Implications of Asian Soybean Rust in Nutrient Management — Research Update

By P.E. Fixen, R.W. Schneider, D.L. Wright, A.P. Mallarino, K.A. Nelson, S.A. Ebelhar, and N.A. Slaton

The increasing threat of Asian soybean rust (ASR) in the U.S. has stimulated significant research on control of soybean diseases. By the end of the 2007 growing season, ASR was verified as far north as central Iowa, where it was detected in a few isolated fields with no impact on yield. In several regions, growers and their advisers debated as to whether the yield loss threat of ASR and other diseases justified the cost of fungicide application. An understanding of the impact of cultural practices on disease development is helpful in such situations. Studies over the last couple of years have demonstrated that nutrient management can at times influence soybean disease development. However, much is yet unknown as to specific effects and if fertilizer BMPs need to be altered when ASR is present or a threat.

Much is known about the influence of plant nutrition on susceptibility and tolerance of crops to diseases (Datnoff et al., 2007). For example:

- K deficiency causes or contributes to thin cell walls, weakened stalks and stems, smaller and shorter roots, sugar accumulation in the leaves, and accumulation of unused N, all of which encourage disease infection (PPI, 1998).
- Application of Cl, usually in the form of KCl (muriate of potash), has been shown to reduce the severity of numerous fungal diseases (Fixen, 1993).
- Although studies have shown that several micronutrients can be involved in development of resistance in plants to both root and foliar diseases, Mn is thought to be the most important (Graham and Webb, 1991). As with Cl, studies have shown differences among varieties in response and some have observed that newer glyphosate-resistant soybean varieties have a reduced capacity to either take up or translocate Mn (Gordon, 2007).
- The likelihood of stem and leaf disease problems increases with crop stress and nutrient shortages and imbalances. Leaf rust in winter wheat has been reduced and yields increased by providing adequate P and K nutrition to the crop (PPI, 1999). A study on the effect of NPK fertilization on ASR-infected soybeans in the Philippines showed some rust suppression when either P (superphosphate) or K (KCl) was applied, but showed the greatest suppression when both nutrients were used.
- Independent anecdotal reports exist of ASR suppression by application of KCl and by application of micronutrients in Brazil.

With the threat and the reality of ASR presence in the U.S., it is reasonable to reevaluate the impact of plant nutrients on soybean diseases and their management. This led IPNI ...through its research affiliate, the Foundation for Agronomic Research (FAR)...to support studies in several states evaluating the influence of nutrient application on ASR and other soybean diseases. In this article, we report on progress while not drawing conclusions. The intent is to offer a “heads up” on some potential effects to growers, crop advisers, and researchers as we continue to study and manage soybean diseases, especially ASR.

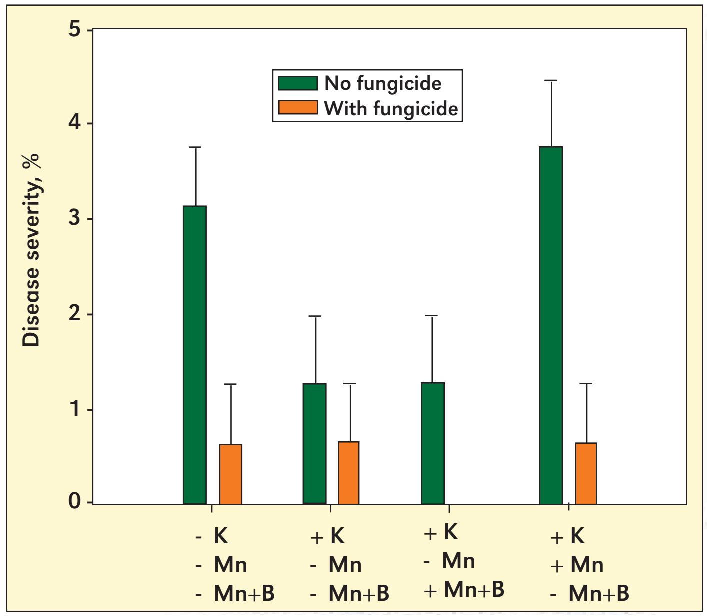
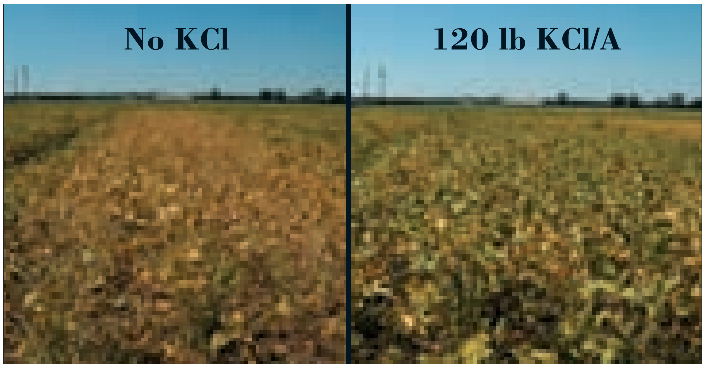


Figure 1. Effects of K, Mn, B, and fungicides on severity of ASR in soybean at Baton Rouge, Louisiana, in 2005.

Louisiana

Studies were initiated at the Louisiana State University (LSU) Agricultural Center in Baton Rouge in 2005. Hurricanes Katrina and Rita prevented the crop from reaching maturity, however, some disease incidence data were collected. Factors evaluated were preplant KCl applied at a rate of 125 lb/A and foliar application of either 0.5 lb Mn/A or 0.5 lb Mn plus 0.25 lb B/A at V4 and V10 growth stages. These fertilizer treatments were compared to Headline® and Folicur® fungicides applied at R3 and R6 growth stages. ASR did not develop until mid-November in 2005 when plants were in the late R6 growth stage and severity remained low. Though incidence was low, fungicide application reduced ASR severity across all treatments (**Figure 1**). KCl also appeared to reduce severity in two out of three treatments, while the micronutrient applications did not reduce severity. Cercospora leaf blight also was present in 2005 and both fungicide and KCl application reduced

Abbreviations and notes for this article: K = potassium; Cl = chloride; N = nitrogen; P = phosphorus; Mn = manganese; B = boron; BMPs = best management practices; ppm = parts per million.



Influence of preplant application on ASR in nutrient study at Baton Rouge, Louisiana, 2007 (Photo by R.W. Schneider).

incidence. However, incidence of this disease also was quite low, with the untreated check having a severity of only 5% (data not shown).

Severe drought in 2006 resulted in abandonment of the plots, but in 2007 a new study was established. The study compared preplant application of KCl and $CaCl_2$, preplant and sidedress application of $CaCl_2$, and evaluated the effects of foliar B+Mn application as well as 5 or 10 lb/A of urea N at the R1 growth stage. ASR incidence in 2007 was severe with 100% of leaf area in the untreated check plots being affected by the mid to late R6 growth stage, which occurred on October 3. The micronutrient application did appear to reduce incidence, especially in the upper canopy, while the sidedress Cl applications did not (**Table 1**).

Application of preplant KCl reduced severity in the upper canopy with the $CaCl_2$ application having a similar effect, indicating that the effect of KCl was due to Cl rather than K (**Figure 2**). The low rate of urea appeared to also reduce severity somewhat, but no effect was noted for the high rate (data

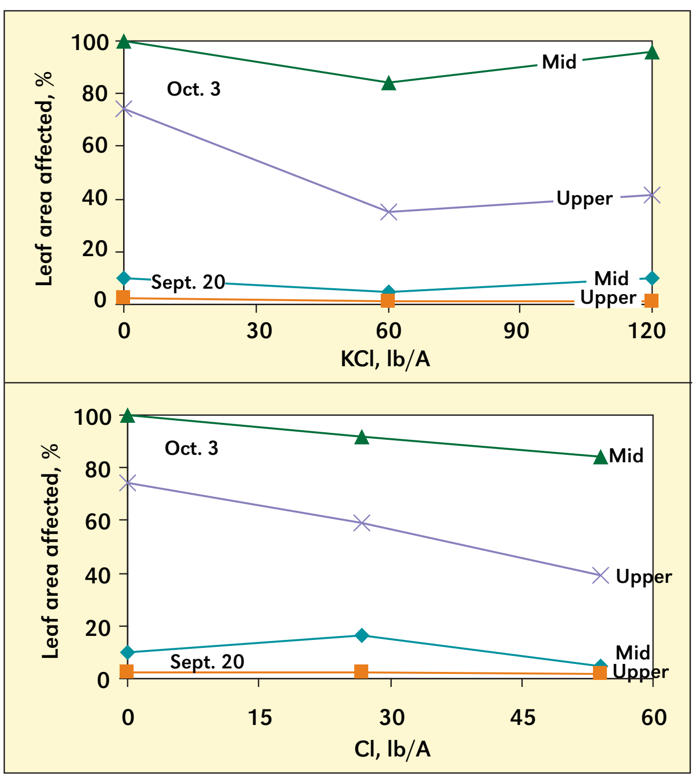


Figure 2. Influence of preplant application of K and/or Cl on leaf area affected by ASR at Baton Rouge, Louisiana, in 2007.

not shown). Yield data from these studies were not available at the writing of this article.

Table 1. Influence of foliar micronutrient application or sidedress Cl at R1 on leaf area affected by ASR at Baton Rouge, Louisiana, in 2007.

Treatment[1], lb/A	Sept. 20, early R6		Oct. 3, mid-late R6	
	Mid	Upper	Mid	Upper
	----- % leaf area affected -----			
No micros	10	2	100	74
0.25B+0.50Mn	11	2	88	47
No sidedress Cl	11	2	93	52
With sidedress Cl	8	1	100	80

[1]Averaged across other treatments.

Florida

Due partly to the pattern of ASR development, studies were initiated in 2006 by the University of Florida at the Quincy research center. Factors evaluated were preplant KCl and $CaCl_2$ at rates of 50 and 100 lb Cl/A and foliar application of B plus Mn at the R2 growth stage. ASR was first observed on October 9 in 2006, however, no effect of KCl or $CaCl_2$ on ASR or grain yield was observed. The micronutrient application did result in reduction of ASR severity and a significant grain yield increase (**Table 2**). No 2007 data were available at the writing of this article.

Missouri

Studies were conducted by the University of Missouri at Novelty and Portageville in 2006 and 2007. Factors evaluated were preplant KCl applied according to soil test-based recommendations and foliar KCl at a rate of 27 lb/A applied with or without fungicides (Headline® or Quadris®) at V4 or R4 growth stages. Diseases evaluated included frogeye leaf spot and Septoria brown spot, though incidence never exceeded 10%. ASR was not present. At the Novelty location, preplant KCl significantly reduced incidence of frogeye and Septoria while foliar application had much less to no effect (**Figure 3**). Preplant KCl increased yield by 5.1 bu/A; foliar KCl increased yield 1.6 bu/A. At the Portageville location, preplant KCl increased yield over 5 bu/A, but there was no yield response to fungicides or foliar KCl. Effects of treatments on disease incidence were variable and inconsistent.

Table 2. Influence of foliar micronutrient application at R2 on ASR severity at Quincy, Florida, in 2006.

Treatment[1], lb/A	ARS Severity			Grain yield, bu/A
	Nov. 2	Nov. 9	Nov. 17	
	-------- % --------			
No micros	17	36	88	22.2
0.25B+0.50Mn	14	18	70	25.2
LSD_{05}	NS	10	17	1.5

[1]Averaged across KCl and $CaCl_2$ treatments.

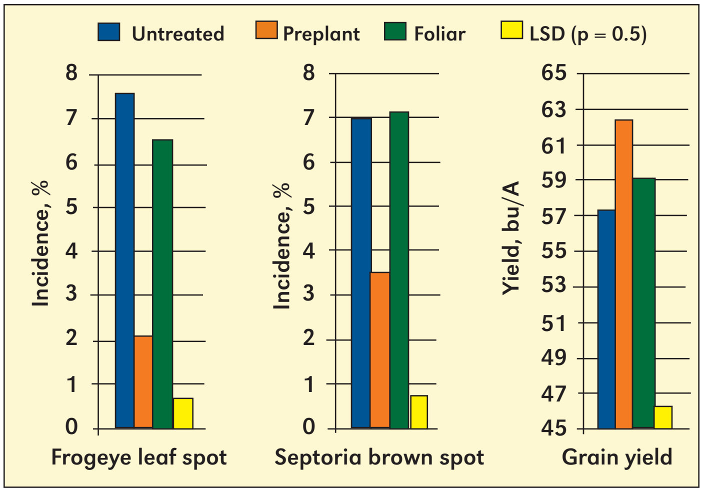


Figure 3. Influence of KCl application on disease incidence and soybean yield at Novelty, Missouri (Avg of 2006 and 2007).

Iowa

Two studies were conducted by Iowa State University from 2005 to 2007. The 2007 data are not yet available. Factors evaluated were foliar application of 3-18-18 and UAN in five trials (two locations in 2005 and three in 2006) and preplant KCl for chisel plow and no-till systems in ten trials (five locations in 2005 and 2006). Diseases evaluated were frogeye leaf spot, Septoria brown spot, and Cercospora (ASR was not present). Fungicide application showed good potential for increasing soybean yield, but foliar fertilization did not and had no consistent effect on measured foliar diseases. At the K study, fertilization increased grain yield in both tillage systems at three locations with soil-test K < 170 ppm and significant disease incidence was observed at only one location in 2005 and two in 2006. Significant K effects on disease incidence were measured at two locations in 2006. At the Northeast Farm, incidence or severity of the three diseases was reduced by KCl application, especially brown spot incidence in the no-till system (**Table 3**). Grain yields were increased by 4 to 5 bu in the chisel system and by 8 bu/A in the no-till system. At the Northern Farm location, brown spot was reduced by KCl in the no-till system, but not in the chisel system (**Figure 4**). Frogeye and Cercospora were reduced similarly in both tillage systems. Grain yields were increased by KCl in both systems.

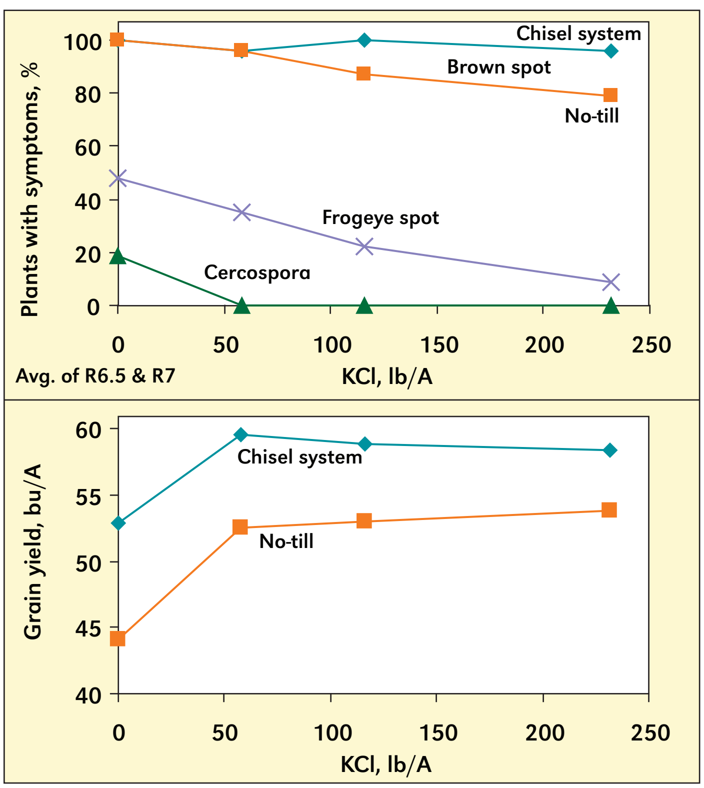


Figure 4. Influence of KCl fertilization on three diseases and yield in Iowa (Northern Farm, 2006).

Table 3. Influence of KCl fertilization on brown spot and grain yield in Iowa (Northeast Farm, 2006).

	Chisel		No-till	
KCl rate, lb/A	Incidence, %	Yield, bu/A	Incidence, %	Yield, bu/A
0	92	56.3	95	52.1
58	83	61.5	92	57.9
116	82	59.7	78	60.1
116[1]	88	61.4	67	60.5

[1]Deep-band K fertilizer placement.

Illinois and Arkansas

Studies are also ongoing by the University of Illinois and by the University of Arkansas. The Illinois studies are evaluating application of KCl, K_2SO_4, foliar B, and foliar Mn on both glyphosate-resistant and non-glyphosate-resistant varieties. The Arkansas studies are examining P and KCl applications. In general, diseases at these locations were slight to none except at one Illinois location in one year where fungicide gave a 7 bu/A response, mostly from frogeye suppression. However, none of the fertilizer treatments reduced disease severity. No yield increases to fertilizer treatments were measured in Illinois while one 8 bu/A response to K was measured in Arkansas. However, it did not appear to be related to disease suppression.

Summary and Questions

Based on these preliminary results, here are some observations.

- KCl application reduced:
  - frogeye leaf spot and Septoria brown spot in Iowa and Missouri, but not in Illinois;
  - Cercospora leaf blight in Iowa and Louisiana;
  - ASR in Louisiana ($CaCl_2$ effect was similar), but not in Florida.
- Mn + B application reduced ASR in both Louisiana and Florida.

In some situations, nutrient application in today's cropping systems appears to reduce soybean fungal disease severity, but does not substitute for fungicides when disease pressure is severe. In epidemiological terms, disease onset was delayed, and the rate of disease development was reduced, although disease severity at the end of the season may not have differed among treatments. However, an improved understanding of these nutrient-disease interactions may offer an opportunity for more cost effective disease management. These studies have clearly identified specific questions that need to be addressed.

- To date at responsive sites, Mn and B have been applied together. Which of these nutrients is responsible for the effect?
- KCl application has suppressed disease. Is this a K effect or a Cl effect or both?
- Do disease considerations alter BMPs for nutrients? For example, if the KCl effect is due to Cl or tied to recently applied K, potash applications may need to be made directly to soybean.
- Are there interactions among nutritional status and predisposing stressors such as water stress, soil compactions, and others? BC

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Dr. Fixen (e-mail: pfixen@ipni.net) is IPNI Senior Vice President and Director of Research, located at Brookings, South Dakota. Dr. Schneider is with Louisiana State University Agriculture Center. Dr. Wright is with University of Florida. Dr. Mallarino is with Iowa State University. Dr. Nelson is with University of Missouri. Dr. Ebelhar is with University of Illinois. Dr. Slaton is with University of Arkansas.

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Note: Proceedings from the third National Soybean Rust symposium are now posted on the Plant Management Network's publicly available Soybean Rust Information Center at this URL:
http://www.plantmanagementnetwork.org/infocenter/topic/soybeanrust/2007

Recognizing Soybean Field Problems

Understanding how various nutrient imbalances, disease risks, and other factors threaten soybean plant health, production, and seed quality can be valuable in diagnosing and preventing field problems.

Shown on this page are a few examples illustrating symptoms from the IPNI publication titled *Be Your Own Soybean Doctor*. It is intended to help growers, consultants, and others in becoming more familiar with symptoms of nutrient deficiencies, toxicities, diseases, and other disorders in soybean production. While it does not substitute for diagnostic tools such as plant tissue analysis and soil testing, the guide can be useful in distinguishing and identifying various field problems. It features 40 color illustrations with brief discussion of each.

The full color publication is 8 pages, 8 ½ x 11 in., and patterned after the classic *Be Your Own Corn Doctor*, which has been widely used for many years. *Be Your Own Soybean Doctor* is available for 50 cents (US$0.50) per copy, plus shipping/handling. Discounts are available on quantity orders.

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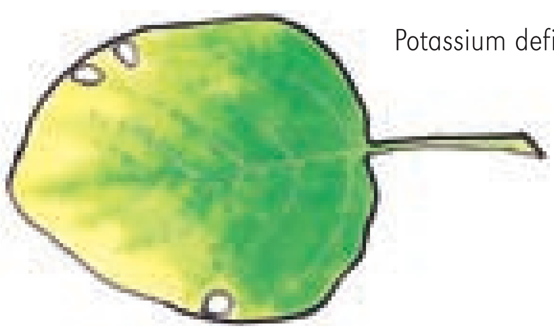
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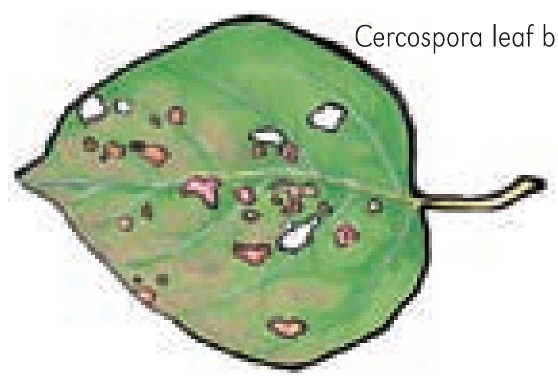
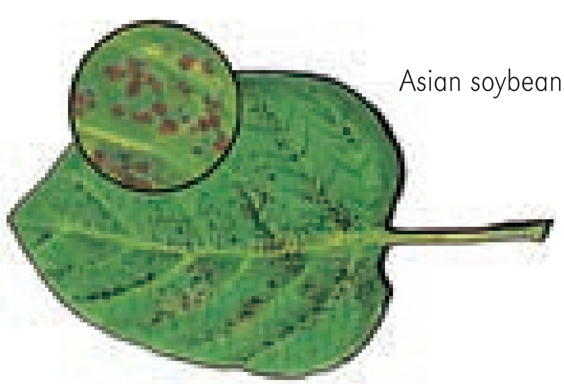
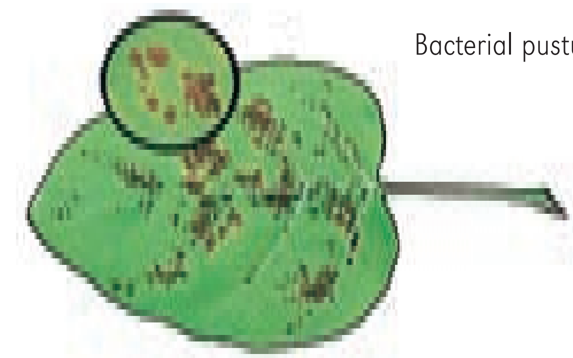

Cercospora leaf blight/Frogeye


Asian soybean rust


Bacterial pustule