields, research was initiated in 1989 to evaluate the effect of banded potash fertilizer on corn production in ridge-till systems. That research has continued through the 1994 growing season.

Hybrid responses differ

Initial research was started in Murray County in southwest Minnesota in the fall of 1988. Potash was knifed into the center of existing ridges to supply 40, 80, and 160 lbs/A of potassium. A coulter and knife assembly was used to place the fertilizer *3.5* to 4 inches below the soil surface. The assembly was also passed through the control plots where no fertilizer was used.

The optimum rate of potash for Pioneer 3732 was 80 lbs/A of potassium. This hybrid also showed the most severe potassium deficiency symptoms (Figure 1). For Pioneer 3737, a hybrid that did not show potassium deficiency symptoms, the use of 40 lbs/A of potassium produced the optimum yield. The soil test for potassium was 145 ppm, a high test by University of Minnesota definitions.

Results from the research in Murray County show that banded application of potash in the center of existing ridges is a management tool that can be used to increase yields in these planting systems. There was, however, no easy explanation for the problem. It appeared that some hybrids were able to use soil potassium much more easily than others. This suggested there must be differences in the development of root systems in ridge-till as compared to conventional-till systems.

Variance confirmed

In 1990, potassium deficiency symptoms appeared on corn grown in

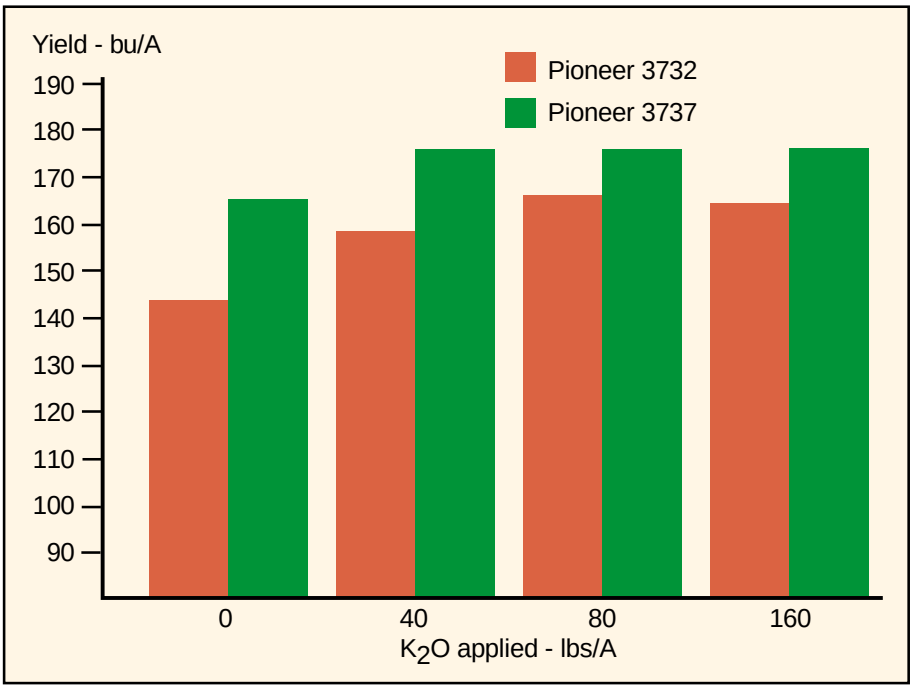

Figure 1. Corn yield in a ridge-till planting system as affected by hybrid and rate of applied potash, Oldham and Rehm, University of Minnesota, 1989.

the ridge-till planting system at the West-Central Experiment Station at Morris. Stemming from this, a research project was initiated in the fall of that year to evaluate band and broadcast application of potassium fertilizer on corn in ridge-till and chisel planting systems. To be consistent, Pioneer 3732 and 3737 were used again. The study was repeated in 1992 and results of the two years are shown in Figure 2. Yields shown are

averaged for the two years. The soil test value for potassium was 151 ppm.

There was a substantial increase in yield of both varieties when 40 lbs/A of potash was fall-applied in the center of the ridge. At this site, the increase was nearly equal for both hybrids. The banded use of potassium also produced a substantial increase in yield of the Pioneer 3732 hybrid in the fall chisel planting system, the hybrid most susceptible to potassium deficiency.

Root growth was also measured early in the growing season at this site to determine the effects of tillage system, hybrid, and potassium fertilization. To measure root growth and density, soil cores were taken at various distances from the corn plants at depths of 0 to 6, 6 to 12, and 12 to 24 inches. Samples were collected twice early in the growing season. Following sample collection, soil was washed from the roots, organic matter particles were removed from the samples, and measurements of root length were taken.

Differences in development of the root systems were found (Figure 3) and might explain the difference of response between the two hybrids. Early in the growing season, the Pioneer 3732 hybrid appeared to develop a root system that explored less of the soil surface. In the absence of primary tillage, soil test potassium increased or stratified near the soil surface.

By contrast, the Pioneer 3737 hybrid, because its root system developed close to the soil surface, was able to more effectively use the higher quantities of potassium found close to the soil surface.

Difference in root development between the two hybrids seemed to

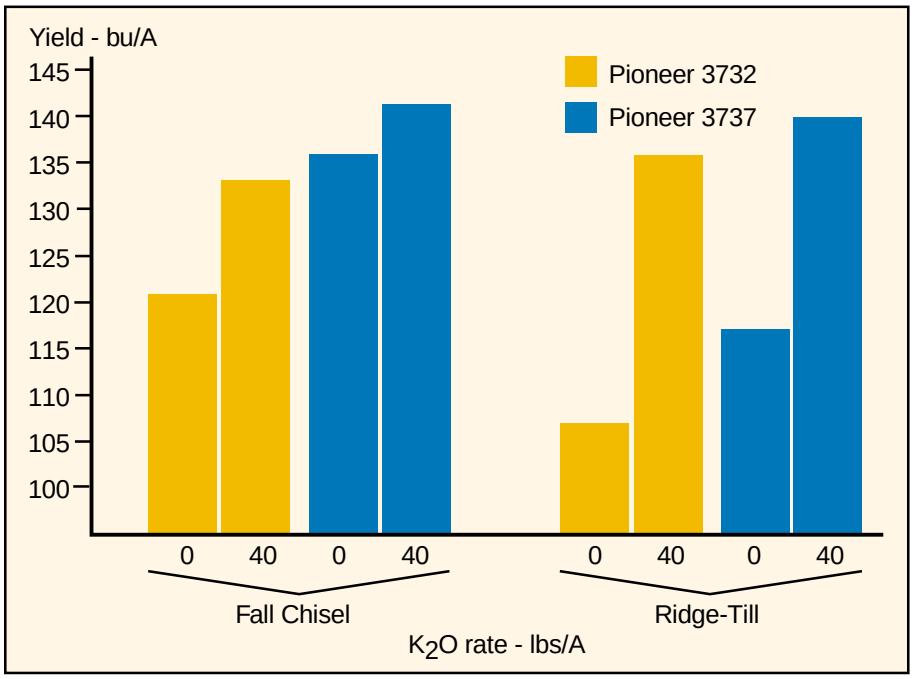

Figure 2. Corn yields in two tillage systems as affected by hybrid and banded potash, yields avg. of two years, Oldham and Rehm, University of Minnesta, 1991-92.

disappear as corn grew throughout the season.

Type of tillage system also had a substantial effect on the development of corn root systems. In ridge-till, a higher percentage of roots appeared to develop in and near the ridge early in the growing season. This difference in early-sea-son development can have a substantial effect on corn yield.

More research needed

Difference in the architecture of the root system may not be the complete explanation for the response to potash. Other factors, such as changes in bulk density of the soil, and changes in potassium chemistry as affected by moisture and temperature, might be involved. Future research is needed to address these possibilities.

The use of banded potash to improve yields in the ridge-till planting system may remove a yield barrier frequently associated with the system. This, in turn, may stimulate farmer interest in the more rapid adoption of this widely accepted soil-conserving system.

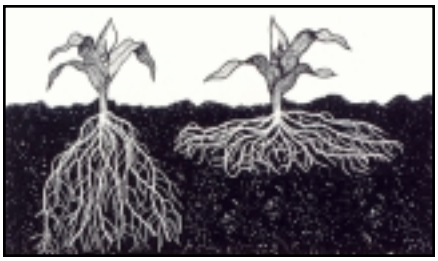

Figure 3. Root system patterns of two hybrids used in field research, Oldham and Rehm, University of Minnesota.

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