RICE FIELD MOSQUITO CONTROL STUDIES WITH LOW VOLUME DURSBAN® SPRAYS IN COLUSA COUNTY, CALIFORNIA. V. EFFECTS UPON HONEY BEES

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Concentrated Dursban ® sprays were applied for mosquito control in rice fields during 1970 by the Colusa Mosquito Abatement District (Womeldorf and Whitesell 1972). This paper reports the effects of spray applications upon honey bees. The applications were of interest for two reasons. One was that Dursban is highly toxic to bees (Atkins *et al.*, 1970a). The second was that malathion applied as an ultra-low volume (ULV) spray has been shown to be more toxic initially and also to persist longer as compared with conventional sprays, thus causing a 2½-fold increase in overall toxicity to bees (Anderson and Atkins 1965, 1966, 1967).

PROCEDURE. Colonies of honey bees for the test were obtained from three Colusa beekeepers. Assistance in placing the colonies and in monitoring the effects upon bees was provided by the Colusa County Department of Agriculture.

Three techniques were utilized in the tests. In the first, Todd Dead Bee Entrance Traps (Atkins *et al.*, 1970b) were placed on four colonies of bees in the rice field, four colonies placed at the edge of the rice field (downwind), and four colonies in an untreated area inside a game refuge approximately 5 miles outside the sprayed areas. The dead bee traps monitored the number of bees dying at the colonies for 3 to 4 days pretreatment and 1 to 2 days post-treatment. The second technique consisted of evaluating effects upon the colonies monitored for the test by observing and recording the number of frames covered with bees at 8 a.m. The third technique included placing caged bees at various locations within the treated rice field, downwind outside the rice field, and in the check or untreated apiary to bioassay the contact effect on exposed bees from the mosquito control application. The cages are 6-inch cubes constructed of 8-mesh hardware cloth and fitted with a lid secured with two no. 64 rubber bands. An aluminum ring fastened to the lid is closed with a no. 7 rubber stopper which has an 18 mm hole to receive a 19 mm, 3-dram glass vial. The vial is provisioned with 13 ml of 1:1 honey-water solution and is closed with an absorbent cotton plug. This provides food for the bees during the experiment. Each cage is loaded with approximately 25 worker honey bees by aspirating the bees from a supply cage into the test cages using a vacuum pump and aspirator (Atkins *et al.*, 1954).

All three mosquito control applications were monitored. Conditions and methods of each application were listed by Akesson *et al.* (1972). During the June 9, 1970 applications, the honey bee tests were restricted to one rice field of 1050 acres, treated between 7:30 and 8:30 p.m. with an actual calculated dosage of 0.011 lb/acre actual Dursban. Wind velocities during application were 3 to 10 mph and temperatures were 90 to 95 ° F. The second application, during the evening of July 14, was in the same rice field. At the time of treatment, 7:00 to 7:30 p.m., wind velocities were 4 to 7 mph and temperatures were 93 to 98 ° F. The actual calculated dosage rate was 0.026 lb/acre actual Dursban. The third application to the same rice field, on August 18, was complicated by adverse wind conditions, resulting in a channeling of the spray pattern. No mortality occurred in either the colonies or the bioassay cages; therefore the data are not presented here. On Au-

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gust 19, a 300-acre field was treated. Unreplicated bioassay cages were spaced at 110-foot intervals at right angles to the aircraft path. Three of twelve 660-foot swaths were monitored. The dosage rate was 0.025 lb/acre actual Dursban.

RESULTS AND DISCUSSION. Tables 1 and 2 summarize results of the first application. Table 1 presents data on bees dying at the colonies and the effects upon the strength of the colonies. The Dursban treatment caused a doubling of bee kill the first day posttreatment and then returned to normal. Table 2 summarized the mortality data of caged bees caused by the chemical. The spray killed all of the exposed bees in the sprayed area and the drift persisted out to ¾ mile from the edge of the treated rice field.

In field tests utilizing Todd Dead Bee Entrance Traps, we consider pretreatment retrievable normal numbers of dead bees to be in the range of 10 to 75 bees per colony per day. We also consider posttreatment dead bee counts of approximately 500 bees per colony per day to be a moderate kill and a level not particularly detrimental if the dead bee retrieval does not remain at this level continuously. On this basis, the effects on the exposed colonies from this treatment were of no consequence in this test. Additionally the exposed caged bees suffered little mortality beyond the edge of the treated field.

Tables 3 and 4 summarize the results of the second application. Table 3 presents data on bees dying at the colonies and the effect upon the strength of the colonies. The Dursban treatment caused a 4-times-normal bee kill in the rice field and a 30-fold kill in the drift area at the edge of the field for one day posttreatment and then returned to normal. Table 4 summarizes the mortality of caged bees caused by the chemical. The spray killed all of the exposed bees in the sprayed area and all of the bees at the edge of the field and ¼ mile downwind in the drift area.

Table 1.—Effects on honey bees of concentrated Dursban® mosquito abatement airplane sprays of 0.011 lb. active ingredient per acre: Mortality of bees at colonies using Todd Dead Bee Entrance Traps.

Apiary and location	No. dead bees per colony for 24 hr. interval					
	Pretreatment date				Post-treatment date	Posttreatment colony evaluation [1]
	6/6	6/7	6/8	6/9	6/10	
Overspray colonies in rice field	110	110	75	63	124	5 frames of bees
	68	68	92	72	165	5 " " "
	12	12	26	16	52	3 " " "
Avg. per col. [2]:	63	63	64	50	114	4⅓ avg.
Drift colonies downwind of rice field	7	7	12	8	9	3 frames of bees
	8	7	10	10	48	11 " " "
	2	3	20	19	32	5 " " "
	8	8	18	16	69	10 " " "
Avg. per col.:	6	6	15	13	40	7¼ avg.
Untreated check colonies	15	14	81	49	19	14 frames of bees
	20	20	16	10	13	12 " " "
	32	33	28	33	22	11 " " "
	30	29	75	46	22	16 " " "
Avg. per col.:	24	24	50	35	19	13½ avg.

[1] Colony evaluation made by observing and recording the number of frames covered with bees at 8 a.m.

[2] One colony was rapidly dying out during the pretreatment period and was dead at the end of the treatment. Colony data withdrawn.

TABLE 2.—Effects on honey bees of concentrated Dursban® mosquito abatement airplane sprays of 0.011 lb active ingredient per acre: Bioassay of ULV spray and drift using honey bees.

Location of bioassay cages	Average mortality of caged bees 24 hrs posttreatment [1]
Untreated checks, laboratory	5.33
Untreated checks, check apiary	18.92
In rice field at over-spray apiary	100.00
At end of rice field, in drift area	77.14
0.25 mile west of rice field	16.67
0.50 mile west of rice field	13.51
0.75 mile west of rice field	8.00
1.00 mile west of rice field	49.33 [2]
1.25 mile west of rice field	86.96 [2]

[1] Average mortality from 3 cages 6 x 6 x 6" each containing approximately 25 worker honey bees at each location. Each cage provisioned with 1:1 honey-water solution for food. Cages remained in sprayed area for 12 hours posttreament and then removed to laboratory. Final mortality determined at 24 hours posttreatment.

[2] These 2 sets of bioassay cages were in drift area of adjacent rice field and received 2 exposures of spray drift.

TABLE 4.—Effects on honey bees of concentrated Dursban® mosquito abatement airplane sprays of 0.026 lb. active ingredient per acre: Bioassay of ULV spray and drift using honey bees.

Location of bioassay cages	Average mortality of caged bees 24 hrs. posttreatment [1]
Untreated checks, check apiary	2.63
In rice field at over-spray apiary	100.00
At end of rice field, in drift area	100.00
0.25 mile west of rice field	100.00
0.50 mile west of rice field	94.93
0.75 mile west of rice field	89.19
1.00 mile west of rice field	100.00 [2]
1.25 mile west of rice field	100.00 [2]

[1] Average mortality from 3 cages 6 × 6 × 6" each containing approximately 25 worker honey bees at each location. Each cage provisioned with 1:1 honey-water solution for food. Cages remained in sprayed area for 12 hours posttreatment and then removed to laboratory. Field mortality determined at 24 hours posttreatment.

[2] These 2 sets of bioassay cages were in drift area of adjacent rice field and received 2 exposures of spray drift.

Ninety-five percent were killed at ½ mile and 89 percent at ¾ mile in the drift area. The 1 and 1½ mile bioassay cages were exposed not only to the drift downwind, but also to the drift from the adjacent rice field, thus preventing an assay of the mortality from downwind drift at these distances from the test field. The overall effect was light to moderate on the exposed bee colonies in the test area; however, the bioassay results show 90 percent

TABLE 3.—Effects on honey bees of concentrated Dursban® mosquito abatement airplane sprays of 0.0262 lb. active ingredient per acre: Mortality of bees at colonies using Todd Dead Bee Entrance Traps.

Apiary and location	No. dead bees/colony for 24 hour interval					Posttreatment colony evaluation [1]
	Pretreatment date			Posttreatment date		
	7/12	7/13	7/14	7/15	7/16	
Overspray colonies in rice field	6	6	7	81	3	2 frames of bees
	20	21	21	54	12	5 " " "
	22	22	23	133	52	2 " " "
	43	44	44	116	11	2 " " "
Avg. per col.:	23	23	24	96	20	3½ avg.
Drift colonies downwind of rice field	8	9	9	684	31	11½ frames of bees
	8	8	9	346	16	9 " " "
	9	9	10	125	20	3 " " "
	14	14	14	200	57	3 " " "
Avg. per col.:	10	10	11	339	31	6¾ avg.
Untreated check colonies	7	7	7	8	5	11 frames of bees
	22	22	23	3	10	7 " " "
	13	13	13	9	8	9½ " " "
	37	37	38	37	8	10 " " "
Avg. per. col.:	20	20	20	14	8	9⅓ avg.

[1] Colony evaluation made by observing and recording the numbers of frames covered with bees at 8 a.m. PDT.

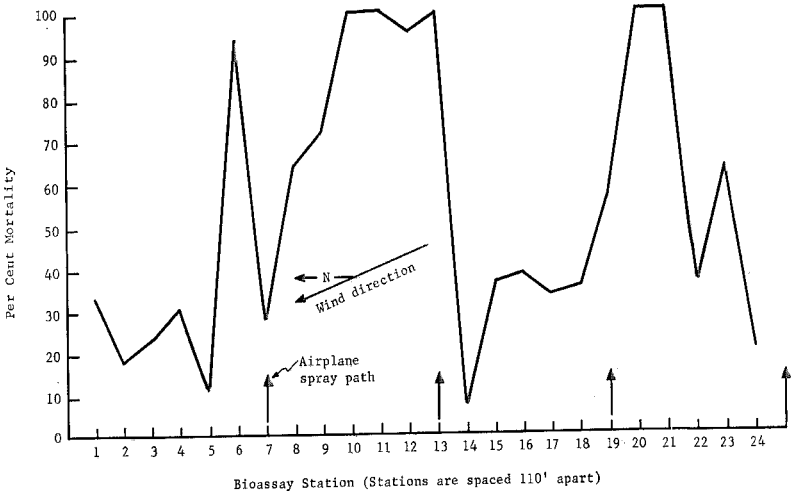

FIG. 1.—Effects upon honey bees of concentrated Dursban® mosquito abatement sprays of 0.025 lb. active ingredient per acre: bioassay of ULV spray using honey bees. Colusa, California, 19 August 1970, 3:25 p.m. PDT.

mortality in caged bees directly exposed at 0.75 mile downwind in the drift area.

The bioassay results of these two tests emphasize the importance of applying this pesticide at these ULV dosages only when bees are not actively foraging in the area to be treated.

Figure 1 presents bee bioassay data from the third application. In addition to demonstrating direct mortality of the cage bees, the data showed the aircraft swath pattern. The wind velocity (averaging 2½ mph) was somewhat lower than desired for optimum wind-carry characteristics, and the resulting channelization is evident. Adult mosquitoes are more sensitive to Dursban than are honey bees, and so the results of the bee bioassay do not necessarily show what would be the effects upon mosquitoes in the field.

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