FIELD TRIALS OF PESTICIDES TO CONTROL LARVAL *CULICOIDES VARIIPENNIS* (CERATOPOGONIDAE)[1, 2]

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ABSTRACT. Replicated field trials of commercial granular formulations of chlorpyrifos, fenthion and temephos were conducted in Colorado against the larvae of *Culicoides variipennis*. Test sites were littoral habitats polluted with decomposing animal manure, ideal conditions for larval development. Efficacy was evaluated by counts made prior to and after treatments. Samples taken at 72 hr post-treatment showed that mean reductions in larval populations by chlorpyrifos at 0.20, 0.10 and 0.05 ppm were 100%, 50% and 63.7% respectively; by fenthion at 1.00, 0.50 and 0.25 ppm were 94.5%, 99% and 90.7%, respectively, and by temephos at 2.0, 1.0 and 0.5 ppm were 99.5%, 99.7% and 99.3%, respectively.

INTRODUCTION

The larvae of the biting midge *Culicoides variipennis* (Coquillett), the common biological vector of bluetongue (BT) virus of ruminants in most of the United States (Jones and Foster 1978) are commonly found in fresh or alkaline water-saturated substrates that are still or slow-flowing, have gently sloping banks, and are polluted with manure (Jones 1961). Concentrations of larvae are often found in scattered sites closely associated with concentrations of animals or their waste and waste disposal. Because of their relatively small size and ease of access, these sites can be easily treated with larvicides. Three chemicals, chlorpyrifos, *0,0*-diethyl *0*-(3,5,6-trichloro-2-pyridyl) phosphorothioate; fenthion; *0,0*-dimethyl *0*-[4-(methylthio)-m-tolyl] phosphorothioate; and temephos, *0,0'*-(thiodo-4,1-phenylene) bis (*0,0*-dimethyl phosphorothioate) have been shown in laboratory tests to be effective against colonized and field-collected *C. variipennis* larvae (Holbrook 1982) in Colorado and against field-collected larvae of the same species (Apperson 1975) in California. The field evaluations of these three chemicals reported here are part of a research effort at the Arthropod-borne Animal Diseases Research Laboratory (USDA-ARS), Denver, CO, to develop methods of vector suppression as part of an integrated management system for BT in ruminant livestock.

MATERIALS AND METHODS

The evaluations were made on larval sites located on the western drainage of the South Platte River between Brighton and Greeley, CO. The area is irrigated for agricultural crop production during the growing season and contains numerous beef cattle feedlots and dairy cattle drylots. Larvicide tests were conducted between May 28 and September 18.

The three chemicals were tested as commercial granular formulations, containing 10% chlorpyrifos, 1% fenthion or 2% temephos. These were broadcast on the surface of the water and exposed wet mud banks in ca a 2 m-band with a hand-cranked fertilizer spreader. Treatments were made to standing water in stable sites ranging in surface area from 8 to 80 m^2. The approximate rates were: chlorpyrifos at 0.2, 0.1 and 0.05 ppm; fenthion at 1.0, 0.5 and 0.25 ppm; and temephos at 2.0, 1.0 and 0.5 ppm (Holbrook 1982). The amount of material to be applied was determined by calculating the surface area and average depth of the water present to estimate volume and then calculating the intended dosage on a weight/volume basis. Each dosage level was tested at least three times on different sites during the test period.

Larval sites were selected for tests when a standard mud sample (consisting of 5 subsamples taken with a cylindrical core sampler 3 cm diam × 2 cm high) yielded more than 25 third and fourth instar larvae. Sampling areas were randomly selected and marked with surveyor flags within those portions of the site determined to be most favorable for larval development. Efficacy of treatment was determined by the percentage reduction of live larvae based on pretreatment counts, and mud samples for evaluations were taken between 0900–1100 hr immediately prior to treatment and at 24 hr and 72 hr post-treatment. The mud samples were placed in plastic bags on wet ice for transportation to the laboratory. The mud was placed in a thin layer in petri dishes with dechlorinated tap water and living and dead larvae counted under magnification.

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[2] Mention of a proprietary product does not constitute an endorsement or recommendation by the USDA.

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RESULTS AND DISCUSSION

Chlorpyrifos at 0.2 ppm resulted in reductions in larval counts of *C. variipennis* of 98–99% at 24 hr and 100% at 72 hr (Table 1), the best and most consistent results in these tests. All rates of temephos tested resulted in reductions of from 93–100% at 24 hr and 98–100% at 72 hr. The results with fenthion were the most variable, although there were individual tests at each dosage rate that resulted in 100% reductions in larval counts at 72 hr. The relative concentrations of these three chemicals required for a 95% reduction in larval counts in these field tests (chlorpyrifos < fenthion < temephos) agrees with laboratory results using colonized and field-collected larvae of *C. variipennis* (Holbrook 1982). Larval populations in all treatment sites returned to pretreatment levels by 3–6 wk post-treatment.

Efficacy is only one factor to consider in selecting a larvicide against *C. variipennis*. For these three chemicals, the LD_{50}s (mg/kg) against female white rats and the LC_{50}s (ppb) against rainbow trout, respectively, are: chlorpyrifos, 82 and 71; fenthion, 245 and 930; and temephos, 13,000 and 3,490 (Schwartz and Hamel 1980). A wide-area control program, even where spot applications to larval sites are used, requires treatment of a variety of habitats in stagnant or slightly flowing water. These polluted sites are not favorable for edible fish or crustaceans and they do not contain potable water, but birds may nest nearby and use the water for other activities, small mammals may contact these sites, and livestock may wallow in the mud and water. The latter can easily be prevented by fencing, particularly where dairy animals are concerned.

The chemical cost per unit of treated area were: chlorpyriofos 0.02 cents/m^2, temephos 0.3 cents/m^2 and fenthion 0.09 cents/m^2 based on local costs at the time these experiments were conducted. Thus, the most expensive material on the largest site treated during these tests would have cost 24 cents. Over 99% of the cost is the labor required in locating sites, making the applications and evaluating the results.

Because of its toxicity to non-target organisms and restrictions imposed chlorpyrifos should probably be limited to use on sites with a very high level of organic matter and with no access by livestock. The residual tolerance for chlorpyrifos in whole milk is 0.01 ppm.

Table 1. Insecticide treatments to control larvae of *Culicoides variipennis* in Colorado.

Chemical	Rate (PPM)	Larval counts (% change)		
		Pretreatment (0 hr)	24 hr	72 hr
Chlorpyrifos	0.20	304	7 (−98)	0 (−100)
		1540	14 (−99)	0 (−100)
		1312	6 (−99)	0 (−100)
	0.10	31	10 (−32)	1 (−97)
		539	77 (−86)	6 (−99)
		63	52 (−17)	92 (+46)
	0.05	90	0 (−100)	0 (−100)
		354	183 (−48)	180 (−49)
		76	52 (−32)	44 (−42)
Fenthion	1.0	58	43 (−26)	13 (−78)
		292	13 (−95)	0 (−100)
		330	0 (−100)	0 (−100)
		237	0 (−100)	0 (−100)
	0.5	77	2 (−97)	0 (−100)
		225	8 (−96)	7 (−97)
		121	24 (−80)	0 (−100)
	0.25	216	0 (−100)	0 (−100)
		37	0 (−100)	2 (−95)
		1052	32 (−97)	0 (−100)
		44	17 (−61)	14 (−68)
Temephos	2.0	330	11 (−97)	7 (−98)
		82	0 (−100)	0 (−100)
		1980	0 (−100)	0 (−100)
		595	21 (−96)	1 (−100)
	1.0	1116	11 (−99)	0 (−100)
		95	0 (−100)	0 (−100)
		781	56 (−93)	5 (−99)
	0.5	1278	40 (−97)	22 (−98)
		71	0 (−100)	0 (−100)
		79	5 (−94)	0 (−100)

According to the product label, fenthion is toxic to fish and wildlife, and application or runoff to ponds, lakes and streams is prohibited. It is approved for limited use on pasture without the removal of livestock. The residual tolerance for fenthion in whole milk is 0.01 ppm. In areas where runoff is unlikely, fenthion could be aerially applied where a large number of small pockets of larval development is present. This would be costly and perhaps justified only during BT epizootics or outbreaks in areas where the virus had not previously been known to occur.

Similarly, the product label for temephos states that it is toxic to birds and crustaceans and should not be applied where these are important resources. Temephos is registered for the control of the larvae of several biting flies for application to still or flowing water and may be used along stream margins or where runoff might occur. It may be used at higher rates for control of midge larvae in waters with abnormally high organic content or otherwise highly polluted water. Temephos was found not to accumulate in drinking water despite monthly additions (Laws et al. 1968). The residual tolerance for temephos in raw agricultural products is 0.1 ppm.

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