EFFICACY OF BAY SIR 8514, AN INSECT GROWTH REGULATOR. AGAINST *PSORPHORA COLUMBIAE* AND *ANOPHELES QUADRIMACULATUS* IN SMALL PLOT AND FIELD TRIALS[1, 2]

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ABSTRACT. Four formulations of an insect growth regulator, Bay Sir 8514 (a benzoylurea compound), were tested against 2 species of riceland mosquito larvae, *Anopheles quadrimaculatus* and *Psorophora columbiae*. Formulations of 25% WP, 0.5% G and 065 EC (65 g/liter) were tested at dosages of 14, 28, 56, and 84 g ai/ha in small plots. The 14 g ai/ha rate was ineffective for all formulations while the 28, 56 and 84 g ai/ha provided 100% mortality through 48 hr posttreatment. The 84 g ai/ha rate gave complete control through 7 days posttreatment.

A 4 F formulation was applied aerially at rates of 24.9 and 49 g ai/ha to a 9.7 ha rice field. The 24.5 g ai/ha rate provided marginal control at 24 hr posttreatment but failed to control larvae at 48 hr. At 49 g ai/ha, the material provided control through the 48 hr posttreatment.

INTRODUCTION

Bay Sir 8514 is one of many benzoylated ureas, which inhibit chitin synthesis during insect molting and are commonly referred to as insect growth regulators or IGR's. Treated larvae appear normal until the advent of ecdysis (Hammann and Sirrenberg 1980). Bay Sir 8514 is active against Lepidoptera, Coleoptera, Thysanoptera and Diptera (Schaefer 1979). Mulla and Darwazeh (1979) reported Bay Sir 8514 to be effective against *Culex quinquefasciatus* Say, a stagnant water mosquito species, as well as *Culiseta incidens* (Thompson), a flood water species. However, no data have been published on efficacy against *Psorophora columbiae* (Dyar and Knab) or *Anopheles quadrimaculatus* Say. Residue and non-target studies by Colwell and Schaefer (1981) indicated that Bay Sir 8514 has no prolonged residues and is an environmentally safe compound with minimal impact on non-target invertebrates and fish.

The objective of this research was to evaluate Bay Sir 8514 as a larvicide against confined *Ps. columbiae* in small rice plots. Bay Sir 8514 was also tested against naturally occurring populations of *An. quadrimaculatus* and *Ps. columbiae* by aerial application to a commercial rice field.

MATERIALS AND METHODS

SMALL PLOT TRIALS. The trial plots were arranged in a completely randomized design. Each rice plot was approximately 6 × 6 m from levee center to levee center. Water in the plot was maintained at an average depth of 10 cm on the growing surface and 23 cm in the levee ditches. The average volume of water treated was 2.8 m^3/plot.

Three formulations, a 25% wettable powder (WP), 0.5% granular (G) and a 65 g/liter emulsifiable concentrate (EC) were applied at rates of 14, 28, 56 and 84 g ai/ha. Each treatment and control was replicated three times. The EC and WP applications were each mixed to make a total volume of 4.2 liters and were applied using a Hudson 12.68 liter hand sprayer and distributed at approximately 30 psi over the plot without preference to either the levee ditch or growing surface.

The G material was applied using a modified 360 cc cardboard carton with a bottom that had approximately 15, one mm perforations. The G was applied evenly to the levee ditch and growing surface.

The bioassay tubes used were constructed of 10.2 cm diam. white polyvinylchloride pipe cut to 20.3 cm lengths. One end of each tube was covered with a 35 × 35 nylon woven mesh. To allow water circulation, a series of three 1.3 cm holes were drilled on opposite sides of the tube 2.5 cm from the screen covered bottom and were also covered with the 35 × 35 nylon mesh. Prior to introduction of the test material one bioassay tube was banded to a 40 cm stake and positioned in each test and control plot on the edge of the growing surface 2.5 cm from mid-bottom leaving approximately 7.5 cm of water in the bioassay tube.

Third instar *Ps. columbiae* larvae were collected from naturally occurring populations and brought to the laboratory in 4.2 liter plastic containers. The larvae were transferred in groups of 10 to 360 cc cardboard cups and transported to the plot test site where one cup of 10 larvae was poured into each staked test and control bioassay tube. The tops of the tubes were then covered with a cloth mesh which was held in place by a rubber band. Bioassays were

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[1] Approved for publication by the Director, Arkansas Agricultural Experiment Station.

[2] This study was conducted, in part, under the auspices of an Environmental Protection Agency Grant, Riceland Mosquito Management Program.

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initiated at 1 hr, 24 hr, 6 days and 13 days posttreatment and the mortality was recorded approximately 24 hr after introduction of the larvae. Mortality was determined by lifting the bioassay tube close enough to the surface to see the condition and number of surviving larvae.

The raw data from the small plot trials were analyzed to determine the mean mortality of each replicated set after mortality had been corrected by Abbott's formula. The data were further subjected to ANOVA and the means compared with Duncan's multiple range test ($P = 0.05$).

The effect of Bay Sir 8514 was observed in the laboratory on a limited number of *Ps. columbiae* larvae. This was done concurrently with the small plot test to gain supplementary information. One 450 ml sample of water was taken from each 56 and 84 g ai/ha replicated test and control plot at 1 hr, 24 hr, 48 hr, 6 days and 20 days posttreatment as the small plot test larvae were being placed into the bioassay tubes. The water samples were taken to the laboratory and a 300 ml portion was poured into 360 ml paper cups and each cup coded with the number of the trial or control plot from which the sample had been taken. Five field collected 3rd instar *Ps. columbiae* larvae were placed in each cup. The cups were maintained in the laboratory until all larvae had successfully emerged or died. The mortality data were collected and treated in an identical manner to the small plot data.

FIELD TRIALS. An aerial application of 4 F Bay Sir 8514 was applied at 24.5 and 49 g ai/ha rates to a 9.7 ha field using a Piper® PA 25–260 aircraft equipped with a conventional Transland® sprayer modified with fan spray tips. The sprayer was calibrated to deliver 18.93 liters of total mixture/ha. The rice canopy of the field was dense with plants in the preboot stage averaging 74 cm in height. The field had been drained for weed control for approximately 2 weeks prior to the test. Flooding was begun 4 days before the Bay Sir 8514 was flown on. For test purposes the field was divided in half along a central levee.

Before application of the treatment, the field was sampled for natural mosquito populations using a standard 450 ml dipper. Random areas of the field were sampled to determine the number of larvae collected in 25 dipper samples.

The area designated for the low dosage had a moderate population (80 larvae/25 dips) of *Ps. columbiae,* primarily late second and early third instars. The *An. quadrimaculatus* population (3 larvae/25 dips) in this area was deemed insufficient to determine larvicidal efficacy. No *Ps. columbiae* were located in the area designated to receive the 49 g ai/ha rate. A small population of *An. quadrimaculatus* (35 larvae/25 dips) was discovered which varied from first to the fourth instar. A field outside the treatment area was used as a control.

RESULTS AND DISCUSSION

SMALL PLOT TRIALS. With the exception of Bay Sir 4F, all formulations were tested in the small plots. The 14 g ai/ha rate was not effective for any of the 3 formulations at 24 hr (Table 1). The efficacy of the 28, 56, and 84 g ai/ha rates for all 3 formulations was 100% except for one G replicate that was 97% through the 48 hr posttreatment bioassay, however this difference was not significant. At 7 days posttreatment, all formulations of the 84 g ai/ha rate and the EC formulation at 56 ai/ha rate were 100% effective. Only the WP formulation at the 28 g ai/ha rate remained effective at 7 days posttreatment. None of the formulations at any rate gave good control at 14 days posttreatment. With the exception of the 14 g ai/ha rate, there was no significant difference between rates and formulations through 48 hr posttreatment. At 7 days posttreatment, the WP formulation was significantly more effective than the EC or G formulation at 28 g ai/ha and the EC formulation was significantly more effective than the WP or G formulation at 56 g ai/ha.

The treatment of choice for short term control against floodwater species such as *Ps. columbiae* was 28 g ai/ha. Most floodwater species will

Table 1. Small plot efficacy for 3 formulations of Bay Sir 8514 against confined 3rd and 4th instar *Psorophora columbiae* larvae in rice plots.[1,2]

Dosage		Percent mortality[3]			
Formulation	g ai/ha	24 hr	48 hr	7 d	14 d
EC	84	100a	100a	100a	36a
WP		100a	100a	100a	26a
G		100a	100a	100a	43a
EC	56	100a	100a	100a	36a
WP		100a	100a	30c	—
G		100a	100a	30c	—
EC	28	100a	100a	10c	—
WP		100a	100a	83b	45a
G		100a	97a	26d	—
EC	14	46b	[4]	—	—
WP		43b	—	—	—
G		25b	—	—	—

[1] Means of 3 replications.

[2] Means within a column not followed by a similar letter differ significantly ($P = 0.05$) according to DMRT.

[3] Mortality was corrected by Abbott's formula.

[4] Dashes denote conclusion of a test.

hatch within hours after flooding occurs and probably be controlled with such a short-term residual compound as Bay Sir 8514. The control provided through 7 days posttreatment by the 84 g ai/ha rate would give the longer efficacy needed to control species that breed in permanent water. The control mortality was less than 10% for all replicates of the 3 formulations at the 4 tested rates.

The developmental time increased from an average of 5 days for naturally occurring populations of *Ps. columbiae* to 8 days for the *Ps. columbiae* held as controls in the laboratory observation phase of the experiment. Although the development time was slowed considerably, there was no significant mortality in any of the controls established in the laboratory. The purpose of the laboratory work was to enable the researchers to closely observe any physical and behavioral changes that the IGR, Bay Sir 8514 induced. The work was not used as a check against the mortality observed in the field.

The mosquito larvae that were subjected to the Bay Sir 8514 when efficacy was declining generally experienced a 2 fold or more increase in development time. This was observed for all formulations in larvae exposed to 14 g ai/ha at 24 hr posttreatment, 28 g ai/ha at 7 days posttreatment and at 56 and 84 g ai/ha at 14 days posttreatment (Table 2). Over 60% of the larvae introduced at this period of diminishing efficacy emerged as adults, however they appeared to have difficulty leaving the water surface and flying.

Larvae that were subjected to samples of treated water in which efficacy was high in the field generally experienced a visual broadening of the body and a color variation from the dark brown of healthy larvae to a milky tan color. Death usually resulted within 24 hr after introduction. As rates decreased or as time increased, these observations of color change, body displacement, lethargic behavior became more drawn out. All larvae that exhibited these signs of contact with Bay Sir 8514 eventually died as larvae, pupae or as adults on the water in the process of emerging from the pupal exuvia. The majority of the larvae died during the ecdysis between the third and fourth or fourth and pupal stage. Bay Sir 8514 seemed to act more quickly on young larvae. The mosquitoes that died as emerging adults or as pupae tended to be larvae that were not introduced to the IGR until they were into the third instar. None of the control *Ps. columbiae* larvae, even few that died, showed any of the signs of color change, body broadening, or lethargic behavior.

FIELD TRIALS. The technique for monitoring of natural populations was based on the average number of larvae located as compared with the pretreatment population previously mentioned and not on adult emergence. The 24.5 g ai/ha rate reduced the natural population of *Ps. columbiae* by 51.4% at 24 hr posttreatment. The *An. quadrimaculatus* population was reduced by 73.7% in the 49 g ai/ha rate area. Further sampling of the natural populations was discontinued because of inadequate water levels. There was no reduction in the average number of larvae/25 dips in the control field at 24 hr posttreatment. Although the canopy was very dense, the 4 F Bay Sir 8514 seemed to penetrate to the surface of the water in the canopy areas as well as in the open areas. This initial work should be followed by more testing of Bay Sir 8514 applied on a commercial basis.

Table 2. Laboratory efficacy of Bay Sir 8514 against confined 3rd and 4th instar larvae *Psorophora columbiae*.[1]

Dosage		Percent mortality[2]			
Formulation	g ai/ha	24 hr	48 hr	7 d	14 d
EC	56	100	73	53	10
	84	100	100	60	36
WP	56	100	86	23	15
	84	100	100	66	10
G	56	100	60	60	10
	84	100	100	100	46

[1] Means of 3 replications.
[2] Mortality was corrected by Abbott's formula.

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