UNIVERSITY OF CALIFORNIA, RIVERSIDE

BERKELEY • DAVIS • IRVINE • LOS ANGELES • RIVERSIDE • SAN DIEGO • SAN FRANCISCO
SANTA BARBARA • SANTA CRUZ

COLLEGE OF NATURAL AND
AGRICULTURAL SCIENCES
CITRUS RESEARCH CENTER AND
AGRICULTURAL EXPERIMENT STATION
DEPARTMENT OF ENTOMOLOGY

RIVERSIDE, CALIFORNIA 92521

4 December 1981

PROJECT NO. 81-N1

EFFECT OF PESTICIDES ON HONEY BEES

Objectives: To protect honey bee pollinators from pesticide hazards in almond orchards.

Progress: Honey bees are an indispensable agricultural tool for pollinating almonds for nut production and are as important as adequate fertilizing, irrigation, and weed and pest control. Previous laboratory research on captan, which is often applied to almonds in bloom, has shown that this fungicide can cause significant mortality to brood and/or deformation to surviving newly emerged adult worker bees if the fungicide is applied during bloom and bees carry captan-contaminated pollen into the hive.

Morphogenic studies of pesticides on the brood of honey bees determines the pesticidal effect and hazard to bees when the pesticide contaminates the hive. There are indications that several pesticides may cause the so-called dwindling of bee populations in commercial colonies. Therefore, research should be conducted to determine the problem and to determine which pesticides are hazardous of those currently being utilized in almond orchards. Some research has been conducted on captan. Reports persist that ziram, benomyl and a combination of ziram/benomyl have caused bee brood problems.

PHASE A — Fungicidal effects on honey bee brood.

The morphogenic methodology has been described in detail in the PROJECT NO. 1499 ANNUAL REPORT, 1980 on pages 658-659. Using these techniques, laboratory assays of the fungicidal effects on honey bee brood were completed. Benomyl (Benlate®), ziram (Zerlate®), and, a combination of benomyl/ziram were assayed for morphogenic effects on the brood of honey bees. These tests consider the effects on eggs, larvae, pre-pupae, pupae and emerging worker honey bees at 3 or more dosages for mortality and morphogenic effects and will be quantified and expressed in relation to the hazard to honey bee colonies in the field at the dosages these fungicides are applied. The summary of the data is in Table 1.

A combination of benomyl and ziram, 1:1 ratio, benomyl and ziram were evaluated for their possible effect on the brood of worker honey bees. Several dosages were applied to the following age groups of brood: 1-2, 3-4 and 5-6 day old larvae. Then, toxicity comparisons were made with previous honey bee laboratory tests.

Benomyl (50%WP), the least toxic to brood of the fungicides tested, was relatively nontoxic to the 3 age groups of brood. One and 2 day old larvae were the most susceptible age group; 5-6 day old larvae were the least susceptible age group. No morphogenic effect was observed. The mode-of-action was as a simple poison.

Ziram (76%WP) was relatively nontoxic to age groups of larvae. The most susceptible age group was the 1-2 day old larvae and the least susceptible age group was the 5-6 day old larvae. The effect of ziram was that of a simple toxicant. In the 5-6 day old larval stage cells containing daed larvae were capped indicating that the larvae were alive at the time the cells were capped and died shortly thereafter ending further larval development.

The benomyl/ziram combination (25%:25%; 1:1 ratio) was more toxic than either benomyl or ziram alone. There was a synergistic or potentiateated effect of the combination on brood toxicity. Again, the most susceptible age group was the 1-2 day old larvae; whereas, the least susceptible age group was the 3-4 day old larvae.

In summary, both benomyl and/or ziram are less toxic to brood of honey bee workers than to adults of honey bee workers. Benomyl, ziram or a combination of benomyl/ziram are relatively nontoxic to honey bee brood and should not cause a problem when utilized on almonds and other crops for fungal control at registered field dosages.

At this time, we do not know what the effect is on honey bee brood of combinations of captan with these fungicides; or, other fungicides used separately.

Respectfully submitted,
E. Laurence Atkins, R.P.E.
Specialist in Entomology & Apiology
David Kellum
Staff Research Associate

UNIVERSITY OF CALIFORNIA, RIVERSIDE

BERKELEY • DAVIS • IRVINE • LOS ANGELES • RIVERSIDE • SAN DIEGO • SAN FRANCISCO

SANTA BARBARA • SANTA CRUZ

COLLEGE OF NATURAL AND
AGRICULTURAL SCIENCES
CITRUS RESEARCH CENTER AND
AGRICULTURAL EXPERIMENT STATION
DEPARTMENT OF ENTOMOLOGY

RIVERSIDE, CALIFORNIA 92521

TABLE 1 — Dosage-mortality Data on the Effect of Various Fungicides on Worker Honey Bee Brood Compared to Effect on Honey Bee Adults

benomyl (50WP), Benlate®, Tersan®					
	Age of Treated Larvae, Days:				
	1-2	3-4	5-6	All	
Correlation coefficient	0.9961	0.9827	0.9105	0.9999	
Slope, probits	0.8517	0.2736	0.1867	0.4180	
Intercept, probits	1.9554	3.3525	3.3170	2.9386	Adults,
% Mort., LD (lethal dose[1])	Larvae, µg/larva				µg/bee
10	117.9	22.0	143.7	73.9	
50	3756.6	1.05×10^{6}	1.02×10^{9}	8.53×10^{5}	NT[2]@
90	11.9×10^{4}	5.0×10^{10}	7.38×10^{15}	9.8×10^{7}	120.86
ziram (76WP), Zerlate®					
	Age of Treated Larvae, Days:				
	1-2	3-4	5-6	All	
Correlation coefficient	0.7103	0.9972	0.9458	0.8264	
Slope, probits	0.6934	1.2147	0.3998	0.5601	
Intercept, probits	2.7423	0.6829	2.4979	2.4274	Adults,
% Mort., LD (lethal dose)	Larvae, µg/larva				µg/bee
10	25.7	316.4	1139.5	203.0	11.4
50	1804.1	3582.2	1.8×10^{6}	3.9×10^{4}	224.7
90	12.7×10^{4}	40.5×10^{3}	2.9×10^{9}	7.6×10^{6}	4438.8
benomyl/ziram, 1:1 ratio					
	Age of Treated Larvae, Days:				
	1-2	3-4	5-6	All	
Correlation coefficient	0.9832	0.9991	0.9999	0.9974	
Slope, probits	2.3481	1.4670	1.7170	1.7654	
Intercept, probits	0.3035	1.1642	1.1044	0.9681	Adults,
% Mort., LD (lethal dose[1])	Larvae, µg/larva				µg/bee
10	28.5	55.2	33.4	36.2	
50	100.1	411.8	185.7	191.9	NI[3]
90	351.0	3070.9	1033.7	1018.8	

[1] % Mortality, LD = lethal dose in micrograms per bee that will kill 10, 50 and 90% of the individual bees exposed to the pesticide.

[2] NT = nontoxic at the given dosage.

[3] NI = no information available for the combination.

L. Atkins & D. Kellum
25 September 1981