Use of Pre-plant or Foliar-Applied Potassium Chloride with Fungicides to Improve Soybean Response and Disease Resistance

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Introduction:

An increased occurrence of K deficiency in soybeans and the potential widespread onset of Asian rust (SBR) (*Phakopsora pachyrhiza*) in soybeans have stimulated interest in new management practices that may improve K nutrition and lower incidence of disease. In 2004, SBR was reported in nine states including Louisiana, other Gulf-coast and southeastern states, and Missouri (APHIS, 2005). Yield loss estimates for this fungal disease range from 10 to 80% in areas where rust is established and could result in economic losses between $640 to $1,341 million the first year of infestation (Sweets et al., 2004). Since current soybean varieties grown in the U.S. have little or no resistance to SBR, a primary method of controlling the spread of the disease has been use of fungicides. Currently, four families of fungicides are available for SBR management: triazoles, strobilurins, chloronitriles, and carboxamides. In addition, extensive research has established a link between plant nutrition and disease incidence including the disease suppressing effects of K, Cl, Mn, B and P (Fixen et al, 2004). Therefore, combining K, Cl and other nutrients either as a pre-plant or foliar application with a fungicide may improve disease management. Recent research by Bradley and Sweets (2005) in Missouri indicates that several fungicides can be tank mixed with glyphosate without significant injury or reduction in yields of soybeans, but the limited penetration of the combined spray into the plant canopy may reduce potential SBR control. Nelson et al. (2004) has also established the KCl and several other K fertilizer sources can be combined with glyphosate without reducing weed control or causing significant foliar injury. This "weed and feed" system could also serve as an example for a system that combines disease control and nutrient management. The possible benefits of this approach include reduction in application costs, improved disease suppression and nutrient response, and flexibility in management response to environmental conditions during the growing season.

The objectives of this study were:

1. Determine soybean yield response, disease incidence and K and Cl tissue concentrations from application of KCl alone or in combination with several fungicides.
2. Examine the effects of application timing of KCl or the fungicides on crop response and disease incidence.
3. Evaluate the cost-effectiveness of applying KCl with fungicides for soybean production.

Materials and Methods:

This study evaluated the effects of either pre-plant or foliar-applied KCl fertilizer sources and rates of application on glyphosate-resistant soybean response and weed control. The first of two site-year field trials was established at the Greenley and Delta Centers on soils with medium to low soil test K. Roundup-Ready® soybeans were no-till planted at 180,000 seeds/acre in 15 inch rows. The study was arranged as a randomized complete block design with four replications. Treatments consisted of a non-treated control, a recommended pre-plant rate of KCl

based on soil test, or a foliar application of 16 lb K/acre (as KCl) in a factorial arrangement combined with and without fungicide applications of 6 oz/acre of pyraclostrobin (Headline®), 6.4 oz/acre of azoxystrobin (Quadris®) or 6.4 oz/acre Quadris® + 2.6 oz/acre of Warrior® (lambda-cyhalothrin insecticide) applied either at V4 or R4 growth stages.

Foliar injury was rated 3, 7, and 28 days after foliar application. Treatments were evaluated for the incidence of Septoria brown spot (*Septoria glycines*), frogeye leaf spot (*Cercospora sojina*), sudden death syndrome (*Fusarium solani*), and Asian rust. Soybeans were harvested and data analyzed to determine the influence of the treatments on crop response and grain yield. Data were subjected to an analysis of variance and means separated at p=0.05 unless otherwise specified. Main effects were generally presented in the absence of interactions.

Results and Discussion:

Injury. Soybean injury was minimal except when fungicides were tank mixed with KCl at Portageville (Table 1). Leaf necrosis was the primary symptom and plants recovered by 10 days after treatment.

Table 1. Soybean response to tank mixture combinations of foliar applied K with fungicide treatments averaged over application timing.

	Injury			
	Novelty		Portageville	
Treatment	3 DAT	7 DAT	3 DAT	10 DAT
	---------- % ----------			
Non-treated	1	0	15	7
Quadris at 6.4 oz/a	1	1	13	7
Quadris at 6.4 oz/a + Warrior at 2.6 oz/a	1	1	17	6
Headline at 6 oz/a	3	1	14	5
LSD (p=0.05)	0.4	0.3	4	2

Abbreviations: DAT, days after treatment; LSD, least significant difference.

Incidence of disease. Asian soybean rust was not present at either location in 2006. The incidence of Septoria brown spot, Frogeye leaf spot, or sudden death syndrome was less than 10% in 2006. Interactions between application timing and fungicide treatment were common. However, KCl fertility did affect the incidence of Septoria brown spot and frogeye leaf spot at Novelty in 2006.

Septoria brown spot was present at Novelty and Portageville. A lower incidence of Septoria brown spot was present in treatments with preplant KCl (Table 2). Foliar applied KCl plus Headline slightly reduced the incidence of Septoria brown spot at this location. At Portageville, Septoria brown spot was reduced when Quadris or Headline were applied at the V4 stage; however, no differences were observed at the R4 application timing.

The incidence of frogeye leaf spot was ranked non-treated = foliar applied KCl > preplant KCl (P=0.0003) when averaged over fungicides and application timings (data not presented). All fungicide treatments when averaged over application timing and KCl fertility treatments reduced the incidence of frogeye leaf spot when compared to the non-treated control (P=0.0007) at Novelty (data not presented). Slight differences in the incidence of frogeye leaf spot among application timings were observed for fungicide treatments at this location (Table 3). At

Portageville, the V4 application timing had a lower incidence of disease than the R4 timing (P=0.026) (data not presented). Sudden death syndrome was sporadic and none of the treatments reduced the incidence of this plant disease when compared to the non-treated control (Table 3).

Table 2. Effect of K fertility and fungicide on the incidence of Septoria brown spot at Novelty in 2006.

Treatment	Non-treated	Preplant KCl at 455 lb K/a	Foliar KCl at 16 lb K/a
	---------- % ----------		
Non-treated	10	5	11
Quadris at 6.4 oz/a	9	4	11
Quadris at 6.4 oz/a + Warrior at 2.6 oz/a	9	4	9
Headline at 6 oz/a	9	4	8
LSD (p=0.05)	---------- 2 ----------		

Table 3. Effect of fungicide and application timing on the incidence of Septoria brown spot, frogeye leaf spot, and sudden death syndrome in 2006.

	Septoria brown spot		Frogeye leaf spot	Sudden death syndrome
Treatment	Novelty	Portageville	Novelty	Portageville
V4 application timing				
Non-treated	9	6	7	0
Quadris at 6.4 oz/a	9	4	7	3
Quadris at 6.4 oz/a + Warrior at 2.6 oz/a	8	5	5	2
Headline at 6 oz/a	9	3	6	1
R4 application timing				
Non-treated	8	6	6	0
Quadris at 6.4 oz/a	8	7	5	0
Quadris at 6.4 oz/a + Warrior at 2.6 oz/a	7	6	5	0
Headline at 6 oz/a	6	6	3	2
LSD (p=0.05)	NS	2	1.3	1

Yield. Grain yield at Novelty and Portageville increased 5.5 to 6.5 bu/a with preplant KCl when compared with the non-treated control and foliar applied KCl (Table 4). At Novelty, fungicide treatments increased yields 2.3 to 3.2 bu/acre, but there was no yield increase when Warrior was added to Quadris. The R4 application timing was 2.6 bu/a greater than the V4 timing in 2006.

Summary and Conclusions:

This research indicates that KCl fertility reduced the incidence of Septoria brown spot and frogeye leaf spot at Novelty, but no differences were observed at Portageville. Preplant KCl increased yield when compared to the non-treated control and foliar applied KCl at Novelty and Portageville which could be related to the combined effects of disease tolerance and fertility. Fungicide treatments applied at the R4 stage of development increased grain yield at Novelty, but had no effect on grain yields at Portageville in 2006. The cost-effectiveness of the treatments will be determined following research in 2007.

Table 4. Seed yield of KCl application timing, fungicide, and application timing main effects at Novelty and Portageville in 2006.

Treatment	Yield	
	Novelty	Portageville
	---------- bu/acre ----------	
KCl application timing		
Non-treated	65.8	62.0
Preplant at 455 lb K/a	72.3	67.6
Foliar at 16 lb K/a	66.8	61.6
LSD (p=0.10)	3.9	5.1
Fungicide		
Non-treated	66.1	62
Quadris at 6.4 oz/a	69.3	64
Quadris at 6.4 oz/a + Warrior at 2.6 oz/a	69.3	61
Headline at 6 oz/a	68.4	67
LSD (p=0.10)	2.0	NS
Application timing		
V4	67.2	64
R4	69.8	64
LSD (p=0.10)	0.4	NS

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