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OPERATIONAL NOTE

EFFECTS OF FIPRONIL AND LAMBDA-CYHALOTHRIN AGAINST LARVAL *ANOPHELES QUADRIMACULATUS* AND NONTARGET AQUATIC MOSQUITO PREDATORS IN ARKANSAS SMALL RICE PLOTS[1,2]

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ABSTRACT. The effects of fipronil and lambda-cyhalothrin, applied at rates labeled for control of the rice water weevil, *Lissorhoptrus oryzophilus,* on 3 nontarget indigenous insect species in Arkansas rice are described. Three replicates of untreated control checks and fipronil- and lambda-cyhalothrin–treated plots containing 3 sentinel cages each were performed. Ten 4th-stage larvae of *Anopheles quadrimaculatus,* 10 adult *Tropisternus lateralis,* or 10 adult *Notonecta indica* were placed within individual cages in small rice plots treated with ICON™ 6.2 FS (fipronil) at 0.025 lb active ingredient (AI)/acre (0.028 kg/ha) or KARATEZ® 2.08 CS (lambda-cyhalothrin) at 0.03 lb AI/acre (0.033 kg/ha) applied over vegetation and water with a single-boom sprayer. At 24 h after treatment in fipronil plots, significantly higher control of *An. quadrimaculatus* and *T. lateralis* (69 and 48% control, respectively) was achieved, compared to *N. indica* (18%). In lambda-cyhalothrin plots 24 h after treatment, 100% reductions of both *T. lateralis* and *N. indica* were highly significant ($P < 0.05$) from the lower level of control in *An. quadrimaculatus* (10%). At 48 h after treatment, no significant differences existed between all species within fipronil plots, with *An. quadrimaculatus, T. lateralis,* and *N. indica* obtaining 41, 10, and 7% control, respectively. Significantly higher ($P < 0.05$) control was obtained in lambda-cyhalothrin plots 48 h after treatment, with 93 and 53% control of *T. lateralis* and *N. indica,* respectively, compared to 7% control of *An. quadrimaculatus.* A marked difference in susceptibility was found between selected nontarget organisms used in this study. When using lambda-cyhalothrin to control adult *L. oryzophilus,* populations of nontarget beneficial insects, such as *T. lateralis* and *N. indica,* could be adversely affected, whereas nontarget pestilent species, such as *An. quadrimaculatus,* could proliferate. Fipronil achieved higher percentages of control against *An. quadrimaculatus,* compared to lambda-cyhalothrin, and was less harmful to both nontarget predators.

KEY WORDS *Anopheles quadrimaculatus, Tropisternus lateralis, Notonecta indica,* fipronil, lambda-cyhalothrin, nontarget organisms

Annual rice production in Arkansas depends on effective integrative control of insect pests, such as the rice water weevil, *Lissorhoptrus oryzophilus* Kuschel (Coleoptera: Curculionidae), by alternating insecticides that target specific life stages of the weevil present within rice fields after permanent flood. Fipronil, a phenyl pyrazole, is used only as a rice seed treatment to reduce damage to the roots of rice plants by weevil larvae, whereas lambda-cyhalothrin, a synthetic pyrethroid ester, is aerially applied against adult weevils shortly after permanent flood to prevent excessive egg oviposition. Although both of these insecticides are important from the standpoint of rice production, little is known about the nontarget effects these chemicals have on indigenous insect species in Arkansas rice fields. Sulaiman et al. (1991) proved that insecticide solutions of lambda-cyhalothrin (99% lethal concentration = 1.53×10^{-7}% active ingredient [AI]) were highly successful in laboratory control of 4th-stage larvae of *Aedes albopictus* (Skuse) compared to deltamethrin and permethrin solutions. Fipronil has been shown to be quite effective in laboratory tests against 4th-stage larvae of *Anopheles quadrimaculatus* Say at a median lethal concentration of 0.00043 ppm when compared to 5 other mosquito species (Ali et al. 1998). Additionally, fipronil has also been tested against larval *Culex quinquefasciatus* Say in the laboratory and was proven to yield more effective control than insect growth regulators, pyrethroids, microbials, and organophosphates (Ali et al. 1999).

Our goal was to investigate the nontarget effects these 2 insecticides had against 3 common insect species found within permanently flooded rice including larvae of a common mosquito pest, *An. quadrimaculatus,* and adults of 2 known mosquito predators, a backswimmer, *Notonecta indica* L. (Hemiptera: Notonectidae), and a water scavenger beetle, *Tropisternus lateralis* Fabricius (Coleoptera: Hydrophilidae). These predators prey upon mosquito larvae as nymphs and larvae, respectively (Alexander et al. 1982; Dennett and Meisch, unpublished data).

[1] Mention of commercial products does not imply a recommendation for use or sale by the University of Arkansas.

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A randomized complete block design was used, which consisted of 9 small rice plots measuring 7.6 × 7.6 m (25 × 25 ft) separated from one another by earthen levees and individually flooded to a depth of 10.2 cm (4 in) and 20.3 cm (8 in) in the pan and ditch areas, respectively. The pan of each plot contained Cypress variety rice approximately 0.76 m (30 in) in height, whereas vegetation within ditches of each plot consisted primarily of duck-salad, *Heteranthera llimosa* (Sw.) Willd., and floating waterprimrose, *Ludwigia* sp.

Three replicates were performed, with treatments consisting of untreated control (UTC) and fipronil- and lambda-cyhalothrin–treated plots. Before application, 3 floating sentinel cages, described by Sandoski et al. (1986), were positioned within ditches of each treatment plot.

ICON™ 6.2 FS (fipronil; Aventis Crop Science, Research Triangle, NC) at 0.025 lb AI/acre (0.028 kg/ha) or KARATEZ® 2.08 CS (lambda-cyhalothrin; Syngenta Crop Protection, Greensboro, NC) at 0.03 lb AI/acre (0.033 kg/ha) was applied over vegetation and water within designated plots. Final mixtures were composed of 0.66 ml of ICON or 2.4 ml of KARATE added to 2,000 ml of water in 2-liter plastic beverage containers. Applications were performed by using a single-nozzle spray boom equipped with a TeeJet® 8002VS nozzle (Spraying Systems, Bellwood, IL) calibrated to deliver 9.2 ml per second at 22 psi, and powered by a 2.2-kg CO_2 cylinder that pressurized chemical mixtures, contained within 2-liter bottles, directly into the spray system.

Upon completing a chemical application to designated plots with 1 compound, the spray system was thoroughly purged twice before continuing with the next compound. Swath width at 71.1 cm (28 in) above the plants was approximately 0.9 m (3 ft). Wind speed at the time of application was variable, but remained at or slightly above 8.0 kph (4.9 mph). Personal protective equipment, consisting of eye goggles, half-face respirator, disposable hooded coveralls, and gloves, were donned before chemical application.

Immediately after application, 10 3rd- to 4th-stage larvae of *An. quadrimaculatus,* 10 adult *N. indica,* and 10 adult *T. lateralis* were transferred to separate cages in each treatment plot. To prevent cross-contamination, installations were made in UTC plots 1st, followed by fipronil plots, and finally lambda-cyhalothrin plots. Upon installation, each cage was tightly covered with nylon tulle fastened by rubber bands to prevent loss of sentinel insects. Notonectid and hydrophilid adults were collected from rice plots located some distance away from the test site by using aquatic nets, whereas 3rd- and 4th-stage larvae of *An. quadrimaculatus* were procured from an improvised insectary described by Dennett and Meisch (2000). Chemical application and 1st installation of sentinel insects was performed on August 11, 2000, which was followed by a 24-h posttreatment reading of the cages and 2nd installation of insects on August 12, which was read 48 h after treatment. Field percent mortality data were corrected for UTC mortality by using Abbott's formula and arcsine transformed, before conducting a 1-way analysis of variance (Abbott 1925, Steel and Torrie 1980, Sall and Lehman 1996). Mean percent mortality for all species in a particular treatment was compared with Student's *t*-test.

At 24 h after treatment in fipronil-treated plots, significantly higher ($P < 0.05$) mortality was obtained in both *An. quadrimaculatus* and *T. lateralis* (69 and 48% mortality, respectively), when compared to *N. indica* (18%; Table 1). An opposite effect was seen in lambda-cyhalothrin plots 24 h after treatment, with 100% reductions of both *T. lateralis* and *N. indica,* which were highly significant ($P <$ 0.05) from the low level of control achieved against *An. quadrimaculatus* (10%; Table 1). At 48 h after treatment, no significant differences existed in the 2nd installation of all species within fipronil-treated plots, with *An. quadrimaculatus, T. lateralis,* and *N. indica* obtaining 41, 10, and 7% mortality, respectively (Table 1). The effect of lambda-cyhalothrin on the 2nd installation at 48 h after treatment mirrored the results obtained at 24 h after treatment. Significantly higher ($P < 0.05$) mortality was obtained against both nontarget species, with 93 and 53% mortality of *T. lateralis* and *N. indica,* respec-

Table 1. Percent control of 3rd- and 4th-stages larval *Anopheles quadrimaculatus,* adult *Tropisternus lateralis,* and adult *Notonecta indica* within small rice plots treated with either Icon™ (fipronil) or Karate® (lambda-cyhalothrin) at rates labeled for control of *Lissorhoptrus oryzophilus* at 24 and 48 h after treatment.

Treatment	Species	Interval after treatment[1] (h)	Mean percent control[2]
Icon	*An. quadrimaculatus*	24	69A
Icon	*T. lateralis*	24	48A
Icon	*N. indica*	24	18B
Karate	*An. quadrimaculatus*	24	10A
Karate	*T. lateralis*	24	100B
Karate	*N. indica*	24	100B
Icon	*An. quadrimaculatus*	48	41A
Icon	*T. lateralis*	48	10A
Icon	*N. indica*	48	7A
Karate	*An. quadrimaculatus*	48	7A
Karate	*T. lateralis*	48	93B
Karate	*N. indica*	48	53B

[1] At 24 h after treatment: F ratio = 9.36, df =8, $P > F = 0.01$ (fipronil), F ratio = 50.83, df = 8, $P > F = 0.00$ (lambda-cyhalothrin); at 48 h after treatment: F ratio = 3.47, df = 8, $P > F =$ 0.09 (fipronil), F ratio = 14.48, df = 8, $P > F = 0.00$ (lambda-cyhalothrin); $\alpha = 0.05$.

[2] Mean percent control of species within particular treatments on a given interval after treatment followed by the same uppercase letters are not significantly different from one another ($P > 0.05$) with Student's *t*-test.

tively, compared to the low 7% control of *An. quadrimaculatus* (Table 1). Based on these results, a marked difference existed in susceptibility to the selected nontarget organisms evaluated in this study. When lambda-cyhalothrin is used to control adult *L. oryzophilus,* populations of nontarget beneficial insects, such as *T. lateralis* and *N. indica,* could be adversely affected, whereas nontarget pestilent species, such as *An. quadrimaculatus,* could proliferate. Fipronil achieved higher percentages of control against *An. quadrimaculatus,* compared to lambda-cyhalothrin, and was less harmful to both nontarget predators. Note that fipronil used in this study (ICON) is labeled only for use as a seed treatment in rice, not as a postflood foliar spray as used in this test. The percent control of *An. quadrimaculatus* and relatively low toxicity to both aquatic predators may not be indicative of the effect ICON has upon these nontarget insects when used strictly as a seed treatment in accordance with the label. Finally, larger field tests currently are being planned to evaluate the impact of rice insecticides upon these and other nontarget organisms.

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