

MISSISSIPPI SOYBEAN PROMOTION BOARD
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PROGRESS REPORT

Title: Impact of fungicides and production systems on the management of soybean rust and other diseases in Mississippi soybean.

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Objectives:

- 1) Evaluate the efficacy of foliar fungicides for control of soybean rust and other diseases.
- 2) Determine the impact of fungicide timing on soybean yield and control of soybean rust and other diseases.
- 3) Investigate the interrelationships between planting date, maturity group, and soybean response to fungicides.
- 4) Assess the impact of adjuvants on fungicide efficacy and soybean injury.
- 5) Incorporate findings into existing foliar fungicide recommendations to maximize yield and offset treatment costs in an effort to determine the most cost effective rust management strategies.

Efficacy trials (Tables 1-7): Studies were conducted at 6 locations in 2005 and six locations in 2006 to assess the efficacy of various fungicides on control of soybean rust and other foliar diseases. Locations in 2005 were Stoneville (2

locations), Verona (1 location), Moorhead (2 locations), and Morgan City (1 location). Locations in 2006 were Stoneville (2 locations), Leland (1 location), Inverness (2 locations), and Verona (1 location). Yield data were not utilized if field variability was too high. However, disease control and plant greening data were utilized from all locations if available.

Sixteen fungicide treatments were evaluated as single and sequential applications. Initial application timings ranged from R2 to R4 and follow-up applications for sequential treatments were made approximately 21 days later. Triazole fungicide treatments included Folicur, Domark, Tilt, and Laredo. Strobilurin fungicides were Quadris and Headline. Commercially available premixes included Quilt and Stratego. Premixes that will likely be available soon included Absolute and Quadris Xtra. Triazole + strobilurin mixtures that represented choices that producers are likely to encounter were also included in the study. The triazole fungicide, flutriafol, was evaluated alone at one location in 2005 instead of Quadris Xtra that was in short supply.

Soybean rust was not present at any trial location during the 2005 growing season. It was present at Verona very late in the growing season in 2006, but likely did not affect yield. Disease pressure in general was low both years due to dry weather at most locations. Most disease pressure showed up late in the growing season. However, economical yield increases were still realized with some fungicide treatments indicating the potential to produce economic returns from fungicides even in the absence of soybean rust.

No benefit was generally seen to a second application with most fungicide applications and no application number by treatment interactions were detected across studies. This means that the best treatments were still the best treatments regardless of how many times they were applied. Yields were generally higher with treatments that contained strobilurin fungicides applied alone or in combination with triazole fungicides. The only triazole to increase yield significantly above the nontreated control was Domark. However, soybean yields with Domark were not as good as the best treatments and the cost of the treatment would not have been offset by the yield increase realized. This suggests limited benefit with most triazole fungicides in the absence of rust. Averaged across fungicide groupings, soybean yields were highest with full rate strobilurins followed by mixtures then triazoles. Bravo Weatherstik and Topsin M treatments did not increase yield.

These findings suggest that strobilurin fungicides will be the most efficacious and economical means of controlling late-season soybean diseases in the absence of rust and that they likely should be incorporated into a rust management program to offset the cost of the overall disease management program. More studies need to be conducted where soybean rust is present.

Triazole Efficacy Studies (Tables 8-11): Studies were also conducted to

evaluate triazoles alone and in combination with Headline. Four locations in 2006 included Stoneville (2 locations), Verona (1 location), and Inverness (1 location). Yield data were not utilized if field variability was too high. However, disease control, injury, and plant greening data were utilized from all locations where available.

Nine triazole treatments were evaluated alone and in combination with Headline. Folicur, Domark, Laredo, Alto, Topguard, Punch, Caramba, Tilt, and Proline were included. Application timing was targeted at the R3 growth stage and was a single application.

Soybean rust was not present at 3 trial locations during the 2006 growing season. It was present at Verona very late in the growing season in 2006, but likely did not affect yield. Low disease pressure in general was due to dry weather at most locations. Most disease pressure showed up late in the growing season. Triazoles did not increase soybean yield but the addition of Headline to caused a 1.2 bu/a increase. This slight increase would not have covered material and application costs.

Adjuvant trials (Table 12): Two trials were initiated in 2006 to evaluate the impact of various adjuvants on fungicide efficacy, triazole injury, and yield enhancement. One location was Leland, MS and one location was Stoneville, MS. Two varieties were utilized, one behind corn dryland and one behind corn irrigated.

Headline + Folicur was applied alone and in combination with 23 different tank mix partners that included adjuvants, herbicides, and insecticides. Folicur, Headline, and Headline + Caramba were included as comparison treatments. Application timing was R4-R5.

Injury and downy mildew ratings were taken when warranted. Downy mildew was the only disease with a ratable infection level. Soybeans were planted early and following corn; therefore, disease pressure was low making it easier to assess the impact of injury on soybean yield. Adjuvants added to Headline + Folicur generally did not improve disease control or soybean yield compared to Headline + Folicur alone. However, Dyne-a-Pak and HM 0107 increased disease control numerically compared to Headline + Folicur alone. All adjuvants and Roundup Weathermax increased injury compared to Headline + Folicur alone. However, injury averaged over locations generally did not exceed 10%. Insecticides did not increase injury and yields were 1.3 to 2 bu/a higher with combinations of Headline + Folicur and insecticides than with Headline + Folicur alone. Hyperactive and Cohere appeared promising as fungicide adjuvants because they caused only minimal increases in injury and increased soybean yield numerically 1 to 1.9 bu/a compared to using no adjuvant with Headline + Folicur.

Fungicide Timing Study (Tables 13-15): A trial to evaluate the impact of application timing of fungicides on efficacy and yield enhancement was repeated at Stoneville, MS.

Folicur alone, Headline alone, and Folicur + Headline were the fungicide treatments. Timings included R1, R3, R5 for the single applications and R1 fb R3, R3 fb R5, and R1 fb R3 fb R5 for the sequential applications.

Disease control was best when applications were made later in the growing season at the R5 growth stage. This is likely due to the fact that overall disease pressure was light and infestations generally occurred late in the growing season. Sequential applications did not improve disease control. Disease control was better with Headline and Headline + Folicur than with Folicur alone. With regards to injury, applications with Folicur at R5 increased injury, and it is interesting to note that sequential applications did not seem to compound this injury. Headline alone caused no injury, and its addition to Folicur did not increase injury. Treatments with Headline yielded the best. A single, timely R3 application equaled the yields seen with sequential applications. All treatment combinations increased yield over the nontreated with the exception of Folicur as single applications. Once again, it is important to note that these results were observed in very light disease pressure. Although the best disease control was achieved with R5 applications in this study, R3 was the timing that resulted in the greatest yield responses. This may suggest that yield responses to strobilurin fungicides like Headline are at least partially due to the factors other than disease control.

Manual Defoliation Trials (Tables 16-18): Two trials simulating the effect of Asian Soybean Rust via manual defoliation were initiated at Stoneville, MS. One trial evaluated various degrees of defoliation (0, 30%, and 60%) at multiple growth stages (R1, R3, R5) using the indeterminate variety AG 4403. The second trial evaluated the impact of 50% defoliation on two growth types (indeterminate DK 4967 and determinate DK 5161) at various growth stages (R1, R3, and R5). Both trials were sprayed at R3 with a 9 oz/a rate of Headline to reduce negative impact of late season diseases.

Defoliation at R1 impacted the indeterminate variety less than the determinate variety. Conversely, defoliation at R5 impacted the indeterminate variety more than the determinate variety. At R1, indeterminate soybeans have only acquired a small percentage of their total vegetative growth. Consequently, defoliation at this stage would likely be of minimal consequence because the plant subsequent to defoliation will put on more growth. In contrast, a determinate variety at R1 has already acquired perhaps 90% of its vegetative growth and would therefore be less able to overcome a defoliation event at this growth stage. In the case of defoliation events late in the growing season, determinate varieties tend to produce more foliage than indeterminate varieties and are therefore more able to tolerate defoliation events late in the growing season. Of particular concern is

that defoliation at R3 drastically reduced yields of both determinate and indeterminate varieties by more than 21 bu/a. Defoliation at this growth stage resulted in pod abortion and drastic yield loss. Therefore, protecting soybeans from rust is most important during the period when the soybean plant is setting pods. The importance of the R3 growth stage to determining soybean yield potential was reiterated in a second study using the indeterminate soybean variety AG 4403. Yield was reduced 6, 17, and 9% when defoliation events occurred at R1, R3, and R5 growth stages, respectively. Yield was reduced 12 and 20% by 30 and 60% defoliation, respectively.

Impact of Fungicides on Maturity Group III, IV, and V soybean planted at various planting dates (Figures 1 and 2): In fields planted to continuous soybean and irrigated, strobilurin-based fungicide programs increased soybean yield regardless of maturity group and planting date. Yield responses increased with increasing maturity group indicating that earlier maturity group soybeans may be successfully avoiding some diseases. In fact, the smallest yield response to fungicides occurred with the MG III variety planted in early April.

Systems/Spray Order studies - 2005 (Tables 19-21): The order in which fungicides are utilized was investigated in an effort to determine effectiveness of various fungicide programs as part of an overall rust management strategy. Products evaluated were Folicur, Headline, Headline SBR (Headline + Folicur), and Quilt. These products represented triazoles alone, strobilurins alone, an efficacious tank mixture, and a supposedly weaker mixture, respectively. Tests were conducted at Stoneville, Verona, and Morgan City.

Significant yield increases occurred at only one of the 3 locations utilized in this study. This is likely due to only light disease pressure across locations. However, obvious yield trends were observed. Yield increases did not generally occur when a strobilurin fungicide was not included in the overall disease control program. Average over all locations, for example, yields with Folicur fb Folicur were 56.2 bu/a compared to 56.1 bu/a in the nontreated control. As a general rule, yields tended to be highest whenever a full rate of Headline was used somewhere in the overall disease management program. This likely indicates improved disease control with full rate strobilurins compared to mixtures like Quilt with reduced rates of strobilurin fungicides. Yields also tended to be higher when Headline was used first as part of a sequential program. This illustrates the importance of timely strobilurin applications and suggests potential overall plant health effects with strobilurins in general.

Spray Coverage -2005 (Table 24): Fungicide treated plot yielded 4 bushels more per acre than non-treated plots averaged across row spacings and spray nozzles type. Large visual differences in spray coverage between nozzle type were apparent and cards are currently being analyzed using Sigma Scan software to determine total level of spray coverage achieved using each nozzle

type. Given the dry growing conditions during the 2005-growing season overall disease pressure was light and spraying versus not spraying was the only factor affecting yield. However, it is suspected that spray coverage and nozzle type will have a differential impact on yield due to differences in disease control during wetter years when disease is more yield limiting and soybean rust is in the picture. More research needs to be conducted.

Additional Adjuvant trials - 2005 (Tables 22-23): Trial location was Stoneville, MS. The field received fall tillage and was planted into a stale seedbed 18/Apr/2005 with DK4461 soybeans at a seeding rate of 116,740 seed/acre into a smooth seedbed of Sharkey silty clay loam with adequate moisture at 1.5 in deep. This was at least the third season that soybeans were planted at this location. Plot width was 13.3 ft., plot length was 40 ft., and row spacing was 40 in. A randomized complete block experimental design with a factorial treatment structure was utilized. Soil description was 2.1% sand, 28% silt, 69.9% clay, 3.0 % organic matter; pH was 7.08 and CEC was 42.5. Fungicide applications were made 14/Jul/2005 with a Kubota tractor using a 10 ft. wide hooded sprayer operating at 39psi and 15 GPA with Teejet XR11002VS nozzles spaced 20 in. apart and operated at a speed of 3.65 MPH 18 inches above the canopy of 18 node soybeans. Fungicides were applied in combination with various adjuvants. Visual ratings of suppression of Frogeye leaf spot of soybean (*Cercospora sojina*) were taken on 2/Aug/2005, about three weeks after treatment. No other diseases were present at levels that warranted evaluation. Harvest data were collected 8/Sept/2005 from each plot.

Disease Control (Table 10): A fungicide by adjuvant interaction occurred with frogeye leafspot control. All fungicides reduced disease levels significantly compared to the nontreated control. The addition of any adjuvant to Quadris improved disease control. This was not the case with Quilt and Headline. Averaged across fungicides the 3 most efficacious adjuvant treatments were Adsee 600 at 0.25% v/v, Penetrator Plus at 8 oz/a, and Agridex at 1% v/v. UAN was the least effective adjuvant. Other general observations were that 0.25% v/v Adsee 600 tended to be more consistent than 0.125% v/v and 8 oz/a Penetrator Plus tended to be more consistent than 0.25% v/v.

Soybean Yield (Table 11): Soybean yields were generally not improved by the use of foliar fungicides. However, this was somewhat expected given that below labeled rates were utilized and disease pressure was extremely low until late in the growing season. Statistically, soybean yields with Headline were higher than with Quadris in the trial. Statistical differences in yield were generally not detected for other main and interaction effects. However, trends in yield were very obvious. Yield tended to increase when adjuvants were added to the azoxystrobin-based Quilt and Quadris treatments. This was not the case with Headline. Quadris is a suspension concentrate formulation and Headline is an EC formulation. This may suggest that solvents in the EC formulation are

sufficient to serve as adjuvants and that no additional adjuvants will be needed to maximize disease control with Headline. Averaged across fungicides, yields tended to be higher with the use of an adjuvant.

Table 1. Brown Spot (*Septoria glycines*) severity as affected by fungicides, 2005-2006.

Fungicide	Formulation	Rate (lb ai/a)	Brown Spot Severity					
			Sequential		Single	Average		
			--0-9--					
Folicur	3.6 F	0.112	2.58		2.63		2.60	b
Domark	1.9 ME	0.0754	2.08		2.54		2.31	bc
Tilt	3.6 EC	0.14	2.25		2.88		2.56	b
Laredo	2 EC	0.109	2.76		2.68		2.72	ab
Stratego Induce	2.09 EC L	0.163 0.25 %	1.29		1.70		1.49	ef
Quilt Agridex	1.67 SC L	0.183 1%	1.38		1.74		1.57	ef
Headline Folicur Induce	2.09 EC 3.6 F L	0.077 0.087 0.25%	1.33		2.00		1.66	ef
Quadris Folicur Induce	2.08 F 3.6 F L	0.078 0.087 0.25%	1.66		2.13		1.89	cde
Absolute Induce	4.2 SC L	0.164 0.25%	1.13		1.83		1.48	ef
Quadris Agridex	2.08 SC L	0.101 1%	1.61		1.95		1.78	def
Headline Induce	2.09 EC L	0.098 0.25%	1.38		1.7		1.54	ef
Bravo Weatherstik	6 SC	1.13	2.49		2.68		2.58	b
Topsin M	4.5 F	0.527	2.00		2.25		2.13	cd
Headline Caramba Induce	2.09 EC 0.75 SL L	0.072 0.045 0.25%	1.25		1.66		1.46	f
Alto Quadris Induce	0.84 SL 2.08 SC L	0.0262 0.089 0.25%	1.41		1.61		1.51	ef
Quadris Folicur Induce	2.08 SC 3.6 F L	0.101 0.112 0.25%	1.66		1.41		1.54	ef
Nontreated Control			3.14		3.14		3.14	a
Average			1.84		2.15		2.00	
		LSD (0.05)			Pr>F			
Fungicide		0.42			<.0001			
Application		0.144			<.0001			
Fungicide by Application		0.60			0.7200			

Table 2. Phytotoxicity severity as affected by fungicides, 2005-2006.

Fungicide	Formulation	Rate (lb ai/a)	Injury Severity					
			Sequential		Single	Average		
			--0-9--					
Folicur	3.6 F	0.112	0.78		0.42		0.60	e
Domark	1.9 ME	0.0754	0.15		0.09		0.12	f
Tilt	3.6 EC	0.14	0.07		0.06		0.06	f
Laredo	2 EC	0.109	0.06		0.06		0.06	f
Stratego	2.09 EC	0.163	0.07		0.03		0.05	f
Induce	L	0.25 %						
Quilt	1.67 SC	0.183	0.13		0.16		0.14	f
Agridex	L	1%						
Headline	2.09 EC	0.077	2.03		1.15		1.59	bc
Folicur	3.6 F	0.087						
Induce	L	0.25%						
Quadris	2.08 F	0.078	1.76		1.17		1.46	cd
Folicur	3.6 F	0.087						
Induce	L	0.25%						
Absolute	4.2 SC	0.164	1.46		1.16		1.31	d
Induce	L	0.25%						
Quadris	2.08 SC	0.101	0.32		0.10		0.21	f
Agridex	L	1%						
Headline	2.09 EC	0.098	0.09		0.06		0.08	f
Induce	L	0.25%						
Bravo Weatherstik	6 SC	1.13	0.03		0.13		0.08	f
Topsin M	4.5 F	0.527	0.07		0.09		0.08	f
Headline	2.09 EC	0.072	2.41		1.33		1.87	a
Caramba	0.75 SL	0.045						
Induce	L	0.25%						
Alto	0.84 SL	0.0262	0.19		0.25		0.22	f
Quadris	2.08 SC	0.089						
Induce	L	0.25%						
Quadris	2.08 SC	0.101	2.08		1.33		1.70	ab
Folicur	3.6 F	0.112						
Induce	L	0.25%						
Nontreated Control			0.09		0.09		0.09	f
Average			0.69		0.45		0.57	
		LSD (0.05)			Pr>F			
Fungicide		0.19			<.0001			
Application		0.06			<.0001			
Fungicide by Application		0.27			<.0001			