LABORATORY TOXICITY OF A NEW BENZOYLPHENYLUREA INSECT GROWTH REGULATOR (UC-84572) AGAINST MOSQUITOES AND CHIRONOMID MIDGES[1]

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The insecticidal potential of benzoylphenylurea (BPU) insect growth regulators (IGRs) has been studied since the early 1970s (Maas et al. 1981). A number of these IGRs have been evaluated in the laboratory and under field conditions against dipterous insects of medical and economic importance, particularly mosquitoes and chironomid midges (Ali and Lord 1980, Mulla and Darwazeh 1979). Among the BPUs, diflubenzuron, Bay Sir 8514, and UC-62644 (2, 6-difluoro-*N*-[[[4-[3-dichloro-5-trifluoromethyl-2-pyridinyloxy]-3,5-dichlorophenyl]-amino] carbonyl]benzamide) exhibited excellent activity against mosquitoes and chironomid midges in a variety of habitats (Ali and Stanley 1981, Mulla and Darwazeh 1979). Reported here is the efficacy of a new BPU, UC-84572 (Union Carbide) tested against eight species of mosquitoes and two species of midges in the laboratory. Diflubenzuron was simultaneously tested against these species as a standard because of its large database.

Technical grade materials of UC-84572 (99%) (chemical structure not disclosed) and diflubenzuron (90%) were utilized to make 1% stock solution (w/v) and 6-7 serial dilutions of each compound in acetone. Fourth instar mosquito larvae of *Aedes aegypti* (Linn.), *Ae. taeniorhynchus* (Wiedemann), *Anopheles albimanus* Wiedmann, *An. quadrimaculatus* Say, *Culex nigripalpus* Theobald, *Cx. quinquefasciatus* Say, *Cx. salinarius* Coquillett and *Wyeomyia mitchellii* (Theobald), maintained at the Florida Medical Entomology Laboratory at Vero Beach, Florida, were utilized. For midge bioassays, 4th instar larvae of *Chironomus crassicaudatus* Malloch and *Glyptotendipes paripes* Edwards were collected from Lake Monroe (*C. crassicaudatus*) and Lake Jessup (*G. paripes*), Sanford, central Florida.

For mosquito bioassays, 20 larvae were placed in a 120-ml disposable cup containing 100 ml of tap water. Distilled water (pH 6.9) was used in tests concerning *Wy. mitchellii* because of the possibility of larval mortality in tap water (Nayar 1982). Five or six different concentrations of UC-84572 and diflubenzuron were tested against each mosquito species each time. Each concentration was replicated three times and three untreated checks were maintained in each test which lasted for 3-7 days. One ml of 1% hog liver + yeast (3:2) was added to each cup at 2-day intervals. Larvae in the cups were examined daily and the final larval or pupal mortality or adult emergence in each treated cup was recorded at the time of complete adult emergence in the checks.

The midge bioassays were conducted in 1,200-ml clear plastic rearing units (Ali and Lord 1980). Each unit received twenty 4th instar larvae, 150 g of sterilized fine sand and 500 ml tap water, and was aerated continuously to maintain an air flow rate of 40 ± 10 ml/min. The IGRs were tested against midge larvae in the same manner as was used in the mosquito bioassays. Food for midges consisted of 0.1 g of ground dog food (Dog Kisses®, Hartz Mountain Products Corp.) added to each unit at 2-day intervals. Dead larvae, pupae, and living or dead adults in each unit were counted and removed daily. The experiment was maintained usually for 5-7 days until no living larvae or pupae remained in the checks.

Each mosquito or midge bioassay was repeated at least three times. A 14-hr photoperiod and 27 ± 2°C were maintained in the evaluation room during the experiments. Evaluations against chironomid species had to be repeated 5-6 times because of high mortality (particularly *C. crassicaudatus*) encountered in the checks on some occasions. This probably was due to the possible stress caused in some larvae during their field recovery and subsequent handling in the laboratory. However, tests with >10% larval mortality in the checks were discarded. The larval mortality in the treated cups in a test was adjusted against any mortality in the corresponding controls (Abbott 1925). The corrected mortality at different concentrations of an IGR was subjected to log-probit regression analysis to determine LC_{50} and LC_{90} values.

The activity of UC-84572 and diflubenzuron

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against eight species of mosquitoes and two species of midges is summarized in Table 1. All species tested (except for *Anopheles* spp.) were highly susceptible to UC-84572. Larvae of *Ae. aegypti*, *Ae. taeniorhynchus* and *Cx. nigripalpus* were the most susceptible to UC-84572 with LC_{90} values of 0.89, 0.78 and 0.53 ppb, respectively. The IGR, UC-84572, was also highly effective against *Cx. quinquefasciatus*, *Cx. salinarius*, and *Wy. mitchellii* as indicated by the LC_{90} values of 1.1, 1.77 and 2.6 ppb, respectively. Both species of *Anopheles* were relatively less susceptible to UC-84572 with LC_{90} values of 11.64 ppb (*An. albimanus*) and 5.1 ppb (*An. quadrimaculatus*). The new IGR was highly toxic to *C. crassicaudatus* (LC_{90} = 1.99 ppb) and *G. paripes* (LC_{90} = 2.37 ppb). A comparison of activity (LC_{90} values) of UC-84572 to that of diflubenzuron indicated that UC-84572 was 5 and 13 times more toxic than diflubenzuron to *Ae. aegypti* and *Ae. taeniorhynchus*, respectively. Against *An. quadrimaculatus*, both IGRs had similar activity, while diflubenzuron was slightly more toxic to *An. albimanus* (Table 1). The three species of *Culex* were 4–11 times more susceptible to UC-84572 than to diflubenzuron. Similarly, *Wy. mitchellii* was 15 times more susceptible to UC-84572 as compared to diflubenzuron. The new IGR also maintained 2 and 4 times higher level of activity than diflubenzuron against *G. paripes* and *C. crassicaudatus*, respectively.

Previous laboratory studies concerning the effects of BPUs on mosquitoes had shown that diflubenzuron caused complete inhibition of adult emergence of *Cx. pipiens pallens* Coquillett and *Cx. tritaeniorhynchus* Giles at 0.2 and 0.1 ppb, respectively (Takahashi and Ohtaki 1976). The LC_{50} values of the same IGR against *Ae. albopictus*, *Ae. subalbatus*, *Cx. p. molestus* Forskal and *Cx. p. pallens* were 0.47, 0.3, 0.72, and 0.18 ppb, respectively (Ishita and Kurihara 1977). The LC_{90} values of diflubenzuron, Bay Sir 6874 (also a BPU), and Bay Sir 8514 against *Cx. quinquefasciatus* amounted to 1.5, 1.8, and 6.8 ppb, respectively, while *Culiseta incidens* (Thomson) was 2–5 times more susceptible to the IGRs than *Cx. quinquefasciatus* (Mulla and Darwazeh 1979). Dame et al. (1976) reported a LC_{90} level of 4 ppb of diflubenzuron against *An. quadrimaculatus*. Against larval chironomids, *G. paripes* and *Chironomus decorus*, the LC_{90} values of UC-62644, diflubenzuron, and Bay Sir 8514, respectively, were 3.1, 4.1, and 7.6 ppb (*G. paripes*) and 5.7, 6.0, and 22.0 ppb (*C. decorus*) (Ali and Stanley 1981).

The present study demonstrated that the new BPU analog, UC-84572, was highly toxic to a

Table 1. Susceptibility of 4th instar mosquito and chironomid midge larvae exposed continuously to a new benzoylphenylurea IGR, UC-84572, and to diflubenzuron in the laboratory.

Species	IGR	Lethal concentration in ppb			
		LC_{50}	95% CL	LC_{90}	95% CL
		Mosquitoes[a]			
Aedes aegypti	UC-84572	0.31	0.24–0.39	0.89	0.80–0.99
	Diflubenzuron	2.03	1.72–2.34	4.72	4.30–5.15
Ae. taeniorhynchus	UC-84572	0.29	0.24–0.35	0.78	0.62–0.92
	Diflubenzuron	1.81	1.50–2.20	9.94	8.12–12.42
Anopheles albimanus	UC-84572	4.50	4.16–4.89	11.64	10.92–12.20
	Diflubenzuron	1.42	1.24–1.60	7.21	5.89–8.56
An. quadrimaculatus	UC-84572	1.40	1.14–1.62	5.10	4.52–5.73
	Diflubenzuron	1.24	1.10–1.40	5.03	4.40–5.82
Culex nigripalpus	UC-84572	0.24	0.21–0.27	0.53	0.48–0.59
	Diflubenzuron	1.11	0.92–1.28	5.92	5.43–6.40
Cx. quinquefasciatus	UC-84572	0.40	0.37–0.44	1.10	1.02–1.19
	Diflubenzuron	1.43	1.22–1.66	4.80	3.42–5.96
Cx. salinarius	UC-84572	0.83	0.69–0.92	1.77	1.50–2.11
	Diflubenzuron	2.92	2.16–3.82	9.61	7.06–11.84
Wyeomyia mitchellii	UC-84572	0.70	0.61–0.82	2.60	2.16–3.05
	Diflubenzuron	15.30	13.21–16.59	39.51	29.74–59.46
		Midges[b]			
Chironomus crassicaudatus	UC-84572	0.58	0.50–0.68	1.99	1.35–2.94
	Diflubenzuron	2.62	2.23–2.89	7.41	6.60–9.12
Glyptotendipes paripes	UC-84572	0.79	0.60–1.02	2.37	2.09–2.80
	Diflubenzuron	2.01	1.69–2.34	5.42	4.89–6.10

[a] Maintained at the Florida Medical Entomology Laboratory, Vero Beach, FL.

[b] Field populations taken from Lake Monroe (*C. crassicaudatus*) and Lake Jessup (*G. paripes*), Sanford, central Florida.

wide variety of mosquito and midge species. The LC_{90} levels of the mosquito and midge species ranged from 0.53–11.64 ppb of UC-84572. The standard, diflubenzuron, also showed high levels of activity against all mosquito and midge species, except for *Wy. mitchellii* which was relatively tolerant to diflubenzuron (LC_{90} = 39.5 ppb). A general comparison of the activity of UC-84572 and diflubenzuron indicated that UC-84572 was 4–13 times more active than diflubenzuron against the exposed mosquito species (except for *An. albimanus* and *An. quadrimaculatus*), and 2 and 4 times against *G. paripes* and *C. crassicaudatus*, respectively. Thus, UC-84572 warrants further evaluation against mosquitoes and chironomid midges under field conditions.

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