ONTARIO

Residual Impacts of Previous Corn Rows on Potassium Nutrition of No-Till Narrow Row Soybeans

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Vertical as well as horizontal K stratification occurs in surface soil horizons of no-till fields following corn production. Several recent studies have addressed the effects of vertical stratification and the benefits of broadcast versus band placement of K fertilizers before soybeans.

The issue of horizontal K stratification has been largely ignored, even though the majority of no-till soybean production in North America is in narrow-row systems following corn. The resultant soybean plants in 7.5 to 20 in. row width systems are thus at various distances from previous corn rows, but little is known about whether soybean response varies with distance to prior corn rows. The knowledge gap becomes more critical as the K fertilization strategies used by corn farmers shift from primarily broadcast K application to deep banding (and with or without starter application), when farmers rely only on biennial K application before corn in a corn-soybean sequence, and when overall soil exchangeable K is at less than optimum levels for soybean production.

Both leaf potassium (K) concentrations and yield were higher for no-till soybean rows positioned near previous corn rows than for those soybean rows positioned between corn rows in Ontario research. The benefit of proximity to a previous corn row was associated with higher soil test K levels in corn rows and was enhanced by K fertilizer applications (particularly deep banding) to corn. Adjustments to the current soil sampling method (using a composite sample based on random points within an area) may be needed when narrow-row no-till soybeans follow corn on low- and medium-testing K soils.

The primary objectives of this study were to: 1) investigate the impacts of previous corn rows on soil K fertility, leaf K nutrition, and seed yield of subsequent narrow-row no-till soybeans; and 2) evaluate the influences of K fertilizer placement for the preceding corn on soybean response to relative proximity to corn rows.

Experimental Approach

Site 1. A corn-soybean rotation was studied from 1997 to 2000 on fields near Paris, Ontario, with a minimum six-year history of continuous no-till. Soil test K levels (0 to 6 in.) were in the low range, less than 61 mg/L [approximately equivalent to 51 parts per million (ppm)], and the soil texture was silt loam.

In 1997 and 1998, three spring tillage systems (no-till, zone-till, and mulch-till) were compared, with four K placement methods...deep band (6 in. deep), surface broadcast, broadcast + shallow band (2 in. deep), and zero K. In 1999, the same K placement methods were compared, but only in a no-till system. Only spring-applied K was evaluated in each season. When K fertilizer was applied, the rate was 107 lb K_2O/A.

The identical experimental design and plot layout in the corn year were used for the subsequent soybean seasons. Soybean variety Pioneer 9163 was no-till planted in 1998 and 1999, and NK S08-80 was grown in 2000 in 7.5 in. row widths in the same direction as the previous corn rows (30 in. widths) in each season, to evaluate the previous corn row effects on soil K fertility and soybean responses. Potassium fertilizer was not applied after corn or during soybean season in any of the experiments.

When soil, plant, or seed sampling was conducted, two separate samples were taken from each subplot. One was randomly collected from soybean rows positioned in previous corn rows, and the other was taken from soybean rows positioned between the previous corn rows (i.e. approximately 15 in. from the corn rows). Soil samples were collected to four depth intervals (0 to 2 in., 2 to 4 in., 4 to 8 in., and 8 to 12 in.) prior to soybean planting and after soybean harvest. Leaf K samples were taken at initial flowering stage. Seed samples were collected by hand harvesting 26 ft. lengths of soybean rows either in or between previous corn rows. Resulting soybean yield estimates are based on unbordered sampling areas. Soil K was extracted with 1 M ammonium acetate (NH_4OAc, pH = 7) solution. Leaf K and seed K were extracted using a dry ash method.

Site 2. Previous corn row effects on subsequent narrow-row no-till soybean yield were also monitored at Kirkton, Ontario, in 1999. The average soil test K levels (0 to 6 in.) were 90 mg/L (approximately equivalent to 75 ppm). The experiment for the corn year (1998) compared fall zone-till and no-till tillage systems, fall K application rates (0 and 90 lb K_2O/A), and spring K rates (0 and 45 lb K_2O/A). Soybeans (variety First Line 2801R) were planted in 15 in. row widths.

Results

Site 1. Before soybean planting in 2000, soil test K levels at the 0 to 2 in., 2 to 4 in., and 4 to 8 in. depth intervals in previous corn rows were higher than those between previous corn rows in both the zero K treatment and K-fertilized treatments (**Figure 1**), suggesting more available soil K was present in previous corn rows even when K fertilizer was not applied to previous corn. Neither spring tillage systems (data not shown) nor K placement methods before corn significantly

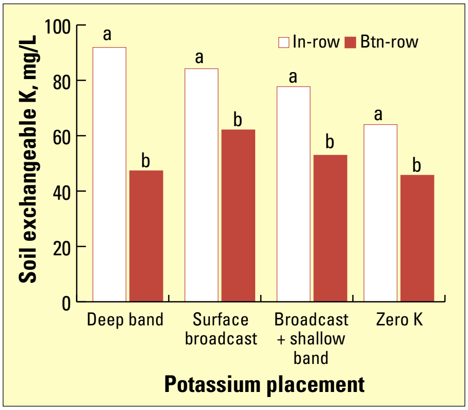

Figure 1. Previous corn row effects on soil K concentrations (0 to 8 in. depth) before soybean planting at Paris in 2000. In-row = in previous corn rows; Btn = between previous corn rows. Within K treatments, bars labeled with the same letter are not significantly different at p = 0.05 according to Fisher's protected LSD test.

TABLE 1. Previous corn row effects on leaf K concentrations at initial flowering stage at Paris from 1998 to 2000.[1]

K placement in prior corn year	1998 In[2]	1998 Btn	1999 In	1999 Btn	2000 In	2000 Btn
	Leaf K, %					
Deep band	2.1	1.6	1.7	1.1	2.8	2.3
Surface broadcast	2.1	1.9	1.6	1.2	2.7	2.4
Broadcast+shallow band	2.1	1.7	1.7	1.0	2.8	2.5
Zero K	1.7	1.4	1.3	0.9	2.6	2.3
Average	2.0a	1.7b	1.6a	1.1b	2.7a	2.4b

[1]Leaf K results are averaged over the three prior tillage systems in 1998 and 1999, and averaged over the three previous corn hybrids in 2000.
[2]In = in previous corn rows; Btn = between previous corn rows.
Means in a row within each year followed by the same letter are not significantly different at p = 0.05 according to Fisher's protected LSD test.

Irregular K deficiency patterns in soybeans, associated with previous corn rows.

Soybean K deficiency symptoms varied with proximity to previous corn rows.

influenced the corn row effects on soil K concentrations.

Visual K deficiency symptoms in soybeans were evident in July and August of both 1998 and 1999 at Paris in plots where K had not been applied in the previous corn year (see photos), and were more prevalent in plants positioned between previous corn rows. This coincided with higher soil K levels in prior corn rows.

Leaf K concentrations of soybeans in preceding corn rows were significantly higher than those between corn rows in all three seasons at Paris (**Table 1**). However, K placement methods significantly affected the row position effects on leaf K only in 1999. Deep banding and broadcast + shallow band resulted in greater differences in soybean leaf K in previous corn rows, versus those between previous corn rows, compared to zero K and surface broadcast. Previous corn row effects on leaf K nutrition of subsequent narrow-row no-till soybeans also occurred even when K fertilizer had not been applied to preceding corn; this may be a result of the elevated soil K levels associated with K release from the corn stover and roots in the corn row areas. Spring tillage systems used in the corn year did not affect soybean leaf K responses to row position (data not shown).

Seed yield of soybean in previous corn rows was 69 percent (14.3 bu/A) higher than those between previous corn rows with the zero K treatment in no-till in 1998 (**Table 2**). In 1999, yield increases for soybean in previous corn rows, versus between rows, averaged 11 percent (4.8 bu/A) over the three K treatments and three tillage systems. However, soybean yield was not significantly higher in previous corn rows in 2000 (**Table 2**), even though leaf K concentrations of soybean in previous corn rows were greater than those between prior corn rows. This may be because leaf K concentrations in the mid-season were very high (>2.2 percent) for both, which suggests that K nutri-

TABLE 2. Previous corn row effects on seed yield at Paris from 1998 to 2000.[1]

K placement in prior corn year	1998 In[2]	1998 Btn	1999 In	1999 Btn	2000 In	2000 Btn
	Yield, bu/A					
Deep band	ND[3]	ND	46.7	43.1	56.1	58.1
Surface broadcast	ND	ND	50.7	46.7	55.5	59.5
Broadcast+shallow band	ND	ND	ND	ND	54.9	54.7
Zero K	35.1a	20.8b	51.9	45.2	54.9	54.7
Average			49.8a	45.0b	55.4a	56.8a

Year and soybean row position

[1]Values are for no-till alone in 1998, but averaged over the three prior tillage systems in 1999, and averaged over three previous corn hybrids in 2000.
[2]In = in previous corn rows; Btn = between previous corn rows.
[3]ND = not determined.
Means in a row within each year followed by the same letter are not significantly different at p = 0.05 according to Fisher's protected LSD test.

tion was unlikely to have been a limiting factor for soybean yield in 2000. The rainfall in June 2000 was 8.6 in., 2.5 times higher than the 30-year average of 3.4 in. Higher soil moisture during critical periods in the growing season could greatly increase soil K availability and plant K uptake, and thus decrease soybean responses to residual K fertilizer applications.

Site 2. At Kirkton, differences in leaf K concentrations of soybeans in previous corn rows versus between corn rows were not significantly influenced by tillage system (data not shown) or fall-applied K, but were affected by spring-applied K imposed on previous corn (**Table 3**). Soybean plants positioned in previous corn rows averaged 10 percent (4.9 bu/A) higher yield relative to those between previous corn rows on this medium testing K soil (**Table 3**). Neither fall-applied K, spring-applied K, nor fall tillage system treatments for previous corn influenced the preceding corn row effects on seed yield.

TABLE 3. Previous corn row effects on leaf K concentrations and seed yield at Kirkton in 1999.[1]

Treatment in prior corn year	Leaf K In[2]	Leaf K Btn	Yield In	Yield Btn
	%		bu/A	
Fall K_2O, lb/A				
0	1.9	1.7	55.9	49.1
75	2.3	2.1	55.2	52.3
Spring K_2O, lb/A				
0	2.1a	1.7b	55.2	49.2
37	2.1a	2.0a	55.9	52.2
Average	2.1a	1.9b	55.6a	50.7b

[1]Values are averaged over the three prior tillage systems.
[2]In = in previous corn rows; Btn = between previous corn rows.
Means in a row within leaf K or yield followed by the same letter are not significantly different at p = 0.05 according to Fisher's protected LSD test.

Implications

The results above suggest that the current soil sampling protocol for soybean (using a composite sample, randomly collected from a specified area) has not only underestimated soil K levels in the zones of previous corn rows, but also overestimated K concentrations between prior corn row zones. Therefore, it may be beneficial to take soil samples from within previous corn rows and between corn rows separately, and then make separate K fertilizer recommendations correspondingly. However, this would double the costs of soil sampling and, if row effects are significant, complicate the application of K fertilizer at varying rates in such narrow zones. Alternatively, a simple and conservative approach is to take a composite soil sample only from between previous corn row areas, and use the result of this sample to make K fertilizer recommendations for the entire field. Although the latter approach may underestimate soil K fertility levels in previous corn rows – and result in over-application of K fertilizer for subsequent no-till soybean in previous corn rows – it may be a preferable strategy due to relatively low cost of K fertilizers, low toxicity of luxurious K uptake to plants, and high cost of yield loss if soil K available to soybeans is not sufficient.

Furthermore, deep banding of K fertilizers for corn has the potential to accentuate the row versus between row responses of subsequent no-till soybeans. So, particularly when overall soil-test K levels are in the low to medium range, broadcast K fertilizer application before no-till soybean is even more beneficial in narrow-row production systems following corn where K fertilizer has been deep banded. BC

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