SOYBEAN AND COTTONSEED OILS AS ADJUVANTS AND DILUENTS FOR INSECTICIDES USED TO CONTROL SORGHUM MIDGE[1/]

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ABSTRACT

Two small-plot field studies were conducted on sorghum to determine effects of soybean and cottonseed oils on efficacy of different insecticides for control of sorghum midge, Contarinia sorghicola (Coquillett). Results from these studies showed that efficacy of the organophosphate, chlorpyrifos (0.28 kg [AI]/ha), was enhanced by the addition of emulsified soybean oil or non-emulsified cottonseed oil to the insecticide formulation. Conversely, soybean and cottonseed oils had no affect on efficacy of the pyrethroids, fenvalerate (0.058 kg [AI]/ha) and esfenvalerate (0.0145 kg [AI]/ha). Also, multiple applications of emulsified soybean oil (1.0 L/ha) without insecticide provided no control of sorghum midge.

INTRODUCTION

In agriculture, oils are commonly used in conventional and ultra-low volume (ULV) insecticide applications. Oils are used as adjuvants in conventional sprays (i.e., water is the pesticide-diluent); whereas, in ULV sprays, oils are commonly used as diluents. In some cases, effectiveness of an insecticide/oil mixture has been greater than when an insecticide is applied in water-only (Luttrell and Wofford 1984, Treacy et al. 1985). This greater effectiveness has been attributed to better coverage of the crop, increased persistence (Ware et al. 1983, Hatfield and McDaniel 1984), and to enhanced penetration of the toxin into the insect body (Awad and Vinson 1968, de Licastro et al. 1983). However, recent evidence suggests that oils do not always improve insecticide efficacy (Ware et al. 1983, Ochou 1985, Bigley and Plapp unpublished data). Effectiveness of insecticide/oil mixtures against crop pests appears to be related to type of insecticide in the mixture.

As compared to information on cotton, soybeans and orchard crops, little information exists on efficacy of insecticide/oil mixtures against insect pests of sorghum. In a study conducted to measure control of sorghum midge, Royer et al. (1986) found that sorghum treated with an

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[1/] Diptera: Cecidomyiidae

aqueous spray of esfenvalerate produced significantly more seed than sorghum treated with esfenvalerate plus emulsified cottonseed oil. Conversely, they demonstrated a two-fold yield increase from sorghum treated with chlorpyrifos plus emulsified cottonseed oil vs. sorghum treated with an aqueous spray of chlorpyrifos (however, this difference in yield was not statistically significant). The tests reported here were conducted to determine effects of soybean and cottonseed oils on efficacy of different insecticides against sorghum midge, *Contarinia sorghicola* (Coquillett).

MATERIALS AND METHODS

Test 1. A small-plot field study was conducted at the Texas A&M University Agricultural Research and Extension Center at Corpus Christi in 1984. Insecticides and dosage rates (AI/ha) evaluated in the study were fenvalerate (Pydrin) at 0.058 kg/ha and chlorpyrifos (Lorsban 4E) at 0.28 kg/ha. Each insecticide was applied in a water-only formulation at a flow rate of 52.2 L/ha, and in a water plus 1.0 L/ha soybean oil formulation at a flow rate of 52.2 L/ha. A water/oil check (i.e., no insecticide) was included in the study to determine the direct impact of soybean oil on control of sorghum midge. Natur'l Oil, a mixture of 93 percent once-refined soybean oil and 7 percent emulsifiers, was used in all oil treatments.

The experiment was conducted in a split-plot design. Treatments listed above were applied on two timing regimens of three- and six-day intervals. Thus, treatment was the whole-plot variable and timing was the split-plot variable in this experiment. There were four replicates of each treatment, with a replicate consisting of a four-row x 15.2-m plot of 'Asgrow Topaz' sorghum. There were two untreated buffer rows of sorghum between each plot.

Treatment applications were initiated when ca. 15 percent of the panicles were in bloom, and treatments were continued on the two schedules until ca. 90 percent of the panicles had completed bloom. Treatments were applied four times at three-day intervals (15, 18, 21 and 24 June) and twice at six-day intervals (15 and 21 June). All treatments were applied with a Hustler high-clearance spray machine. The flow rate of the spray was regulated by size 6X hollow-cone nozzles (three nozzles per row) at 35 psi.

Counts of adult midges were made in the untreated plots at three-day intervals to monitor midge abundance during the study. At soft-dough stage, percent seed damaged by midges was visually estimated on the middle two rows of each plot. Also, seed was harvested from two, 4.2-m sections of row in each plot for yield analysis. Significant differences among treatments, in percent seed damaged by midges, and in yield, were determined with analysis of variance (P= 0.05). Treatment means were separated by Fischer's protected LSD test (P=0.05).

Test 2. A small plot field study was conducted at the Texas A&M University Agricultural Research and Extension Center at Corpus Christi in 1986. Insecticides and dosage rates (AI/ha) evaluated in the study were esfenvalerate (Asana) at 0.0145 kg/ha and chlorpyrifos (Lorsban 4E) at 0.28 kg/ha. Each insecticide was applied in a water-only formulation at a flow rate of 30.4 L/ha (conventional/water), and in an oil-only formulation at a flow rate of 7.0 L/ha (ULV/oil). A refined non-emulsified cottonseed oil was used in both oil treatments.

The experiment was conducted in a split-plot design. As described in the previous experiment, treatment and spray timing (three- and six-day intervals) formed the experimental whole- and split-plot variables, respectively. There were four replicates of each treatment, with a replicate consisting of a three-row x 15.2-m plot of 'Funks DR-522' sorghum. There were four untreated buffer rows of sorghum between each plot.

Due to heavy rainfall and muddy soil conditions, treatments were not initiated until ca. 70 percent of the panicles were in bloom. Applications continued on schedule until ca 90 percent of the panicles had completed bloom. Treatments were applied three times at three-day intervals (6, 9 and 12 June) and twice at six-day intervals (6 and 12 June). ULV/oil treatments were applied with a modified CO_2 pressurized backpack sprayer equipped with a Micromax controlled droplet atomizer. The flow rate was regulated with a Spraying Systems flow regulator orifice plate No. 4916-16, at 15 psi, operated at 3500 rpm. The atomizer was powered by a 12-volt battery. Conventional/water applications were made with a CO_2 pressurized (36 psi) backpack sprayer equipped with size 2X hollow-cone nozzles (three nozzles per row).

Counts of adult midges were made in the untreated plots at three-day intervals to monitor midge abundance during the study. At soft-dough stage, percent seed damaged by midge was visually estimated on the middle row of each plot. Also, panicles were harvested from a 4.2-m section of row in each plot for yield analysis. Significant differences among treatments, in percent seed damaged by midge, and in yield, were determined by using analysis of variance (P=0.05). Treatment means were separated by Fischer's protected LSD test (P=0.05).

RESULTS AND DISCUSSION

Test 1. Midge infestations in the test site were heavy. There were ca. 50 adult midges per panicle throughout the blooming period (i.e., based on counts taken in untreated plots at three-day intervals).

There were no significant differences among insecticide-treated plots in percent seed damaged by midge (Table 1). However, all insecticide-treated plots had significantly less seed damaged by midge than the water/oil and untreated check plots. Further, there was no significant difference between the water/oil and untreated checks in percent damaged seed. When applied at the three-day interval, each

Table 1. Effects of Emulsified Soybean Oil and Application Interval (3-day and 6-day) on Efficacy of Selected Insecticides Against Sorghum Midge, 1984.[a/]

Insecticide and rate (AI)/ha	Spray type	Mean % seed damaged 3-day	Mean % seed damaged 6-day	Mean seed wt (kg/ha) 3-day	Mean seed wt (kg/ha) 6-day
Chlorpyrifos (0.28 kg)	Water	25.9 b,A	63.3 b,B	2454.8 b,A	1721.2 b,B
	Water + oil	24.3 b,A	59.3 b,B	2608.9 ab,A	1919.2 a,B
Fenvalerate (0.058 kg)	Water	25.3 b,A	64.0 b,B	2733.5 a,A	1868.6 ab,B
	Water + oil	20.0 b,A	68.4 b,B	2667.4 a,A	1752.8 ab,B
Checks	Water + oil	89.6 a,A	94.4 a,A	583.4 c,A	452.2 c,A
	Untreated	84.6 a,A	95.5 a,A	526.5 c,A	504.0 c,A

[a/] Means within columns followed by the same lower-case letter, or within rows by the same upper-case letter are not significantly different (P=0.05; Fischer's protected LSD test).

insecticide treatment had significantly less seed damaged by midges than when each treatment was applied at the 6-day interval.

At both three- and six-day application intervals, there were no significant differences between water and water/oil applications of fenvalerate in seed production. Although not significantly different at the three-day interval, plots treated with chlorpyrifos in water plus oil produced more seed than plots treated with chlorpyrifos in water-only at the six-day application interval. There was no significant difference in yield between the water/oil and untreated checks. Yields for each of the four insecticide treatments were significantly greater at the three-day application interval than at the six-day interval.

Test 2. Based on counts taken in untreated plots at three-day intervals, there were 50-100 adult midges per panicle throughout the blooming period.

At both three- and six-day application intervals, there were no significant differences between conventional/water and ULV/oil sprays of esfenvalerate in percent seed damaged by midges or in yield (Table 2).

Table 2. Effects of Non-emulsified Cottonseed Oil and Application Interval (3-day and 6-day) on Efficacy of Selected Insecticides Against Sorghum Midge, 1986.[a]

Insecticide and rate (AI)/ha	Spray type	Mean % seed damaged		Mean panicle wt (kg/ha)	
		3-day	6-day	3-day	6-day
Chlorpyrifos (0.28 kg)	Conventional/ water	44.5 b,A	79.8 b,B	5199.5 a,A	2191.5 c,B
	ULV/oil	47.0 b,A	69.8 c,B	5310.2 a,A	2883.5 b,B
Esfenvalerate (0.0145 kg)	Conventional/ water	46.3 b,A	70.5 c,B	5267.8 a,A	3615.0 a,B
	ULV/oil	56.5 b,A	75.8 bc,B	4837.2 a,A	3522.5 a,B
Untreated		98.8 a,A	99.0 a,A	918.2 b,A	957.5 d,A

[a] Means within columns followed by the same lower-case letter, or within rows followed by the same upper-case letter are not significantly different (P=0.05; Fischer's protected LSD test).

Although not significantly different at the three-day interval, plots treated with chlorpyrifos in ULV/oil had significantly less damaged seed, as well as a greater yield, than plots treated with aqueous sprays of chlorpyrifos at the six-day interval. Also, percent damaged seed in each of the four insecticide treatments was significantly lower at the three-day application interval than at the six-day interval. Yields for each of the insecticide treatments were significantly greater at the three-day application interval than at the six-day interval.

In conclusion, these studies indicate that effects of vegetable oils on residual toxicity of insecticides to sorghum midge depend on type of toxin used. Efficacy of the organophosphate, chlorpyrifos (0.28 kg [AI]/ha), against sorghum midge may be improved by the addition of emulsified soybean oil or non-emulsified cottonseed oil to the insecticide formulation. Conversely, soybean and cottonseed oils appear to have no affect on efficacy of the pyrethroids, fenvalerate (0.058 kg [AI]/ha) and esfenvalerate (0.0145 kg [AI]/ha), against sorghum midge. Further, multiple applications of emulsified soybean oil (1.0 L/ha) without insecticide provides no control of sorghum midge.

ACKNOWLEDGEMENT

We thank Mr. Clemon Montgomery of Texas Cottonseed Crushers' Assoc., Mr. Ron King and Mr. Tommy Barnes of VALCO Chemicals, Dow Chemical, and Shell Chemical Co. for their support of this study. Gratitude is also extended to Ms. Brenda Mayo and Mr. Craig Peeples for their technical assistance on this study. This article was approved for publication by the Texas Agric. Exp. Stn., College Station, TX as Technical Article 21935.

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