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Repellency of Surfactants to Honey Bees^{1,2}

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ABSTRACT

Either of 2 surfactants, Multi-Film[®] X-77 or Dow Corning[®] Fluid 471A, repelled honey bees, *Apis mellifera* L., when they were added to pond water at a concentration of 500 ppm; bees almost completely ceased visiting the surfactant ponds during the first 3 months and were partially repelled for 6 months after the treatment. The few bees visiting the treated ponds drowned at a much higher rate per visit than bees visiting ponds containing no surfactants.

The repellency of 11 chemicals as measured on drip boards varied from slight to 99%, depending on the surfactant. The 4 most repellent materials were Brij[®] 30 s.p., Renex[®] 30, Renex[®] 36, and Dow Corning Fluid 471A.

The number of honey bees visiting saltcedar, *Tamarix pentandra* Pall., flowers was not significantly reduced when these shrubs were sprayed with 1000 ppm of either Multi-Film X-77 or Dow Corning 471A.

Surfactants are widely used for domestic, industrial, and agricultural purposes. In 1960, more than 1.7 million tons of synthetic detergents, a class of surfactants, were produced in the United States. The world production of cleaning agents (synthetic detergents, soaps, and scouring agents) was more than 15 million tons in 1968. Surfactants also are used extensively in agriculture in the formulation and distribution of pesticides, as compatible agents for liquid fertilizer-pesticide mixtures, as buffering agents, and as anti-foam agents (Davidsohn and Milwidsky 1972).

Detergents have been found frequently in streams, ponds, and sewage systems. In addition, detergents and other surface-active agents used by agriculture and industry are potential contaminants of other water sources utilized by honey bees. A previous study had shown that one surfactant, Multi-Film X-77, caused extensive drowning of honey bees when it was added to small ponds or buckets of water (Moffett and Morton 1973). This study was made because of the potential widespread exposure of surfactants to honey bees.

The areas explored were: (1.) The time period in which either X-77 or Dow Corning Fluid 471A repelled and/or drowned bees after these 2 surfactants had been added to the water in small ponds. (2.) The repellency of 11 surfactants plus a chemical frequently occurring in surfactants. These tests were made by adding the chemicals to water which was supplied to drip boards. (3.) Visitation of saltcedar, *Tamarix pentandra* Pall., flowers. A field study was made to determine if 2 surfactants would prevent bees from visiting these flowers.

Methods and Materials

Chemicals Used

The surfactants studied were: 1. Brij[®] 30 s.p. (polyoxyethylene(4)lauryl ether); 2. Brij[®] 92 (poly-

oxyethylene(2)oleyl ether); 3. Brij[®] 96 (polyoxyethylene(10)oleyl ether); 4. Buffer X[®] (alkylarylpolyoxyethanol, free and combined fatty and phosphoric acids, and isopropanol); 5. Dow Corning[®] Fluid 471A (polyoxyethylene polymethylsiloxane), hereafter referred to as 471A; 6. Isopropanol; 7. Multi-Film[®] X-77 (hereafter referred to as X-77), a blended nonionic surfactant containing alkylarylpolyoxyethylene glycols, free fatty acids, and isopropanol; 8. Renex[®] 30 (polyoxyethylene(12)tridecyl ether); 9. Renex[®] 31 (polyoxyethylene(15)tridecyl ether); 10. Renex[®] 36 (polyoxyethylene(6)tridecyl ether); 11. Tween[®] 20 (polyoxyethylene(20)sorbitan monolaurate); 12. Tween[®] 81 (polyoxyethylene(5)sorbitan monooleate).

Cement Pond Study

On June 20, 1972, X-77 was added at a rate of 500 ppm to 30 gal of water in each of 5 cement ponds which were 3 ft² at the top, 1 ft² at the bottom, and 1 ft deep. Each of the surfactant ponds was paired with 5 similar check ponds which contained water without surfactants. The ponds were in a 2-acre experimental apiary containing about 30 colonies.

The number of bees collecting water was counted at 8:30 AM, 11:30 AM, and 2:30 PM daily except on weekends and holidays.

Dead bees were removed from the ponds at 7:00 AM and were considered to have died the preceding day or days.

A 2nd test using 471A instead of X-77 was made for 38 wk (Jan. 7–Oct. 2, 1974). Otherwise, all other conditions were similar to the first test.

Drip Board Study

Ten drip boards were placed in a circle around two 55-gal barrels located within 100 yards of the cement ponds. Water was piped from the barrels by copper tubing and was turned on at 7:00 AM and off at 7:00 PM by an automatic timer. One barrel supplied water plus 500 ppm of the surfactant, except for tests involving X-77 when 4 different concentrations of this surfactant were used.

The 2nd barrel supplied water only to the other 5

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² Company and trade names are given for identification purposes only. Mention of a proprietary product in this paper does not constitute endorsement by USDA.

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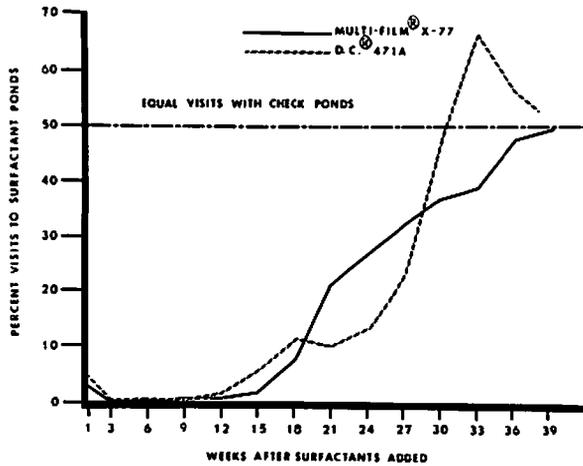


FIG. 1.—The influence of time on the repellency to honey bees of 2 surfactants added once at a concentration of 500 ppm to 30 gallons of water in cement ponds.

boards, except in the direct comparison between Renex 31 and Renex 36 when both barrels contained surfactant at the same time. Boards were paired and the boards receiving surfactants were determined by random selection. Counts of bees collecting water were made hourly from 7:30 AM through 3:30 PM except on weekends and holidays.

Saltcedar Study

To determine if surfactants would prevent honey bees from visiting flowering plants, we selected 11 pairs of flowering saltcedar plants (*Tamarix pentandra* Pall.) growing in a stream bottom near an 8-colony apiary. The number of honey bees visiting each plant was determined at ½-h intervals for a period of 2 h immediately prior to treatment. Then

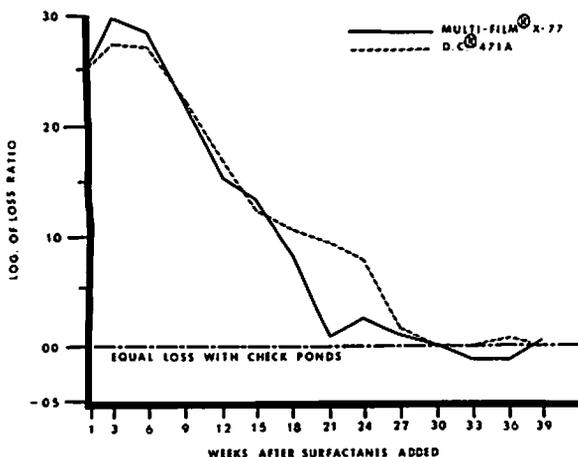


FIG. 2.—The influence of time on honey bee losses per visit to cement ponds containing 500 ppm surfactants in 30 gallons of water. The surfactants were added once to the water at the start of the tests. A log of 0 means losses equal to the check ponds, while log 3 means a 1,000 times greater loss.

Table 1.—Repellency to honey bees of 11 surfactants on drip boards, 1972-74, Tucson, Ariz.

Surfactant	Repellency ^a		Days of maximum repellency	Consecutive days tests were run
	2nd day	Maximum		
Tween 20				
Test 1	1.2	1.2	2 and 7	7
2	2.7*	3.9**	6	7
3	1.6	2.5*	6	7
Dow Corning 471A	3.5	93.5**	15	15
Isopropanol	1.1	1.3	6	7
Buffer-X	5.2**	11.4**	8	19
Renex 30	39.6**	79.6**	4	4
Brij 30 s.p.	5.0	85.9**	6	8
Brij 96 ^b	3.1*	13.0**	8	9
Tween 81	7.6*	9.7	3	4
Brij 92	2.3**	2.7**	3	3
Renex 31	5.8**	6.2**	3	3
Renex 36	72.3**	72.3**	2	2

^a Repellency was determined by dividing bee visits to uncontaminated water by bee visits to water containing 500 ppm surfactant. An average of 1,106 honey bees per day was counted visiting the 5 check drip boards.

^b This surfactant floated on the surface of the water and did not dissolve well.

* Significantly different from the check at the 5% level.
 ** Significantly different from the check at the 1% level.

on June 14, 1974, one plant of each pair was sprayed to the point of runoff with a water spray containing 471A. Four days later X-77 was applied in a similar manner. The concentration of surfactant was 1000 ppm in each instance. The other plant in each pair was left untreated. Honey bees visiting each treated and untreated plant were counted at ½-h intervals for 1.5 h after treatment on the day of treatment and from 7:00 to 10:00 AM during the 2 days after treatment.

Results and Discussion

Both X-77 and 471A at 500 ppm in water repelled honey bees visiting cement ponds for more than 6 months (Fig. 1).

For 3 months virtually no bees visited the ponds containing surfactants. Then visitations rose slowly until 7 to 8 months after the addition of the surfactant, when they were similar to the number of bee visits to the check ponds. Two months after the addition of the surfactant the few bees visiting these ponds still drowned at a 100 times greater rate per visit than bees visiting the check ponds (Fig. 2). This high rate dropped steadily for 6 months until it was similar for both treated and untreated ponds.

The repellency of the 11 chemicals tested on drip boards varied greatly (Table 1). The component of some commercial surfactants, isopropanol, was only slightly repellent. Brij 92 and Tween 20 reduced visits to 60-80%. Renex 31 and Tween 81 reduced visits more than 80%. The other 6 repellents reduced visits 90-99%.

Table 2.—Repellency to honey bees of 3 concentrations of Multi-Film X-77 on drip boards, 1973-74, Tucson, Ariz.

Concentration of X-77 (ppm)	Repellency		Days of maximum repellency	Consecutive days tests were run
	2nd day	Maximum		
62.5	2.8*	2.8*	2	2
62.5	2.6**	2.6**	2	2
125	9.6	11.7	1	2
250	8.0*	8.0*	2	2
500	4.2**	4.9*	3	7

* Significantly different from the check at the 5% level.
 ** Significantly different from the check at the 1% level.

The relative repellency of Renex 31 and Renex 36 was compared by using only these compounds in one test with no other source of water nearby. By the 2nd day the 5 drip boards treated with Renex 36 in a water solution had only 4% as many honey bee visitors as the boards containing Renex 31.

Variable results were obtained when the repellency of 4 concentrations of X-77 was tested on the drip

boards (Table 2). Water containing 62.5 ppm X-77 was less repellent than water containing high concentrations of X-77. However, concentrations of 500 ppm on the boards was much less repellent than the same concentration in ponds.

The number of honey bees visiting saltcedar flowers was not significantly reduced by treatment of the plants with either 471A or X-77. Although these surfactants were repellent to honey bees in water on drip boards and in ponds, they were not sufficiently repellent to keep honey bees from visiting the saltcedar flowers.

Surfactants can cause large losses of honey bees by drowning in experimental tests but concentrations in the field should seldom be high enough to cause serious losses. Also, honey bees prefer water which contains no surfactant and probably will not visit water containing surfactants if other water sources are readily available nearby.

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