Evaluation of Baited and Unbaited Traps for Monitoring Plum Curculios in Commercial Apple Orchards

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In the summer 1999 issue of *Fruit Notes* we reported in 1999 tests in which we compared odor-baited with unbaited traps for monitoring plum curculios (PCs) in commercial and unsprayed orchards. The odor used was a combination of two synthetic components of host fruit odor (ethyl isovalerate and limonene) plus synthetic male-produced sex pheromone (grandisoic acid). Odor-baited and unbaited traps were of three types: pyramid, cylinder and Circle. Unfortunately, none of these trap types captured significantly more PCs when baited than when unbaited.

Here, we evaluated each of six synthetic components of host fruit odor in combination with grandisoic acid and in association with pyramid, cylinder and Circle traps in 12 commercial apple orchards in 2000. The orchards were those selected for a study of the influence of orchard and border area architecture on third-level IPM practices.

Materials & Methods

The three types of traps were: (a) black pyramid traps (24 inches wide at base x 48 inches tall) placed on the ground next to apple tree trunks, (b) black cylinder traps (3 inches diameter x 12 inches tall) fixed vertically onto horizontal branches within apple tree canopies, and (c) aluminum-screen "Circle" traps (developed by a grower named Edmund Circle in Oklahoma for pecan weevils) wrapped tightly around ascending tree limbs and designed to intercept PC adults walking upward.

The six synthetic components of host fruit odor were among the most attractive of the 30 components evaluated in 1999 in conjunction with boll weevil traps placed on the ground (results reported in the summer 1999 issue of *Fruit Notes*). They were benzaldehyde, decanal, ethyl isovolerate, hexyl acetate, limonene, and trans-2-hexenal. Each was purchased from Aldrich Chemical Company and was deployed in small polyethylene vials that fit into the screen-funnel top of a boll weevil trap that capped each pyramid, cylinder or Circle trap. The release rate of each compound was about 10 milligrams per day (achieved by adjusting the number of vials per trap according to compound volatility). Each baited trap also contained a plastic dispenser of grandisoic acid (obtained from Chem-Tica, Inc. in Costa Rica) designed to release about 5 milligrams of pheromone per day.

Traps were placed in plots of four apple trees in each of the 12 orchards. Each plot consisted of seven perimeter trees. Each tree (save one) contained one baited or one unbaited trap of the above three types. All three baited traps in a given plot received the same odor. In each orchard, each of three plots received a synthetic fruit volatile in combination with grandisoic acid. The fourth plot received grandisoic acid alone. In all, there were six replicates of each synthetic fruit volatile among the 12 orchards.

All traps were deployed at tight cluster or early pink (April 28-May 4). Traps were examined for captured PC beginning at petal fall (May 9) and every 3 to 4 days thereafter for 7 weeks until June 27. Vials of benzaldehyde and dispensers of grandisoic acid were renewed on May 28-30 (mid-way during the experiment). At each trap examination, 20 fruit on each of the six trapped trees per plot were examined for PC oviposition scars. All plots received two or three sprays of azinphosmethyl or phosmet to control PC.

Results

For PC captures summed across all three trap types (bottom of Fig. 1), results show that traps baited with grandisoic acid alone captured no more PCs than unbaited traps. Among the six synthetic fruit volatiles tested in combination with grandisoic acid, three captured about twice as many total PCs as did corresponding unbaited traps: benzaldehyde, ethyl isovalerate and limonene. For each of these three compounds, captures by baited pyramid traps were never more than twice as great as captures by unbaited corresponding pyramid traps, whereas captures by baited cylinder or Circle traps were always more than twice as great as captures by corresponding unbaited cylinder or Circle traps (Fig. 1). Owing to the limited number of replicates (six per treatment) and variability among replicates, there were no significant differences in PC response to baited versus unbaited traps,

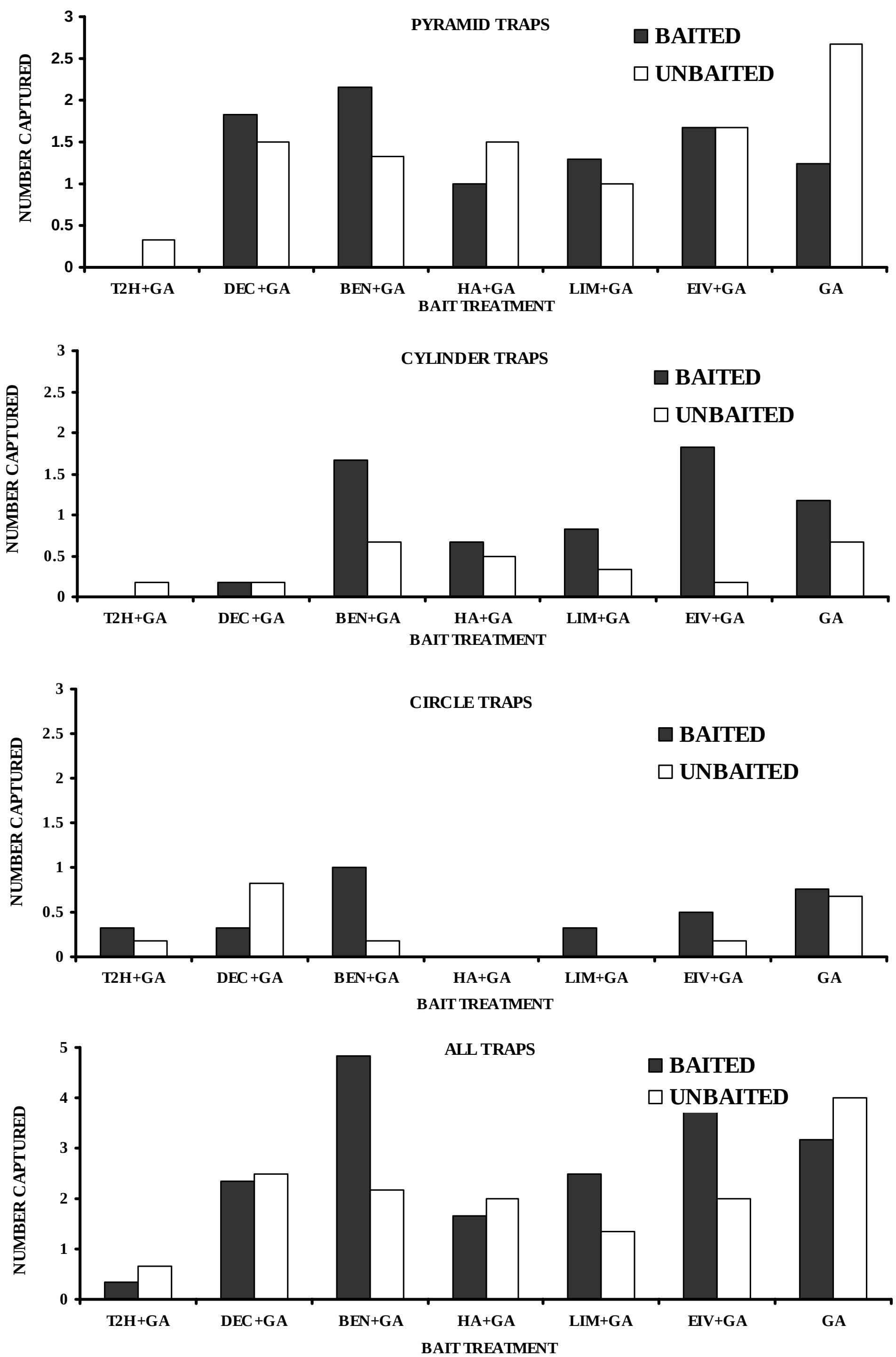

Figure 2. Captures of overwintered plum curculios by odor-baited traps placed beneath or within canopies of perimeter apple trees in commercial orchards from May 1-June 27, 2000. No significant differences at odds of 19:1 were detected for any paired comparisons involving an odor-baited treatment and its corresponding unbaited treatment. T2H= trans-2-hexenal, DEC= decanal, BEN= benzaldehyde, HA= hexyl acetate, LIM= limonene, EIV= ethyl isovalerate, GA= grandisoic acid

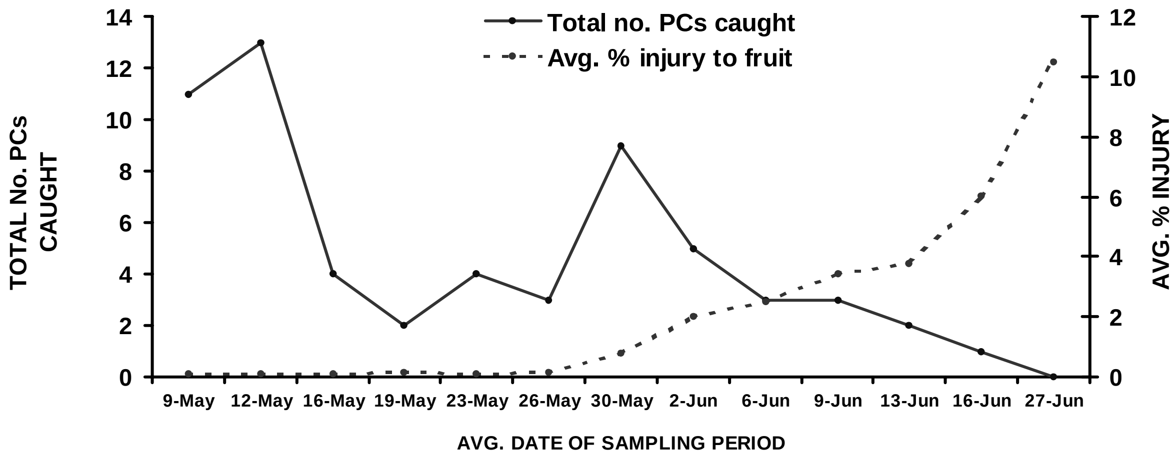

Figure 2. Relationship between combined captures of PCs on pyramid, cylinder, and Circle traps baited with benzaldehyde, ethyl isovalerate and limonene (in combination with grandisoic acid) and average percent fruit injury for each of the 13 sampling sates from May 9-June 27 in commercial orchards.

despite strong numerical trends. Traps baited with any of the remaining three synthetic fruit volatiles (decanal, hexyl acetate and trans-2-hexenal) in combination with grandisoic acid captured no more total PCs than corresponding unbaited traps (Fig. 1).

For a trap to have real value in monitoring PC abundance in a commercial orchard, trap captures ought to correlate well in time and total amount with time and total amount of PC injury to fruit. Fig. 2 shows that when capture data were summed across baited pyramid, cylinder and Circle traps and across benzaldehyde, ethyl isovalerate and limonene (in conjunction with grandisoic acid) as bait, periods of increase in trap capture were not well correlated with periods of increase in fruit injury. For example, average fruit injury increased successively from 0.78% to 10.50% of all fruit sampled during each sampling period from May 30 to June 27, but there was no corresponding successive increase in captures of PCs during this period by traps baited with these three compounds. Nor was there any significant correlation between phenology of PC trap captures (pattern of occurrence over time) and phenology of PC injury to fruit for any of the individual trap types baited with any of the individual synthetic fruit volatiles in combination with pheromone (Table 1). There was, however, a strong correlation between total

Table 1. Degree of correlation between time or amount of captures of PCs by pyramid, cylinder, or Circle traps baited with benzaldehyde, ethyl isovalerate, or limonene (each in combination with grandisoic acid) and PC injury to fruit in plots where traps were located in commercial orchards.

		Correlation r value*	
Odor	Trap	Time of capture vs. time of injury	Total capture vs. total injury
Benzaldehyde	Pyramid	0.30	0.97
	Cylinder	0.10	0.26
	Circle	0.70	0.51
Ethyl isovalerate	Pyramid	0.10	0.42
	Cylinder	0.10	0.10
	Circle	0.10	0.62
Limonene	Pyramid	0.33	0.98
	Cylinder	0.57	0.28
	Circle	0.22	0.99

*The value of r indicates the strength of correlation. Perfect correlation: r = 1.00 (or –1.00). Total absence of correlation

Table 2. Captures of PCs by all traps combined and percent of PC-injured fruit in relation to type of cultivar comprising perimeter-row trees and type of habitat bordering perimeter-row trees.

	Cultivars in perimeter rows		Adjacent habitat		
Category	Gala, Jonagold, Fuji	McIntosh, Empire	Open	Hedge	Woods
Number of orchards	6	6	4	4	4
Avg. no. trapped PCs per orchard	23.2	8.0	14.0	10.0	22.7
Avg. injury (%)	23.1	5.3	15.3	4.6	22.6

captures of PCs across the season and total amount of fruit injury (at season's end) for pyramid traps baited with benzaldehyde or limonene and for Circle traps baited with limonene (Table 1).

When effects of orchard architecture and outlying habitat are considered, results show that trap captures were about three times greater and fruit injury was about four times greater when Gala, Jonagold or Fuji trees comprised perimeter rows than when McIntosh or Empire trees comprised perimeter rows (Table 2). Also, we were surprised to find that trap captures and fruit injury on perimeter rows directly facing 100 or more yards of open space were nearly as great as on perimeter rows directly facing woods 10 yards or less away (Table 2).

Conclusions

Our findings indicate that PCs discriminate quite well between cylinder traps or Circle traps baited with benzaldehyde, ethyl isovalerate or limonene (each in combination with grandisoic acid) and corresponding unbaited traps. This is the first time anywhere that PCs have been found to respond in a substantial way to odor-baited traps placed in apple tree canopies. These results will serve as a springboard for future studies aimed at pinpointing the dose at which each of these three synthetic fruit volatile compounds is most attractive in association with cylinder or Circle traps. PCs did not discriminate as well between pyramid traps baited with these three compounds (in combination with grandisoic acid) and corresponding unbaited pyramid traps. Perhaps the location of the odor bait (at the top of a pyramid trap) was too far away from the point of PC entry (usually at the base of a pyramid trap) to be attractive, or perhaps the strong visual stimulus of a pyramid trap exceeded the stimulus of attractive odor.

Despite the progress in trapping PCs in commercial orchards reported here, we have not yet reached our goal of development of an odor-baited trap whose captures reflect both the timing and the amount of PC injury to fruit. Even so, the findings reported here represent progress toward this goal.

Finally, we were surprised by the much greater number of PC captures and amount of injury on perimeter Gala, Jonagold, and Fuji trees compared with perimeter McIntosh and Empire trees. We were also surprised by the large average amount of captures and injuries on perimeter trees facing open fields. Perhaps PCs are immigrating into orchards from distances much further than we have recognized, and doing so especially in response to odor emitted from certain attractive cultivars. We plan to explore both of these aspects further in the coming year.

Acknowledgements

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