MISSISSIPPI SOYBEAN PROMOTION BOARD
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Title: Evaluation of Alternative Management Tactics for Early Season Insect Pests of Soybeans and Impact of Seed Treatments on Stand Establishment and Replant Prevention

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BACKGROUND AND OBJECTIVES

Prior to the introduction of the neonicotinoid seed treatments, there was very little if any use of at-planting insecticides in Mississippi soybean production. Most of the products that were available required an in-furrow application (granular or liquid), with acephate being the exception.

Neonicotinoid insecticides are used in soybean production as foliar applications and as seed treatments; this represents most, if not all, of the insecticide seed treatment usage in Mississippi soybean production since 2007. The use of neonicotinoid seed treatments has steadily increased since their introduction, with the most current estimate (2014) of 90% adoption by Mississippi soybean growers. These are an important tool for managing early season insect pests that can impact yield and stand establishment. Yield responses to neonicotinoid seed treatments in Mississippi have averaged 2.5 bu/acre, with a positive economic benefit of ca. 70% of the studies.

The early soybean production system has many advantages; however, with early planting the chances of less than optimal conditions for plant growth are greater than at later planting dates. Slower plant growth can result in greater susceptibility to insect injury or result in larger impacts from insect injury than would be observed on more vigorous plants. With increased input costs for soybeans, especially at-planting costs including seed, replanting is a major economic decision for growers. The consensus among growers, consultants, and entomologists is that the use of these products has reduced the risk of having to replant in many situations because of reduced stand loss. However, the impact and value of reduced replant risks has been difficult to quantity.

The U.S. Environmental Protection Agency issued a preliminary report during 2014 stating that neonicotinoid seed treatments provided no benefits to soybean production. Published data from the mid-Southern states demonstrates a positive economic benefit for the use of neonicotinoid insecticide seed treatments in Mid-South soybean production. In spite of this demonstrated benefit and other research findings that indicate that neonicotinoid insecticides applied as seed treatments to soybeans are not present in soybean floral structures, the use of neonicotinoid insecticides could be restricted or prohibited in the future.

Currently growers have very few, if any, alternatives to neonicotinoid seed treatments if these products are restricted or prohibited. The loss of these products, assuming no replacements, would result in a ca. $30,000,000 loss to Mississippi soybean growers based on 90% seed treatment adoption on 2.33 million acres (2015 estimate), $6.56/acre insecticide seed treatment costs, and $8.50/bu soybean selling price. Preliminary studies conducted during 2015 indicated that several treatments including bifenthrin, chlorantraniliprole, and cyantraniliprole performed equal to a neonicotinoid seed treatment.

EXPERIMENTAL APPROACH AND OBJECTIVES

Objectives:

To evaluate at-planting insecticides as possible alternatives to neonicotinoid seed treatments.

To evaluate the impact of neonicotinoid seed treatments on stand establishment and estimate the value of seed treatments with regard to minimizing risk of having to replant.

REPORT OF PROGRESS/ACTIVITY

Objective 1

Three experiments were conducted to evaluate the performance of at-planting alternatives to neonicotinoid seed treatments. **These studies were conducted in a field that had a vetch winter cover crop to increase the possibility of insect infestations.** In two of the studies, insect infestations were minimal and there were no significant differences among treatments in stand establishment or yield. In another study (Table 1), soil insect and pea leaf weevil infestations were present. In this experiment all of the insecticides were applied as seed treatments in addition to the fungicide seed treatment (ApronMaxx RFC).

Dermacor (chlorantraniliprole) alone (both rates) resulted in significantly greater plant density at 35 days after emergence (DAE) compared to the fungicide-only control. However, plant density in plots that received Dermacor alone was significantly lower than in plots that received Gaucho (alone or in combination with Dermacor). All of the insecticide seed treatments that included Gaucho and/or Dermacor resulted in significantly higher soybean yield compared to Acephate or the fungicide-only (ApronMaxx RFC) control. Yield differences between the insecticide plus fungicide treatments and the fungicide-only treatment ranged from 0.3 to 12.4 bu/acre. Currently chlorantraniliproleis not labeled as a seed treatment for soybeans, but is labeled for foliar applications in soybeans (Prevathon) and as a seed treatment for corn (Lumivia) and rice (Dermacor). Currently acephate is not labeled as a seed treatment for soybeans, but is labeled for foliar applications.

Based on the performance of bifenthrin (Capture LFR), chlorantraniliprole, and cyantraniliprole (Verimark) in previous trials, soybean flower samples were collected at R2 from one of the experiments described above for insecticide residue analysis. Bifenthrin (Capture LFR) was applied in-furrow, while chlorantraniliprole (Dermacor) and cyantraniliprole (Verimark) were applied as seed treatments. None of the three compounds were detected in soybean flowers, indicating little to no risk of exposure to pollinators from at-planting applications.

Two studies were conducted to evaluate the value of neonicotinoid seed treatment in soybean production. **Both studies were conducted in a field that had a vetch winter cover crop to increase the possibility of insect infestations.** In one study insect infestations were minimal and no significant differences in stand establishment or yield were measured. In the other study (Table 2), there was a substantial pea leaf weevil infestation. Seed for all treatments, except the Untreated Control, received EverGol Energy plus Allegiance fungicides. All of the insecticide treatments (all contained a neonicotinoid) resulted in significantly higher plant density at 27 DAE compared to the untreated control and the fungicide-only treatment. Also, all of the insecticide plus fungicide seed treatments resulted in significantly higher yields compared to the fungicide-only treatment and the untreated control. Yield differences between the insecticide plus fungicide seed treatments and the fungicide-only treatment ranged from 10.3 to 12.6 bu/acre, and yield differences between the insecticide treatments and the untreated control ranged from 22.0 to 24.3 bu/acre.

Objective 2

One study was conducted to evaluate the impact of neonicotinoid seed treatments on soybean stand establishment and their role in minimizing the risk of having to replant. This study included five planting dates (early April, mid April, early May, mid May, and early June). Two levels of insecticide seed treatment (Gaucho 1.6 fl oz/cwt plus fungicide and fungicide alone) were also included. Another factor in the study was early season plant population to simulate early season plant loss. This included two early season plant population targets (optimal 129,000 seed-plants/acre and sub-optimal 77,000 seed-plants/acre). Based on conversations with soybean agronomists, 77,000 plants/acre is in the range where the decision to replant would be difficult for growers.

All plots were planted at a seeding rate of 129,000 seed/acre. For the 77,000 seed-plants/acre (sub-optimal target) plots, the equivalent number of Roundup Ready soybean seed (Asgrow 4632) for a seeding rate of 77,000 seed/acre was blended with the equivalent of 52,000 Liberty Link soybean seed/acre to yield a total seeding rate of 129,000 seed/acre. At the V1 growth stage, plots were treated with glyphosate to eliminate the Liberty Link soybean plants to simulate plant loss from early season insect pests and other factors that can reduce plant density.

An additional factor was included within the sub-optimal plant population target—this included keeping the sub-optimal plant population or destroying the current stand and replanting at the optimal planting rate. To accomplish this, plots designated for replanting were treated with paraquat at V3 growth stage to destroy existing soybeans and were replanted at a seeding rate of 129,000 seed per acre. The V3 stage was chosen because it is generally when maximum damage (plant loss) from early season and soil insect infestations are visually detectable based on observations from other experiments and grower fields. The glyphosate application timing (V1) was chosen so that death of the Liberty Link plants would occur by the V3 growth stage.

In this study insect infestations and damage were minimal; therefore, there were no significant effects of insecticide seed treatment. A significant interaction was observed among planting date, early season plant population target, and replant decision for actual plant density at the V3 growth stage (Table 3). For the optimal early season plant population target, there were no significant differences among planting dates for actual plant densities at V3. Similar results were observed for the sub-optimal plant population target.

For the plots that were replanted, significantly higher actual plant densities were measured for the fourth planting date (initial planting 17 May, replant 16 June) compared to the first (initial planting 5 April, replant 18 May), second (initial planting 18 April, replant 18 May), and fifth planting dates (initial planting 7 June, replant 1 July). Replanting resulted in a significantly higher actual plant density at V3 only for the third (initial planting 3 May, replant 7 June) and fourth planting dates (initial planting 17 May, replant 16 June) compared to keeping the sub-optimal plant population at V3. There was no significant interaction among planting date, early season plant population target, and replant decision for actual plant density at harvest. Also, there were substantial reductions in plant density (up to 45%) between V3 and harvest.

There was a significant interaction among planting date, early season plant population target, and replant decision for yield. With regard to the optimum early season plant population target (129,000 seed/acre), significantly higher yields were measured from the mid April and early May plantings compared to those before or after these periods. These results are similar to those from several other studies. Similar results were measured with the sub-optimal early season plant population target, where significantly higher yields were measured from the mid April and early May plantings compared to plantings before or after these periods. The optimal plant population target resulted in significantly higher yields compared to the sub-optimal plant population target only from the early May planting. Within all planting dates except the early April date, replanting resulted in significantly lower yields compared to keeping the sub-optimal early season plant population. With the early April planting, there was no yield penalty from replanting, but there was no advantage either.

IMPACTS AND BENEFITS TO MISSISSIPPI SOYBEAN PRODUCERS

Preliminary results from these studies demonstrate the unpredictability of early season/soil insect infestations. These studies also demonstrate the value of at-planting insecticide treatments as risk management tools, because there are no reactive/rescue treatments for many early season/soil insect pests when they are present.

With the increased interest/focus on cover crops, early season/soil insect pest management may be more important than in other production systems. In these studies conducted in a field with a legume cover crop, several responses were found—no yield differences, moderate yield reductions (up to 22% in one trial), and severe yield reductions (up to 52% in one trial). Although insect infestations were low in the replant trial, the data demonstrate that management strategies to avoid replanting are in the best interest of the grower. Having to replant results not only in higher costs from the extra equipment operation and seed costs, but depending on planting date, may also result in reduced yields (from lower yield potential associated with later planting dates) and gross returns.

END PRODUCTS–COMPLETED OR FORTHCOMING

2017 Annual Meeting of the Mississippi Agricultural Consultants Association. Feb. 2-3, 2017. Starkville, MS.

Results were also presented at 16 grower meetings throughout the state of Mississippi during the winter/spring of 2017.

Table 1. Impact of seed treatment alternatives (Non-Nic) to neonicotinoids on soybean stand establishment and yield in the only test (out of three) that had insect pressure.

Treatment/Formulation	Rate	Plant Density 35 DAE[4]	Yield (bu/acre)
Fungicide Only	-	37,897c	43.9b
Gaucho 600FS	1.6[1]	67,137a	56.3a
Acephate 90S (Non Nic)	8.0[1]	42,308bc	44.2b
Dermacor 5.21FS (Non Nic)	0.25[3]	52,925b	52.1a
Dermacor 5.21FS (Non Nic)	0.5[3]	51,945b	51.6a
Gaucho 600FS + Dermacor 5.21FS	1.6[1] + 0.25[3]	70,241a	55.4a
P>F		<0.01	<0.01

Means within columns followed by a common letter are not significantly different (FPLSD *P>F* 0.05).
[1]fluid oz product/cwt seed.
[2]oz product (wt.)/cwt seed.
[3]mg ai/seed.
[4]Days after emergence.

Table 2. Impact of selected insecticide (neonicotinoid) seed treatments on soybean plant stand establishment and yield in the only test (out of two) that had insect pressure.

Treatment/Form.	Rate	Plant Density 27 DAE[3]	Yield (bu/acre)
Untreated	-	17,887b	22.5c
Fungicide Only	-	23,849b	34.2b
Gaucho 600FS	0.12[1]	61,420a	44.5a
Poncho/Votivo 5FS	0.13[1]	55,131a	45.1a
Aeris 5FS	0.20[1]	56,928a	46.8a
Cruiser 5FS	1.28[2]	59,868a	44.8a
P>F		<0.01	<0.01

Means within columns followed by a common letter are not significantly different (FPLSD *P>F* 0.05).
[1]mg ai/seed.
[2]oz product/cwt seed.
[3]Days after emergence.

Table 3. Impact of planting date, planting population, and replanting on soybean plant density at the V3 growth stage, plant density at harvest, and yield.

Planting Date	Initial Plant Density/Rate (seed/acre)	Replant Date	Plant Density at V3 (plants/acre)	Plant Density at harvest (plants/acre)	Yield (bu/acre)
5 Apr	129,000	-	105,851a	64,278	52.2ef
5 Apr	77,000	-	76,260cde	57,527	52.7ef
5 Apr	77,000	18 May	70,077de	46,523	50.1f
18 Apr	129,000	-	106,749a	65,953	66.9ab
18 Apr	77,000	-	72,310de	39,842	66.1abc
18 Apr	77,000	18 May	77,673cde	51,413	51.9ef
3 May	129,000	-	95,560abc	74,243	71.1a
3 May	77,000	-	64,687e	53,783	65.2bc
3 May	77,000	7 Jun	85,840bcd	58,946	47.9f
17 May	129,000	-	97,357ab	60,775	60.2cd
17 May	77,000	-	70,040de	53,237	57.3de
17 May	77,000	16 Jun	98,010ab	53,413	42.4g
7 Jun	129,000	-	100,705ab	63,660	51.9ef
7 Jun	77,000	-	68,186e	55,502	49.1f
7 Jun	77,000	1 Jul	68,648e	47,589	31.7h
$P>F$			0.03	0.27	<0.01

Means within columns followed by a common letter are not significantly different (FPLSD $P>F$ 0.05).

Seed treatment products used in this study:

ApronMaxx RFC—mefenoxam plus fludioxonil fungicides
EverGol Energy—Prothioconazole plus penflufen plus metalaxyl fungicides
Allegiance—Metalaxyl fungicide
Gaucho 600—imidacloprid insecticide (neonicotinoid)
Acephate—acephate insecticide (non-neonicotinoid)
Dermacor—chlorantraniliprole insecticide (non-neonicotinoid)
Poncho/Vitovo—clothianidin insecticide (neonicotinoid)/*Bacillus firmus* nematicide
Aeris—imidacloprid insecticide (neonicotinoid) + thiodicarb
Cruiser 5FS—thiamethoxam insecticide (neonicotinoid)