

EFFICACY OF DUPLEX® AND VECTOBAC® AGAINST *PSOROPHORA COLUMBIAE* AND *ANOPHELES QUADRIMACULATUS* LARVAE IN ARKANSAS RICEFIELDS^{1,2}

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The discovery of *Bacillus thuringiensis* var. *israelensis* serotype H-14 (*B.t.i.*) and its subsequent commercial development have greatly benefited integrated pest management (IPM) practices against mosquitoes. Various formulations, application methods and production procedures have resulted in efficient and environmentally safe products (Margalit and Dean 1985). Tests in Arkansas ricefields using *B.t.i.* have demonstrated excellent control against *Psorophora columbiae* (Dyar and Knab) and *Anopheles quadrimaculatus* Say (Stark and Meisch 1983). This and other studies have provided data which augmented the commercial development of Vectobac®,⁴ a *B.t.i.* formulation.

The insect growth regulator (IGR), methoprene, prevents adult emergence and has been shown to be effective against mosquito larvae (Mulla and Darwazah 1975, Walker 1987). Methoprene has been used in combination with various mosquito pathogens. These combinations resulted in higher mortality to test insects than when methoprene or pathogens were applied separately (Finney et al. 1977, Spencer and Olson 1982, Allen and Sweeney 1985). Recent interest in improving *B.t.i.* efficacy by addition of methoprene has surfaced.

This paper reports on tests conducted in 1987 using Duplex®,⁵ a compound containing methoprene (IGR) and *B.t.i.*, against *Ps. columbiae* and *An. quadrimaculatus* in Arkansas ricefields.

Objectives of this research were to determine the initial mortality caused by application of either Duplex or Vectobac at a rate of 2.64 oz AI/acre (78 ml AI/ha); what differences may occur in the mortalities of *Ps. columbiae* exposed to 1.32 and 2.64 oz AI/acre (39 and 78 ml AI/ha) of both materials; the residual capabilities; and the additional mortality caused by the IGR.

Pretreatment counts of natural *An. quadrimaculatus* larval populations were made in 3 ricefields to determine the initial mortality caused by Duplex and Vectobac. A total of 300 dips per field were taken by 5 people using standard 400 ml long-handled dippers. One field then received an aerial application of Duplex and another of Vectobac at rates of 78 ml AI/ha each. Treatments were made with a Beecomist® sprayhead mounted on a Piper Aztec® aircraft. The aircraft flew 241.9 km/hr at an altitude of 18.2 m during application. Swath width was approximately 30.5 m and each treatment area consisted of 6.1 ha. The third field remained untreated to act as a control. Population counts were again taken at 24 hr posttreatment.

A ricefield containing early instar larvae was used to determine activity of these compounds against *Ps. columbiae*. Pretreatment counts were obtained from 3 separate pan areas within the rice field. Little water movement existed between the pans and at least 2 levees separated each pan area used. Three persons sampled each area for a total of 100 dips per area. Aerial applications of Duplex and Vectobac were made in the same manner as above to each of 2 areas at 78 ml AI/ha. The third area remained untreated as a control. Twenty-four-hr posttreatment counts were made in the same manner as pretreatment counts.

A seep ditch with naturally occurring *Ps. columbiae* larvae adjacent to a ricefield was used to evaluate a 39 ml AI/ha application rate. Levee gates were positioned to effectively isolate 2 separate areas 152.4 m in length and 1 m in width with a 152.4 m length of ditch as buffer area. Two samplers took a total of 100 dips for pretreatment counts in these areas and in a previously established *Ps. columbiae* nursery of the same proportions. The nursery was located on the University of Arkansas Rice Research and Extension Center near Stuttgart, AR, and served as a control. Applications of Duplex and

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⁴ Vectobac was provided by Abbott Chemical Company and is composed of 1.2% *B.t.i.* as AI (Listed on the label as 12AS, 1200 ITUs/mg formula).

⁵ Duplex was provided by Zoecon Chemical Company and is composed of 1.5% *B.t.i.* and 0.2% methoprene as AIs (listed on the label as experimental chemical compound SAN 809 1).

Vectobac were made to separate areas of the test site with the plane flying perpendicular to the ditch. Posttreatment counts were made 24 hr later.

A series of six 3.2-liter plastic and mesh floating sentinel containers (Sandoski et al. 1986) were immediately placed diagonally across areas of fields aerially treated in the manner previously mentioned with 78 ml AI/ha Duplex and Vectobac and in a control field. Each container held 10, 2nd-3rd instar *Ps. columbiana* larvae acquired from the nursery on the Rice Research and Extension Center. Another series of containers were similarly positioned within the same fields 24 hr later. Larvae were monitored until death or emergence to determine the residual capabilities of the compounds.

Determination of the additional mortality caused by the 2 compounds was made by collecting 100 *Ps. columbiana* late 4th instar larvae and pupae prior to treatments of Duplex and Vectobac at the 78 ml AI/ha rate. These larvae and their corresponding field water were removed to a laboratory and held in enamel pans as controls. Another 100 *Ps. columbiana* were collected from each of the 2 treated areas 24-hr posttreatment and removed to the laboratory in the manner above. All individuals were observed daily until death or emergence.

Data from the field tests were corrected for check mortality by Abbott's formula, transformed (arc sin) and subjected to ANOVA for testing the hypothesis that mortality among treatments was equal. Mean separation was accomplished by *t*-tests (SAS 1985).

Psorophora columbiana populations treated with Duplex and Vectobac at 78 ml AI/ha were reduced initially, whereas there was an increase within the untreated control area (Table 1). Vectobac was significantly more effective than Duplex. *Anopheles quadrimaculatus* populations were also reduced initially by both Duplex and

Vectobac, but the decrease was significantly greater with Duplex than Vectobac treatment. Data from the field test exposing naturally occurring *Ps. columbiana* to 39 ml AI/ha of Duplex and Vectobac indicated that this rate was ineffective for both materials.

Mortality of sentinel *Ps. columbiana* introduced at 0 hr posttreatment to 78 ml AI/ha Duplex was 75.3%. Mortality to larvae introduced 24 hr posttreatment was 29.2%. Sentinel *Ps. columbiana* exposed to Vectobac at the same rate resulted in mortalities of 93.8% and 84.9%, respectively, when introduced at 0 and 24 hr posttreatment.

The percent reductions of *Ps. columbiana* in the laboratory emergence study were 28.5 and 4.9 in the Duplex and Vectobac treatments, respectively. The overall mortality caused by Duplex was higher than Vectobac and indicates an effect of the IGR in Duplex.

Based on results from these tests, the following conclusions are made. The application rate of 78 ml AI/ha for both Duplex and Vectobac was more effective than 39 ml AI/ha. *Anopheles quadrimaculatus* were more affected initially by Duplex, while *Ps. columbiana* were more affected initially by Vectobac. Long-term, IGR effect of Duplex was promising with additional reduction occurring in *Ps. columbiana* represented by the emergence study. Vectobac caused little reduction in emergence.

Duplex caused about 75% initial mortality to *Ps. columbiana* populations, which left about 25% still present in the field. If 28.5% of those left are unable to emerge, that is equivalent to 7% additional mortality to the population. The total mortality caused by Duplex then begins to approach that of Vectobac. A longer period of time is required to reduce larval populations, but ultimately adult emergence is reduced by a factor similar to that of Vectobac.

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Table 1. Efficacy of Duplex[®] and Vectobac[®] applied at 2.64 oz AI/acre (78 ml AI/ha) against field populations of *Psorophora columbiana* and *Anopheles quadrimaculatus*.

Treatment	Per-dip average		
	Pretreatment	24 hr post-treatment	% mortality*
<i>Ps. columbiana</i>			
Duplex	1.30	0.39	69.1**
Vectobac	1.43	0.23	84.1**
Control	2.10	3.29	0.0
<i>An. quadrimaculatus</i>			
Duplex	0.44	0.02	95.1a**
Vectobac	0.59	0.15	72.3b**
Control	0.55	0.52	5.5

* Mean values followed by the same letter are not significantly different ($P \geq 0.05$) by *t*-tests.

** Percentages adjusted by Abbott's formula.

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