Manage Nutrition for Profit Advantage

Soybean Nutrition and Pest Management Implications

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We have known for a long time that high soil fertility levels and good plant nutrition lead to higher soybean yields. But did you know that proper plant nutrition can help reduce susceptibility to the incidence and severity of a number of soybean pest problems?

Yield losses from diseases alone were estimated to exceed 10 to 14 million metric tons (M t) per year (approximately 367 to 514 million bushels) in the U.S. in the late 1990s (Wrather et al., 2001), representing an economic loss in excess of $2.06 billion/year. As profit margins continue to be squeezed, it becomes increasingly important for management strategies to provide the best chances possible for soybeans to reach their attainable yield potential.

There is an increasing body of scientific evidence that shows well-nourished plants possess properties which may reduce the incidence and severity of a number of diseases, and also the populations of and damage by certain insect pests. Illinois pest management specialists have stated: "*Inadequate phosphorus or potassium can increase losses from soybean cyst nematode, charcoal rot, other root rots, and pod and stem blight. Vigorous plants are more tolerant of pathogens and are better able to produce an almost normal yield despite diseases.*" >http://www.ipm.uiuc.edu/diseases/series500/rpd507/index.html<

Let's consider some examples of what we do know from published and recent research.

Examples: Foliar Diseases

Cercospora leaf blight (*Cercospora kikuchii*)– Recent research by scientists at Louisiana State University showed the effects of this disease might be reduced with improved potassium chloride (KCl or muriate of potash) fertilization on a relatively fertile Commerce silt loam soil. It has long been known that reductions in purple seed stain are possible with improved phosphorus (P) and potassium (K) nutrition (Camper and Lutz, 1977).

Asian soybean rust (*Phakospora pachyrhizi*)– Research in the Philippines has shown some rust suppression with P or K, but better suppression was reported when both nutrients were applied (Piccio and Franje, 1980). PPI/FAR-supported research began last year in the U.S. and is continuing this year to evaluate the effects of soil-applied K and Cl, and foliar-applied manganese and boron on disease incidence and severity.

Examples: Insects and Nematodes

Soybean aphid (*Aphis glycines* Matsumura) Proper K nutrition appears to reduce soybean aphid populations. These pests first appeared in the U.S. in 2000 and have been shown to cause 15 to 20% yield losses. A recent study in Wisconsin (Myers and Gratton, 2006) showed that medium and higher soil test K levels decreased aphid reproductive rates, slowed rates of population increases, and lowered peak aphid abundance (**Figure 1**). Potassium deficiency increases amino acids and soluble nitrogen (N) while lowering sugar concentrations. This chemical change would be favorable to sap-feeding aphids that concentrate N while excreting surplus sugars.

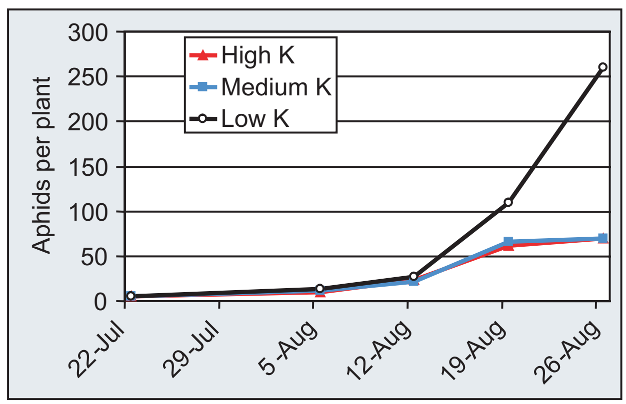

Figure 1. Soybean aphid populations at three K fertility levels in 2004 (Myers and Gratton, 2006).

Soybean cyst nematode (*Heterodera glycines*) – A P and K study by Howard et al. (1998) in Tennessee showed that high K fertilization (≥100 lb K_2O/A) on a low K soil increased soybean yields (**Figure 2**) and limited the increase in cyst nematode populations, compared to low or medium K fertilization rates (25 to 50 lb K_2O/A). The Tennessee study was in close agreement with work by Luedders et al. (1979), but contrasted with results reported by Hanson et al. (1988) who found no soybean yield or cyst nematode population responses to K fertilization on a soil with 135 to 188 parts per million (ppm) extractable K. Subsequent work (Smith et al., 2001) found that: "*Increasing K fertility level in soybean*

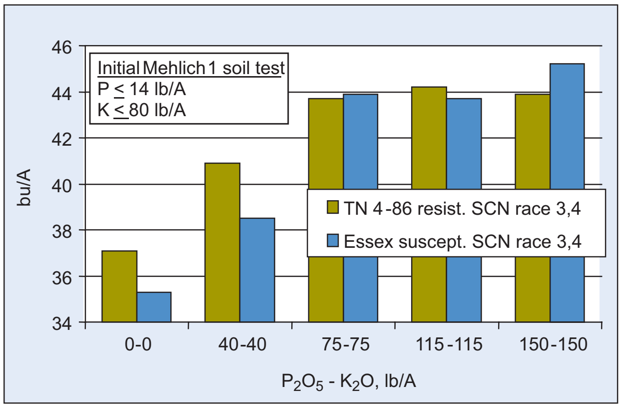

Figure 2. Phosphorus and K increase 6-year average no-till soybean yields of two varieties (Howard et al., 1998).

fields may not benefit vegetative growth of soybean infected with SCN." Yet, the authors of this study also reported, "*...at the medium level of K fertility, SCN reduced K concentration in soybean roots, and increasing K fertility to the high level overcame the effect.*"

Examples: Root and Stem Diseases

Sudden death syndrome (*Fusarium solani f. sp. glycines*) – A study conducted in Arkansas (Rupe et al., 1993) measured greater severity of sudden death syndrome (SDS) where levels of available P, magnesium (Mg), and organic matter were higher. This result agrees with field observations in this area that SDS occurs on soybeans growing in high yield environments. Further insights into these relationships were provided by a study conducted under controlled laboratory conditions (Sanogo and Yang, 2001). Like the study in Arkansas, higher SDS severity was related to increased rates of applied P and therefore higher soil test P levels. However, when K was applied, the source containing Cl actually reduced SDS severity while other K sources (nitrate and sulfate-containing forms) increased it. This is consistent with a large body of research investigating the positive effects of Cl on disease resistance of other crops (Fixen, 1993). Roy et al. (1997) reported that: "*Although Sudden Death Syndrome (SDS) is favored in highly fertile fields with a high yield potential, maintenance of the plant nutrient status may delay premature plant death caused by SDS and limit yield losses.*"

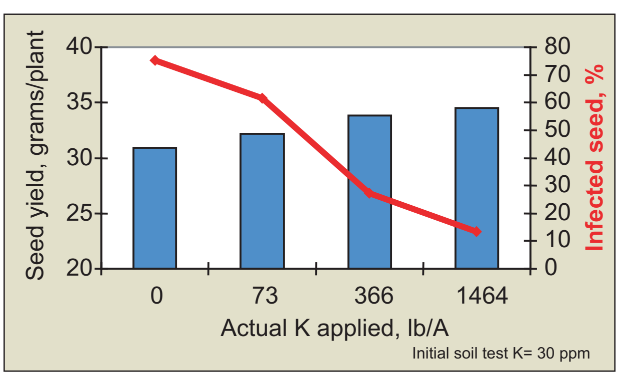

Figure 3. Effects of K on soybean seed yield and infection by pod and stem blight at an initial soil test K level of 30 ppm (Crittenden and Svec, 1974).

Pod and stem blight (*Diaporthe phaseolorum* var. *sojae*) – Potassium deficient plants are highly susceptible to pod and stem blight. **Figure 3** demonstrates a response to K fertilization from a study in which KCl and potassium sulfate (K_2SO_4) were compared. The disease reduction benefits were the same from either source of K. These data may indicate that rates above those required for a yield response may help confer a disease suppressive benefit. ■

References

Camper, H.M. and J.A. Lutz, Jr. 1977. Plowsole placement of fertilizer for soybeans and response to tillage of plowsole. Agron. J. 69:701-704.

Crittenden, H.W. and L.V. Svec. 1974. Effect of potassium on the incidence of *Diaporthe sojae* in soybean. Agron. J. 66:696-697.

Fixen, P.E. 1993. Crop responses to chloride. p. 107-150. *In* D.L. Sparks (ed.) Advances in agronomy, Vol. 50. Academic Press, London, UK.

Hanson, R.G., J.H. Muir, P.M. Sims, and J.K. Boon. 1988. Response of three soybean cultivars to cyst nematode and KCl fertilization. J. Prod. Agric. 1:327–331.

Howard, D.D., A.Y. Chambers, and G.M. Lessman. 1998. Rotation and fertilization effects on corn and soybean yields and soybean cyst nematode populations in a no-tillage system. Agron. J. 90:518–522.

Luedders, V.D., J.G. Shannon, and C.H. Baldwin, Jr. 1979. Influence of rate and source of potassium on soybean cyst nematode reproduction on soybean seedlings. Plant Dis. Rep. 63:558–560.

Myers, S.W. and C. Gratton. 2006. Influence of potassium fertility on soybean aphid, *Aphis glycines* Matsumura (Hemiptera: Aphididae), population dynamics at a field and regional scale. Environ. Entomol. 35:219-227.

Piccio, V.L. and N.S. Franje. 1980. Rust incidence in soybean (*Glycine max* (L.) Merr.) as affected by varying levels of NPK applied alone and in combination. Soybean Rust Newsletter 3:18-22.

Roy, K.W., D.E. Hershman, J.C. Rupe, and T.S. Abney. 1997. Sudden death syndrome. Plant Dis. 81(10):1100-1111.

Rupe, J.C., W.E. Sabbe, R.T. Robbins, and E.E. Gbur. 1993. Soil and plant factors associated with sudden death syndrome of soybean. J. Prod. Agric. 6:218-221.

Sanogo, S. and X.B. Yang. 2001. Relation of sand content, pH, and potassium and phosphorus nutrition to the development of sudden death syndrome in soybean. Can. J. Plant Pathol. 23:174-180.

Smith, G.J., W.J. Wiebold, T.L. Niblack, P.C. Scharf, and D.G. Blevins. 2001. Macronutrient concentrations of soybean infected with soybean cyst nematode. Plant and Soil 235:21-26.

Wrather, J.A., W.C. Stienstra, and S.R. Koenning. 2001. Soybean disease loss estimates for the United States from 1996 to 1998. Can. J. Plant Pathol. 23: 122–131.

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