Proceedings of the Tenth International Conference on Urban Pests
Rubén Bueno-Marí, Tomas Montalvo, and Wm. H Robinson (editors) 2022
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CONTROLLING YELLOWJACKETS IN URBAN RECREATIONAL AREAS

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Abstract Outdoor areas were monitored for two pestiferous species of yellowjackets, *Vespula alascensis* Packard and *Vespula pensylvanica* Saussure (Hymenoptera: Vespidae), in southern and northern California. Heptyl butyrate attracted *V. acadica* (Sladen), *V. alascensis*, *V. atropilosa* (Sladen), and *V. pensylvanica* whereas minced chicken only attracted *V. alascensis* and *pensylvanica*. Hydrogel formulations prepared with dinotefuran, fipronil, and metaflumizone were attractive to yellowjackets for 24 to 72 h. Baits containing 0.025% dinotefuran and 0.025% fipronil provided ≈ 50% significant reductions in trap counts after 14 and 20 d, respectively. Baits containing 0.001% metaflumizone were slower acting providing 80% control at day 41.

Key words *Vespula pensylvanica*, *Vespula alascenisis*, dinotefuran, metaflumizone, fipronil

INTRODUCTION

In the western United States, *Vespula alascensis* Packard, *V. germanica* F., and V. *pensylvanica* Saussure (Hymenoptera: Vespidae) are particularly pestiferous because they are readily attracted to human foods, increasing the likelihood of stinging incidences. Urban recreational areas adjacent to chaparral and foothills are especially known to harbor yellowjackets. Nest treatments, trapping, and baiting have been utilized to provide control with varying degrees of success (Rust and Su, 2012). Previous studies have shown that minced canned chicken is extremely attractive to foraging *V. alascensis* and *penyslvanica* and may be formulated as a matrix for baits (Rust et al., 2010, 2017). To develop a bait matrix that dries out slowly and extends its attractiveness, the liquid contents of minced chicken have been formulated into hydrogel crystals (Choe et al., 2018). In the United States, the only toxicant registered for use as a bait for yellowjacket control is a microencapsulated esfenvalerate, but it is ineffective (Rust et al., 2010). Experimental baits containing fipronil have provided significant reductions in yellowjacket trap counts (Rust and Su, 2012; Rust et al., 2017; Choe et al., 2018).

The objectives of the research were to identify potential toxicants and to develop a bait matrix that is attractive for several days.

MATERIALS AND METHODS

Test Sites. At Lake Tahoe, Serene Lakes, a private lakeshore park ≈ 16.1 km west of Truckee, CA (elev. 1945 m), was monitored. In southern California, Irvine Regional Park (IRP. elev. 172 m), a multiple-use park (≈ 65 ha), is surrounded by undeveloped wilderness areas composed primarily of a riparian coastal sage scrub and oak woodland plant community. A large campground (≈ 1,137 ha) located near Idyllwild, CA (elev. 1120 m) is surrounded by coastal sage scrub and valley grasslands. Another site is an animal park situated in northern San Diego Co. A single site in the San Francisco Bay area (SFB), the UC Berkeley Richmond Field Station, is ≈ 10 km northwest of the main campus. This area is a coastal grasslands environment with several large eucalyptus stands.

Monitoring. The foraging activity of yellowjackets was measured using monitoring traps provisioned with a highly attractive chemical lure, heptyl butyrate (Landolt et al., 2003) or minced canned chicken at the Lake Tahoe sites. Traps provisioned with ≈ 7 ml heptyl butyrate were used at SFB and southern California sites (Reierson et al.,

2008). One site in southern California used Rescue Disposable Yellowjacket Traps (Sterling International Inc., Spokane WA) with heptyl butyrate. At the Lake Tahoe sites, larger bucket style traps baited with either chicken or heptyl butyrate were hung in trees to prevent animals from disturbing them. Wasps that entered the traps were funneled into a jar containing a solution of propylene glycol and water (70:30 vol:vol).

Hydrogel Bait Preparation. Juice from cans of chicken (127 g, Swanson Premium Chunk Chicken Breast, Campbell Soup Co., Camden, NJ) was collected in a beaker and diluted with water (1:3). Technical metaflumizone or fipronil (Sigma Aldrich, PESTANAL®, analytical standard) dissolved in 1 ml of EtOH or dinotefuran (Alpine 40WSG, Whitmire Micro-Gen Research laboratories, St. Louis, MO was added to the diluted chicken juice. Once the liquid bait was well mixed, 45 g of polyacrylamide hydrogel (Miracle-Gro Water Storing Crystals, Miracle-Gro Lawn Products, Marysville, OH) was added. The hydrogels were refrigerated overnight until all the liquid was absorbed. Twenty to 30 g of the hydrogel bait was placed into each 59.2 ml cup. The cups were capped, weighed, and stored in the refrigerator.

Bait Studies. Bait stations were constructed from two pieces of pine board and a piece of 2.54-cm hardware cloth. The hardware cloth was stapled to the edges of the boards to construct a cage (Choe et al., 2018). Each bait station was provisioned with three bait cups containing 20 to 30 g of bait and hung near monitoring traps (within 1 m). At the animal park, Havahart® rodent traps with bait cups inside were placed on the ground to prevent animals from feeding on the baits. To estimate water loss from hydrogel baits, evaporation control stations containing five cups were hung alongside bait stations. To prevent yellowjackets from feeding on the evaporation controls, a fine metal screen (1 mm mesh) was wrapped around these cages. The evaporation stations were removed after 24 to 72 h depending upon the baiting period, and the cups weighed.

Yellowjacket activity level (i.e., 10 yellowjackets/trap/day) was used as an action threshold for baiting at each location (Rust et al., 2010). ***Lake Tahoe Site***. On 9/27/2018 a bait acceptance test was conducted using 4 bait stations, each provisioned with one bait cup of each of three concentrations of dinotefuran (0.00075%, 0.001%, and 0.0025%) bait. Bait stations and evaporation checks were returned to the laboratory after 48 h. ***Southern California Sites***. On 8/22/2017, 13 different sites at IRP were baited with 0.001% metaflumizone baits. Three cups containing 20 g of bait were placed in each bait station. Bait stations and evaporative checks were removed after 24 h. On 9/3/2019 a bait trial was conducted at three sites at IRP using three different bait stations, each provisioned with three bait cups for each of three concentrations of dinotefuran (0.00075%, 0.001%, and 0.0025%) bait. Three bait stations for each concentration and evaporation checks were hung for 24 h. On 9/24/2019, four sites at the animal park were baited with 0.0125, 0.025, and 0.05% dinotefuran and 0.025% fipronil hydrogel baits. The baits and evaporation checks remained in the field for 72 h. ***SFB Site***. Two yellowjacket trap lines (transects) were monitored from 8/29/2018 to 10/10/2018. One transect was baited on 9/5/2018 and again on 9/24/2018 using dinotefuran concentrations 0.00075%, 0.001%, and 0.0025%, as above, while the other transect was untreated, serving as a control. The baits and evaporation checks were returned to the laboratory after 24 h.

Data Analysis. Monitoring counts by trap or by transect were compared with paired *t*-tests or with a Wilcoxon signed-ranks tests. For choice tests, differences in bait removal by concentrations were analyzed with ANOVA or Wilcoxon signed-ranks tests.

RESULTS

At Lake Tahoe sites, traps provisioned with minced chicken attracted *V. alascensis* (n= 235) and *V. pensylvanica* (n= 219) while traps provisioned with heptyl butyrate attracted *V. acadia* (n = 57), *V. alascensis* (n= 14), *V. atropilosa* (n= 30), and *V. pensylvanica* (n= 1885). The monitoring traps with minced chicken caught 94.4% of the *V. alascensis* and 10.4% of the *V. pensylvanica.* Traps in SFB and southern California sites primarily caught *V. pensylvanica*. A few *V. atropilosa* workers were caught in the mountain sites in southern California in early June.

Baiting Studies. At Serene Lakes, the average removal of all three baits was 4.2 g/cup (50.4 g total). There was no difference in the amount of bait removed among the three concentrations of bait ($F=4.35$, $df=2,9$, $P=0.32$). There was a significant reduction in the numbers of yellowjackets trapped in a 7-d period after baiting than before ($W=6$, $n=10$, $P<0.05$). ***In 2017***, IRP was baited with 0.001% metaflumizone hydrogel baits. The entire amount of bait (20 g) from each cup was removed by the yellowjackets (1,050 g total). Concurrently, the evaporation control cups lost 4.0 ± 0.2 g (mean ± SEM). A gradual and consistent decrease in wasp activity was observed throughout the park, providing ≈ 59% reduction by 27 d after baiting and 81% reduction 41 d after baiting. ***In 2019***, dinotefuran baits failed to significantly reduce the traps counts at IRP (Table 1). The hydrogel baits lost ≈ 42% of their weight due to water loss during the 24-h baiting. A total of 66.6 g, 62.8 g and 75.2 g of 0.00075%, 0.001% and 0.0025 bait were removed,

respectively. At the animal park, hydrogel baits containing 0.025% dinotefuran resulted in significant reductions in yellowjackets trapped after 13 d (Table 2). The results were inconsistent with those associated with baits containing 0.0125% and 0.05% dinotefuran. However, hydrogel baits containing 0.025% fipronil provided a significant reduction after 6 d (53.2%) and after 20 d (44.4%) (Table 2). The trap counts at the animal park in southern California were the highest that we have ever encountered with >100 yellowjackets/trap/day. The 0.025% fipronil baits provided about 50% reductions for 20 d, but it was necessary to bait that site again monthly for the next two months.

SFB Site. There were no significant differences in the amount of bait removed among dinotefuran concentrations ($F = 3.25$, $df = 2,6$, $P = 0.11$), even though decreasing amounts were removed as bait concentration increased: 1.88 g (0.0025% dinotefuran), 2.25 g (0.001% dinotefuran), and 3.15 g (0.00075% dinotefuran). Evaporation of water from hydrogels was significant, with a mean loss of 5.7 g (≈ 19%) during the 9/5 to 9/6/2019 baiting period (24 h). Yellowjacket trap counts along the baited transect were significantly lower (3.6 ± 0.7 wasps / d) after two baiting events than those recorded immediately prior to baiting (16.4 ± 3.1 wasps / d) ($\chi^2 = 16.9$, df = 2, P = 0.0002). This was in contrast to yellowjacket trap counts along the unbaited transect, which did show any significant decrease during the same period ($\chi^2 = 2.99$, df = 2, P = 0.224).

Table 1. Efficacy of 0.00075%, 0.001%, 0.0025% dinotefuran hydrogel baits against western yellowjackets at Irvine Regional Park.

		Avg. No./trap/day (% reduction)				
Concn (%)[a]	**Avg. taken (SD) (g)**	**Pre-Count**	**14 days**	**28 days**	**42 days**	**56 days**
0.00075	9.7 ± 5.48	17.6	18.5 (+4.9)	19.8 (+12.5)	13.3 (24.9)	9.2 (47.9)
0.001	6.6 ± 5.08	10.9	9.6 (11.2)	21.1 (+94.5)	6.0 (45.0)	2.4 (78.3)
0.0025	5.5 ± 6.95	28.9	17.1 (40.6)	18.1 (37.3)	10.0 (65.3)	6.0 (79.3)
Untreated		12.0	12.8 (+7.0)	20.0 (+66.7)	8.4 (29.9)	6.9 (42.6)

[a]Baits applied on 9/3/2019 for 24 h.

Table 2. The efficacy of baits against yellowjackets at an animal park facility in southern California[1].
[1]Baits deployed 9/24/2019.

Toxicant	**Concn (%)**	**Avg. Trap Counts/day (% reduction)**			
		Pre-Count	**6 days**	**13 days**	**20 days**
Dinotefuran	0.0125	14.5	12.4 (14.5)	7.7 (46.9)*	6.2 (57.2)
	0.025	19.7	7.3 (62.9)*	11.0 (44.1)*	10.6 (46.1)
	0.05	14.2	5.7 (60.0)	14.7 (0.0)	14.1 (1.0)
Fipronil	0.025	100.5	47.0 (53.2)*	46.3 (53.9)*	55.9 (44.4)*

* Denotes a significant reduction in trap counts at $P<0.05$ (paired *t* tests)

DISCUSSION

Neither of the non-pest species, *V. acadica* and *atropilosa*, was attracted to the minced chicken. Thus, baits containing the minced chicken were only attractive to pest species encountered at each of the sites and will not impact non-target species. The hydrogel matrix increased the period of attractiveness of baits and allowed for longer baiting periods. Baits containing 0.001% metaflumazone and 0.025% fipronil provided significant reductions in the numbers of yellowjackets trapped. Baits containing 0.025% dinotefuran provided significant reductions of yellowjackets at several sites, whereas results with baits containing 0.05% and 0.0125% dinotefuran were inconsistent.

ACKNOWLEDGEMENTS

The authors would like to thank Linda Post for her assistance in conducting the field research at the animal park. This research was in part funded by California Department of Consumer Affairs.

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