RESPONSE OF RIDGE-TILL CORN TO POTASH FERTILIZATION

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In recent years there has been an increased interest in growing corn with either ridge-till or no-till planting systems. This interest has been stimulated by concern for conservation compliance, farm profitability and the environment. Many problems have surfaced as these tillage systems are adopted by more and more farmers. The appearance of potassium deficiency symptoms has been a major concern for those who grow corn and soybeans with these tillage systems for the past four or five years.

For several years, there had been scattered reports of the appearance of potassium (K) deficiencies in corn grown in ridge-till planting systems. These symptoms were frequently noted even though soil test values for K were considered to be in the high category.

The severity of the problem appeared to be related to hybrid. Some hybrids showed more severe deficiency symptoms.

The problem in the northern Corn Belt did not appear to be confined to specific soils or specific environments. Reports of the problem have come from a diversity of corn production situations in Minnesota and neighboring states.

MORE REPORTS IN 1988

The frequency of observations of K deficiency in ridge-till corn increased substantially in 1988. It was apparent that some answers and/or explanations were needed. Therefore a study was initiated in southwestern Minnesota in the fall of 1988 to evaluate the effect of banded applications of potash fertilizer on K uptake and subsequent corn yield. The soil test value for potassium (0-6 inches) at the experimental site was 145 ppm. This is considered to be high by University of Minnesota standards.

Three rates of K_2O (40, 80, 160 lb./acre) were applied in a band in the center of existing ridges in early November. The band was applied at a depth of 3 to 4 inches. Three hybrids (Pioneer 3902, Pioneer 3732, Pioneer 3737) were planted in late April. The treatments, selected to provide for a complete factorial, were arranged in a randomized complete block design with four replications. Appropriate controls were used for each hybrid.

Whole plant samples were collected from all plots at approximately 4 weeks after emergence (V4) and approximately 6 weeks after emergence (V8). Ear leaf samples were also collected at silking.

Both rate of applied K_2O and hybrid had a significant effect on the K concentration in the corn tissue. As might be expected, the K concentration increased with rate of applied K_2O (Table 1). This increase is not unique to ridge-till planting systems and might be explained by the concept of luxury consumption.

Table 1. The effect of rate of applied K_2O on K concentration in corn tissue in 1989.

K_2O Applied	Stage of Development V4		V8		Ear Leaf	
lb./acre	- - - - - - %K* - - - - - - -					
0	.91	d**	1.08	d	.95	d
40	2.18	c	1.49	c	1.21	c
80	2.57	b	1.75	b	1.37	b
160	3.06	a	2.08	a	1.46	a

* Values reported are averaged over 3 hybrids.
** Treatment means in any column followed by the same letter are not significantly different at the .05 confidence level.

When averaged over rates of applied K_2O, the hybrid had a significant effect on K concentration in the corn tissue (Table 2). For all stages, the concentration was lowest in Pioneer 3732 and highest n Pioneer 3737. This observation could be the result of a fixed genetic trait or there could be differences in the development of the root systems. The data collected do not provide an explanation.

Table 2. The effect of corn hybrid on K concentration in corn tissue.

Hybrid	Stage of Development V4		V8		Ear leaf	
	- - - - - - %K* - - - - - - -					
Pioneer 3902	2.23	b*	1.71	b	1.23	b
Pioneer 3732	1.90	c	1.28	c	1.15	c
Pioneer 3737	2.40	a	1.80	a	1.36	a

* Treatment means in a column followed by the same letter are not significantly different at the .05 confidence level.

The effect of hybrid and rate of applied K_2O on corn yield in 1989 is illustrated in Figure 1. A rate of 40 lb. K_2O per acre was needed for optimum yield for the 3902 and 3737 hybrids. This increased to 80 lb. K_2O per acre for the 3732 hybrid. Yield increases from the added K_2O were substantial (10-20 bu./acre).

The yield data from 1989 show that the banded application of K_2O could be used to correct the potassium deficiencies which appeared in ridge-till corn. The data also indicated that a rate of approximately 40 lb. K_2O per acre was needed to correct the problem if soil test values for K are considered to be high. Response data are not yet available for soils having medium, low, and very low soil test values for K.

GROWER EXPERIENCES

Some farmers who used the ridge-till planting system had recognized the problem for several years and conducted some comparisons in their own fields. The results from one of these trials conducted in 1989 are summarized in Table 3. The trials were in a field in west-central Minnesota. Treatments were applied in strips which were 6 rows wide and replicated four times. The soil test value for K was considered to be in the high range.

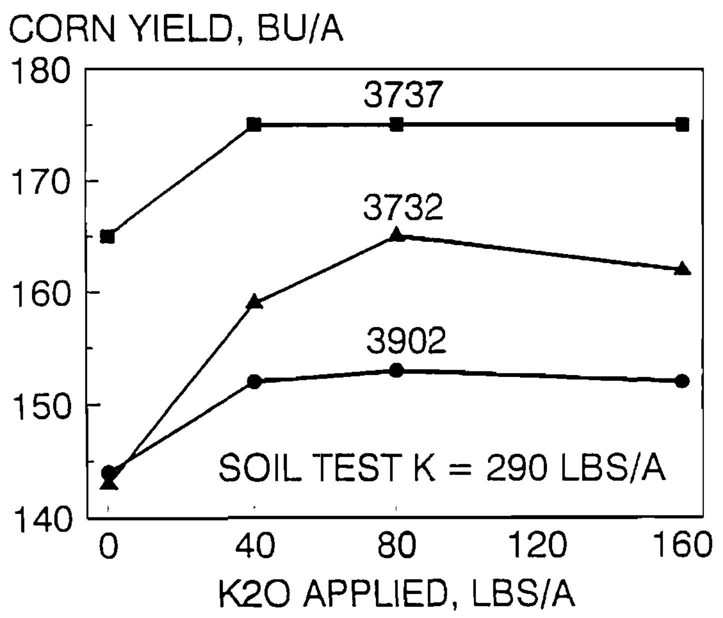

Figure 1. The effect of corn hybrid and rate of applied K_2O on corn yield in 1989.

Table 3. The effect of method of K_2O application on corn yield in a ridge-till planting system in west-central Minnesota. 1989.

Fertilizer Treatment	Yield
	bu./acre
control	154 b
starter only (100 lb. 7-21-7/acre)	153 b
fall band (5 N-26 P_2O_5-100 K_2O/acre)	171 a
starter plus fall band	173 a

These results indicate that small amounts of K_2O (about 10 lb./acre) applied in a starter band at planting are not adequate for correcting the K deficiency. The 100 lb. K_2O per acre applied in the fall band in this situation may have been more than needed for optimum yield. The response, however, shows the impact of a higher rate of K_2O. There apparently is no need for a combination of a fall band and a starter band for optimum yield.

IMPACT ON SOYBEAN PRODUCTION

The corn/soybean rotation dominates a large part of the acreage in the northern Corn Belt. Soybeans are also grown in ridge-till planting systems and the response of this crop to K_2O banded in the ridge was unknown. Therefore, soybeans were planted in 1990 in the plots in southwestern Minnesota that had been established in 1989.

The various rates of K_2O were banded in the fall of 1989 following corn harvest. The design of the study was also changed. The hybrid or variety variable was removed and replaced with a frequency of application variable. This change was made in an attempt to determine the frequency of application of K_2O needed for optimum yield of both corn and soybeans. The soybean yields recorded in 1990 are summarized in Table 4.

Table 4. Effect of frequency and rate of K_2O on soybean yield in southwestern Minnesota in 1990.

Year of K_2O application	Rate applied each year	Yield
		bu./acre
1988	0	49.6 c
	40	49.6 c
	80	49.7 c
	160	52.5 b
1988, 1989	0	49.5 c
	40	51.0 b
	80	51.5 b
	160	54.3 a

The highest yield resulted from the annual application of 160 lb. K_2O per acre. A single application of 160 lb. K_2O per acre in 1988 produced yields that were equivalent to those from annual application of 40 and 80 lb. K_2O per acre.

These results show that the banded application of K_2O is important for optimum yields of both corn and soybeans. The data also indicate that a yearly application of K_2O may not be needed for optimum production. It may be practical to apply enough K_2O in a band to correct the problem for two years of production. Additional studies are being conducted to determine the optimum frequency of application.

WHY THE PROBLEM?

The specific reason for the K availability problem in ridge-till planting systems is not known. Limited observations indicate that this problem also occurs with the no-till planting systems. Nevertheless, one can speculate about potential causes.

Some soils can become compacted under reduced tillage. More compaction could reduce root density by decreasing root elongation rates, and locally elevated bulk density could slow K diffusion. Similar patterns of preferential root growth along paths of least resistance over years could decrease the effective K concentration near individual roots. Subtle changes in root hair density, induced by ridge-till and no-till planting systems, could also be involved.

RESEARCH IN PROGRESS

The data collected at this time show that K deficiency may be limiting the yield of both corn and soybean grown in the northern Corn Belt. With corn the severity of the deficiency appears to vary with hybrid. The preliminary data suggests that an annual application of 40-50 lb.K_2O/acre is needed to correct the problem.

Yet, there are many questions that are not answered. Several projects are under way in hopes of generating some answers.

Considerable effort is being devoted to a project designed to evaluate the impact of tillage system and hybrid on growth and development of the corn root system early int he growing system. Two methods are being used to evaluate root growth. One involves the placement of tnree non-essential cations (strontium, rubidium, lithium) at various positions from the corn plant and measurement of uptake at various growth stages. The second method focuses on measurement of roots in soil cores collected at several times throughout the growing season.

Other active research projects focus on determining the frequency of application of K_2O that is needed for optimum yield. Additional trials are aimed at fine-tuning the rate of K_2O needed for optimum yield.

PROCEEDINGS OF THE TWENTY-SECOND

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