MISSISSIPPI SOYBEAN PROMOTION BOARD
PROJECT NO. 57-2017 (YEAR 2)
FINAL REPORT

Title: Evaluation of Multiple Agronomic Considerations with Harvest Aid Use in Mississippi Soybean Production

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EXECUTIVE SUMMARY

Harvest aid use in soybean production in Mississippi is fast becoming a standard production practice for a number of growers. However, there are a number of considerations with the use of soybean harvest aids that need to be investigated.

The commonly used compounds applied as harvest aids in soybeans are paraquat (Gramoxone), saflufenacil (Sharpen), and sodium chlorate (Defol). Each chemical label recommends or states that different adjuvants (Crop oil concentrate [COC], methylated seed oil [MSO], non-ionic surfactant [NIS]) must be used.

The label of harvest aids specifies a pre-harvest interval (PHI), which is the minimum amount of time that must elapse between chemical application and soybean harvest. Different harvest aids have different PHI requirements that will affect the amount of time a soybean crop is in the field after harvest aid application. Similarly, wet fall conditions after harvest aid application can prevent equipment from getting into the field to harvest the soybean crop in a timely manner.

Studies were conducted at Stoneville, Miss. in 2016 and 2017 to: 1) Investigate the effects of different adjuvants on harvest aid performance; 2) Investigate the effects of spray volume on the efficacy of various soybean harvest aids; 3) Investigate the effects of harvest interval after harvest aid use on soybean yield, seed moisture content, and shattering; and 4) Determine the effect of various rates of paraquat on soybean at multiple growth stages to simulate issues with spray tank contamination and drift.

Harvest aid products used were Gramoxone, sodium chlorate (Defol), and Sharpen applied alone or with adjuvants that included either crop oil concentrate (COC), methylated seed oil (MSO), or nonionic surfactant (NIS).

The following major results accrued from this project.

The harvest aid products used in this study and applied alone did not affect soybean seed yield in either year when compared to each other and the untreated control (UTC).

Yield results from this two-year study indicate that Gramoxone applied alone and with no adjuvant is the best product to use for defoliating soybeans prior to harvest.

Overall, Gramoxone applied alone resulted in the most cost-efficient and effective defoliation in both years.

Yield losses from delayed harvest in this study were not significant until well after the end of the PHI for Gramoxone that can be applied at R6.5.

Of the products used in this study, Gramoxone has the longest PHI of 15 days. If this product is

applied at the earliest allowed time to prevent yield loss (R6.5), then this 15-day waiting period will end soon after R8 or maturity. Thus, a properly timed application of Gramoxone as a harvest aid will not cause a delay in harvest beyond the time of harvest maturity. If harvest is delayed because of inclement weather, then some yield loss will occur whether or not a harvest aid was applied.

BACKGROUND

Harvest aid use in soybean production in Mississippi is fast becoming a standard production practice for a number of growers. However, there are a number of considerations with the use of soybean harvest aids that need to be investigated.

The commonly used compounds applied as harvest aids in soybeans are paraquat (Gramoxone), saflufenacil (Sharpen), and sodium chlorate (Defol). Each chemical label recommends or states that different adjuvants (Crop oil concentrate [COC], methylated seed oil [MSO], non-ionic surfactant [NIS]) must be used. Research is needed to investigate the effects of different adjuvants not only on individual harvest aids but on common mixtures of harvest aids.

Similarly, harvest aid labels also require or recommend certain application volumes for best performance. Harvest aid spray volumes vary by application equipment (airplane vs. groundrig) and can affect performance of harvest aids. Research needs to be conducted to evaluate the performance of harvest aids at various application volumes.

The label of harvest aids also specifies a pre-harvest interval (PHI), which is the minimum amount of time that must elapse between chemical application and soybean harvest. Different harvest aids have different PHI requirements that will affect the amount of time a soybean crop is in the field after harvest aid application. Similarly, wet fall conditions after harvest aid application can prevent equipment from getting into the field to harvest the soybean crop in a timely manner. Research needs to be conducted to evaluate how various harvest aids and harvest aid combinations affect soybean moisture content and shattering at various harvest timings after harvest aid application.

One of the most popular harvest aids is paraquat (Gramoxone). Aside from being used as a harvest aid, paraquat is used extensively as a burndown herbicide in Mississippi soybean production. Given that soybean planting (April- June) and harvest (August-November) can be spread out over a number of months, multiple opportunities exist for misapplication of paraquat when used as both a burndown and harvest aid. Paraquat has the potential to drift onto a young soybean crop or to accidentally be applied to a soybean crop via tank contamination when paraquat is being sprayed as a burndown. Similarly, paraquat can drift onto a soybean crop during reproductive growth when harvest aids are being applied to an adjacent field or through tank contamination. Research is needed to determine the effect of multiple rates of paraquat on soybean at different growth stages.

OBJECTIVES

Objective 1: Investigate the effects of different adjuvants on harvest aid performance.

Objective 2: Investigate the effects of spray volume on the efficacy of various soybean harvest aids.

Objective 3: Investigate the effects of harvest interval after harvest aid use on soybean yield, seed moisture content, and shattering.

Objective 4: Determine the effect of various rates of paraquat on soybean at multiple growth stages to simulate issues with spray tank contamination and drift.

PROGRESS/ACTIVITY

ADJUVANT STUDY

Soybean Yield

The harvest aid products used in this study (Gramoxone, sodium chlorate—Defol, and Sharpen) and applied alone did not affect soybean seed yield in either year when compared to each other and the untreated control (UTC) (Table 1).

In 2016, harvest aid products applied with adjuvants or with each other did not affect seed yield compared to each applied alone or to the UTC. In 2017, however, a significant reduction in seed yield occurred when Gramoxone was applied with COC (69.4 bu/acre) compared to Gramoxone applied alone (73.0 bu/acre) and with MSO (73.8 bu/acre). Defol and Sharpen applied with any of the adjuvants did not significantly affect yield compared to either product applied alone.

In 2017, applying Gramoxone with any of the other defoliation products did not improve yield above that resulting from Gramoxone applied alone (73.0 bu/acre). However, Gramoxone+Sharpen resulted in a lower yield (67.8 bu/acre) than all other combinations, even with an NIS added to the mix (68.7 bu/acre).

Yield results from this two-year study indicate that Gramoxone applied alone and with no adjuvant is the best product to use for defoliating soybeans prior to harvest.

Defoliation and Shattering

All the harvest aid products either with or without adjuvants (81 to 90%) resulted in higher defoliation compared to the untreated control (65%) in both years (Table 2). Gramoxone had 9% and 13% greater defoliation than Sharpen in 2016 and 2017, respectively, and 7% more defoliation than Defol in 2016 only (90% vs 83%).

Use of COC with Defol reduced defoliation compared to when Defol was used alone or with MSO in 2017. Use of COC and MSO with Sharpen resulted in 6% and 9% greater defoliation than Sharpen and Sharpen+NIS, respectively, in 2017.

Use of adjuvants with Gramoxone did not increase defoliation in both years of this study. Using NIS with Gramoxone+Defol resulted in 10% less defoliation than with COC, MSO, or when used without any adjuvant (78% vs 88%) in 2016.

Overall, Gramoxone applied alone resulted in the most cost-efficient and effective defoliation in both years.

Shattering score (1 to 10%) was not affected by the harvest aid products used in both years of this study. The average shattering score among all treatments was 2.0 and 3.8 in 2016 and 2017, respectively.

DRIFT STUDY

When averaged over rates, soybean yields were greater at the V3 and R5 application timings of paraquat compared to R3 in both years (Table 3). As expected, early vegetative soybean is rather tolerant to paraquat. This is likely due to vegetative soybean's ability to branch and compensate when the main growing point is destroyed or damaged from a drift event.

When data were averaged over the application timings, paraquat rates of 0.0625 and 0.125 pint/acre did not affect yield compared to untreated soybeans (0 pints/acre) (Table 4). However, increasing paraquat rates from 0.25 to 4 pints/acre reduced yields by 28.6 and 49.7 bu/acre in 2016 and 2017, respectively.

An interaction between timing and rates showed that soybean yield was not reduced with paraquat rates up to 0.5 pints/acre in both years at the V3 growth stage when compared to untreated soybean. This indicates that paraquat drift events that occur during early reproductive growth will likely not require a replant and will have enough time to recover.

Soybeans were extremely sensitive to paraquat when it was applied at the R1growth stage (beginning of flowering) in both years. R1 is a critical stage for yield determination, and other stresses (drought, pests) that occur during this period can significantly reduce yield. At the R1 stage, a significant yield decrease was observed at the 0.5 pints/acre rate in 2016 and 2 pints/acre rate in 2017.

At the R3 growth stage, significant losses in yield occurred at paraquat rates of 1 pint/acre or higher in both years. Paraquat caused no reduction in yield when applied at the R5 growth stage in 2016, whereas about 20.1 and 27.0 bu/acre yield loss was measured with paraquat rates of 2 and 4 pints/acre, respectively, compared to untreated soybeans in 2017.

Sensitivity to paraquat decreased as soybeans progressed through reproductive stages. When the R5 application occurred, soybeans were nearing the end of R5 and probably approaching R6. Previous studies have shown that R6 soybean do not experience yield loss when desiccant rates of paraquat were applied.

SHATTERING STUDY

Harvest date after harvest aid application (DAT) affected soybean yield in both years (Table 5). In 2016, soybean yield was 3.4 and 5.1 bu/acre greater at 7 DAT compared to 15 and 30 DAT, respectively. Yield data were not taken for the 7 DAT in 2017 due to rainfall. Soybean yield at 15 DAT was 2.1 bu/acre greater than yield at 30 DAT.

In 2017, an interaction between harvest dates and harvest aid products showed that Gramoxone+Defol had 4.3 bu/acre lower yield than the untreated soybeans when measured 15 DAT (Table 6), which is the earliest allowed PHI for gramoxone.

These results indicate that soybean should be harvested as soon after defoliation as allowed by the label to prevent yield loss.

Table 1. Soybean seed yield as affected by harvest aids with and without use of different adjuvants in 2016 and 2017.

Harvest Aids	Soybean Seed Yield (bu/acre)			
	2016		2017	
	Mean	Grouping	Mean	Grouping
Defol (sodium chlorate)	67.9	A	73.1	AB
Defol+COC	76.9	A	72.4	AB
Defol+MSO	74.6	A	72.9	AB
Defol+NIS	77.0	A	72.5	AB
Gramoxone	77.8	A	73.0	AB
Gramoxone+COC	71.7	A	69.4	CDE
Gramoxone+MSO	78.0	A	73.8	A
Gramoxone+NIS	74.9	A	71.1	ABCD
Gramoxone+Defol	73.6	A	73.1	AB
Gramoxone+Defol+COC	75.3	A	71.9	ABC
Gramoxone+Defol+MSO	74.0	A	72.8	AB
Gramoxone+Defol+NIS	75.1	A	70.9	BCD
Gramoxone+Sharpen	72.5	A	67.8	E
Gramoxone+Sharpen+COC	76.5	A	72.0	ABC
Gramoxone+Sharpen+MSO	74.1	A	71.3	ABCD
Gramoxone+Sharpen+NIS	75.5	A	68.7	DE
Sharpen	76.3	A	70.9	ABCD
Sharpen+COC	73.6	A	71.1	ABCD
Sharpen+MSO	74.2	A	70.6	BCDE
Sharpen+NIS	75.2	A	72.5	AB
Untreated Control	73.0	A	72.1	ABC

Table 2. Defoliation as affected by the harvest aid products with or without adjuvants.

	Defoliation (%)			
	2016		2017	
Harvest Aids	**Mean**	**Grouping**	**Mean**	**Grouping**
Defol	83	BCDE	83	CDE
Defol+COC	80	DE	75	FG
Defol+MSO	83	BCDE	85	BCDE
Defol+NIS	85	ABCD	80	EF
Gramoxone	90	A	88	ABC
Gramoxone+COC	88	ABC	85	BCDE
Gramoxone+MSO	86	ABCD	84	BCDE
Gramoxone+NIS	89	AB	88	ABC
Gramoxone+Defol	89	AB	86	ABCD
Gramoxone+Defol+COC	88	ABC	89	AB
Gramoxone+Defol+MSO	88	ABC	86	ABCD
Gramoxone+Defol+NIS	78	E	88	ABC
Gramoxone+Sharpen	89	AB	91	A
Gramoxone+Sharpen+COC	85	ABCD	89	AB
Gramoxone+Sharpen+MSO	85	ABCD	86	ABCD
Gramoxone+Sharpen+NIS	86	ABCD	86	ABCD
Sharpen	81	CDE	75	FG
Sharpen+COC	83	BCDE	81	DE
Sharpen+MSO	83	BCDE	81	DE
Sharpen+NIS	86	ABCD	73	G
Untreated Control	65	F	65	H

Table 3. Paraquat drift effects on soybean seed yield in 2016 and 2017.

Application Timing	Paraquat rate (pints/acre)	Soybean Seed Yield (bu/acre)							
		2016		2017		2016		2017	
		Mean	Grouping	Mean	Grouping	Mean†	Grouping	Mean†	Grouping
V3	**0**	52.3	AB	67.9	A	40.2	B	50.1	A
	0.0625	51.0	AB	64.1	AB				
	0.125	49.6	AB	64.2	AB				
	0.25	48.7	AB	66.7	A				
	0.5	46.7	AB	62.1	ABC				
	1	36.1	ABCDE	45.5	CDEF				
	2	23.4	DEF	24.3	GHI				
	4	14.0	EF	6.5	IJ				
R1	**0**	50.7	AB	61.1	ABCD	27.5	D	46.6	AB
	0.0625	46.1	ABC	61.4	ABCD				
	0.125	41.9	ABCD	54.7	ABCDE				
	0.25	33.1	ABCDE	56.5	ABCDE				
	0.5	23.8	CDEF	52.9	ABCDE				
	1	14.0	EF	43.0	DEF				
	2	7.5	F	31.6	FGH				
	4	2.6	F	11.4	IJ				
R3	**0**	49.7	AB	63.1	ABC	34.5	C	43.6	B
	0.0625	49.9	AB	62.2	ABC				
	0.125	47.3	AB	61.9	ABC				
	0.25	40.6	ABCD	56.2	ABCDE				
	0.5	30.3	BCDE	47.7	ABCDE				
	1	21.2	DEF	32.5	FGH				
	2	13.8	EF	22.8	HI				
	4	23.5	DEF	2.3	J				
R5	**0**	51.3	AB	61.3	ABCD	51.7	A	50.7	A
	0.0625	51.2	AB	64.1	AB				
	0.125	52.1	AB	60.3	ABCD				
	0.25	52.5	AB	55.6	ABCDE				
	0.5	52.2	AB	46.1	ABCDE				
	1	53.2	A	43.3	DEF				
	2	52.1	AB	41.2	EFG				
	4	49.3	AB	34.3	FGH				

†mean values averaged over all application rates for each application timing.

Table 4. Paraquat drift rate effects on soybean seed yield in 2016 and 2017.

Paraquat Rate (pints/acre)	Soybean Seed Yield (bu/acre)			
	2016		2017	
	Mean	Grouping	Mean	Grouping
0	51.0	A	63.4	A
0.0625	49.6	A	62.9	A
0.125	47.7	A	60.3	A
0.25	43.7	AB	58.7	AB
0.5	38.2	BC	52.2	B
1	31.1	CD	41.1	C
2	24.2	D	30.0	D
4	22.4	D	13.6	E

Table 5. Soybean yield as affected by the harvest dates (expressed as days after treatment—DAT).

DAT	Soybean Seed Yield (bu/acre)			
	2016		2017	
	Mean	Grouping	Mean	Grouping
7	84.8	A		
15	81.4	B	82.5	A
30	79.7	B	80.4	B

Table 6. Soybean yield as affected by interaction of harvest dates (DAT) and harvest aid products in 2017.

DAT	Harvest Aids	Yield (bu/acre)	Grouping
15	**Defol**	82.7	AB
	Gramoxone + Defol	81.0	B
	Gramoxone + Sharpen	81.3	AB
	Gramoxone	83.2	AB
	Sharpen	81.4	AB
	Untreated Control	85.3	A
30	**Defol**	82.7	AB
	Gramoxone + Defol	80.5	B
	Gramoxone + Sharpen	79.1	B
	Gramoxone	79.3	B
	Sharpen	81.1	B
	Untreated Control	79.7	B