ONTARIO

Critical Leaf Potassium Is Higher in No-Till Soybeans

By Xinhua Yin and Tony J. Vyn

The critical leaf potassium (K) concentration for maximum yield of conservation-till soybeans was estimated to be 2.4% in nine Ontario trials from 1998 to 2000. This is substantially higher than the critical levels used in Ontario and many states. Critical leaf K levels for the maximum concentrations of oil and isoflavones in soybean seed were estimated to be similar to those for maximum yield. Soils with stratified soil test K appeared to require higher critical levels of leaf K.

Plant analysis for K in soybean leaves at the initial flowering stage (R1) can be a useful tool for identifying K deficiencies. Critical levels ranging from 1.2 to 1.7% have been used in Ontario and many U.S. Corn Belt states. These critical leaf K values were established for traditional production in conventional tillage and primarily in wide row widths, and have not changed with the advent of conservation tillage and narrower rows. These changes in production practices, combined with overall yield improvements, have raised new concerns about the applicability of these critical leaf K concentrations. This concern may be most acute on long-term no-till fields where significant vertical soil test K stratification has occurred.

The objectives of this study were to: 1) determine the critical trifoliate leaf K concentrations of soybean at R1 for maximum yield and seed quality components in conservation-till production systems, and 2) evaluate the influences of vertical soil test K stratification on soybean critical leaf K concentrations.

The investigations were conducted at three sites in Ontario from 1998 through 2000. Each site had a history of at least 5 years of continuous no-till. Soil test K levels in the 0 to 6 in. depth ranged from low (35 parts per million [ppm]) to very high (155 ppm). Soybeans followed winter wheat at two locations and corn at the third. Treatments included both rates and placement (broadcast vs. banded) of K fertilizer at all sites, and fall disk tillage to a depth of 4 in. as a variable at two of the sites. All remaining treatments were grown with no tillage. The investigations involved a total of four varieties; soybean row widths were consistently at 15 or 7.5 in. Further treat-

Low K levels in soybean leaves can lead to deficiency symptoms as the crop matures.

ment details are available in Yin and Vyn (2004).

Composite soil samples were collected from each plot during the spring of each year. Soil probes were divided into depth increments of 0 to 2 in., 2 to 4 in., and 4 to 8 in. to determine the extent of vertical soil test K stratification in each plot. A leaf sample consisting of the most recently fully developed trifoliate leaves, including the petiole, was taken from 20 plants at R1 in mid- to late-July of each year from each plot for the determination of K concentrations.

A quadratic-plateau model was fitted to determine the relationships of leaf K concentration to yield and to concentrations of oil and isoflavones in seed. The critical leaf K value determined by a quadratic-plateau model is the leaf K concentration at which the two portions (quadratic and plateau) of the model join. In order to minimize the influences of year and site (due to soil types, weather conditions, soybean cultivars, etc.), all data of soybean yield and seed quality components were normalized by expressing them as percentages of the highest treatment mean within an individual site-year.

We found the critical leaf K concentration for maximum yield of soybean was 2.4% when all site-years were pooled (**Figure 1**), and 2.6% when only the no-till soybeans were considered. These values are double the critical value of 1.2% which had been used in Ontario soybean production systems for decades. This critical concentration is also remarkably higher than the 2.1% average of the sufficiency leaf K range (1.7 to 2.5%) that was proposed by Small and Ohlrogge (1973) and reported in Georgia (Plank, 1979). It is also greater than the critical leaf K values reported by Sartain et al. (1979) and by deMooy and Pesek (1970) for soybean at developmental stages slightly later than the initial flowering stage.

Critical leaf K concentration for seed oil concentration was estimated to be 2.4%—similar to that for seed isoflavone concentration—when all the data were pooled (**Figures 2 and 3**). Estimations of these critical leaf K concentrations for seed quality components are helpful to producers who aim to produce high-quality soybean for value-added markets. Similar critical values of midseason leaf K for maximum yield and seed quality components suggest that high yield and high seed quality components of soybean can be achieved simultaneously.

Critical leaf K concentrations for maximum yield...and maximum levels of oil and isoflavone...were higher in the plots with a soil test K stratification index greater than 2, than with an index of 2 or less (**Table 1**). This suggests that the extent of vertical soil K stratification affects the midseason critical leaf K concentrations for soybean. Because soil test K stratification commonly occurs in fields under long-term conservation-till (particu-

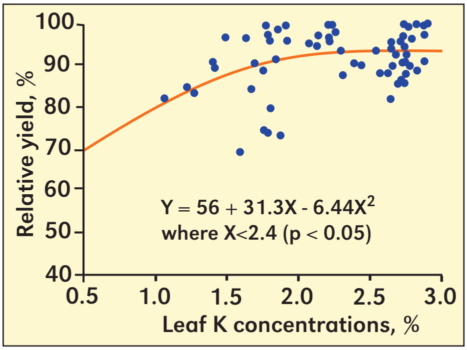

Figure 1. Relative soybean yield vs. leaf K concentration.

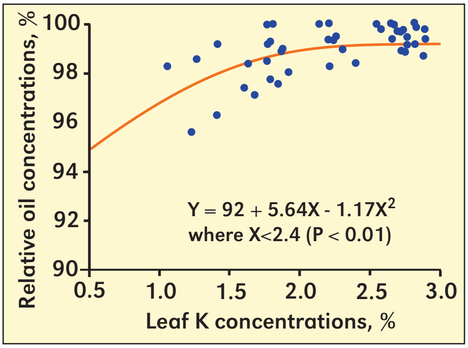

Figure 2. Relative soybean seed oil concentration vs. leaf K concentration.

Table 1. Impact of soil K stratification (KSC) on critical leaf K concentrations.

Dependent variable	KSC[1]	Critical leaf K, %
Yield	>2.00	2.3
	≤2.00	1.9
Oil	>2.00	2.5
	≤2.00	2.2
Isoflavone	>2.00	2.6
	≤2.00	2.2

[1]KSC, vertical soil test K stratification coefficient, is defined as the ratio of soil test K concentration in the 0 to 2 in. layer divided by K concentration at the 4 to 8 in. depth.

larly no-till) management, and the crop acreages under conservation tillage systems have increased rapidly, it will be important to consider the influences of vertical soil test K stratification on critical leaf K values in plant K analysis interpretations.

We also acknowledge that use of narrow row widths (instead of wide rows), and soybean yield improvement with time may have contributed to the higher critical leaf K values in this study compared with those reported previously.

The higher critical leaf K value we observed suggests that K fertilizer application based on the old critical leaf K concentrations may result in yield losses under conservation-till (particularly no-till) soybean production systems.

Increased vertical stratification of soil K may drive critical levels even higher. Based in part on the findings of this study, the optimum leaf K concentration in Ontario's soybean recommendations was raised from 1.2% to 2.0% in 2003. BC

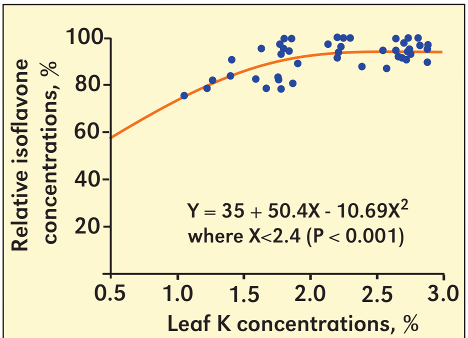

Figure 3. Relative soybean seed isoflavone concentration vs. leaf K concentration.

Dr. Yin is Assistant Professor at the Mid-Columbia Agricultural Research and Extension Center, Oregon State University in Hood River, OR; e-mail: Xinhua.Yin@oregonstate.edu. Dr. Vyn is Professor of Agronomy at Purdue University, West Lafayette, IN; e-mail: tvyn@purdue.edu.

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