Commercial-orchard Evaluation of Traps for Monitoring Plum Curculio: 2001 Results

Ronald Prokopy, Brad Chandler, and Jaime Piñero
Department of Entomology, University of Massachusetts

In the 2000 issue of *Fruit Notes*, we reported our year 2000 tests in which we compared odor-baited with unbaited traps of three types (pyramid, cylinder, and Circle) for monitoring plum curculios (PC's) in commercial apple orchards. Results suggested that traps baited with grandisoic acid alone (= synthetic male sex pheromone) captured no more PC's than unbaited traps. However, when grandisoic acid was combined with any one of three different synthetic host fruit volatiles (benzaldehyde, ethyl isovalerate, or limonene), captures by baited traps were about twice as great as captures by unbaited traps. Addition of the synthetic fruit volatiles decanal, hexyl acetate, and trans-2-hexenal to grandisoic acid did not enhance captures.

Here, we report results of 2001 studies in commercial orchards in which we further evaluated the best odor combinations found in 2000, again in association with pyramid, cylinder, and Circle traps.

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 tree canopies, and (c) aluminum-screen "Circle" traps (developed by a grower named Edmund Circle in Alabama for pecan weevil), wrapped tightly around the base of tree trunks so as to completely encircle the trunk and afford maximum chance of intercepting adults walking upward.

The three synthetic components of host fruit odor were benzaldehyde, ethyl isovalerate, and limonene. 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 type or number of vials per trap according to compound volatility). Each baited trap also contained a plastic dispenser of grandisoic acid (obtained from Great Lakes IPM) designed to release about 1 milligram of pheromone per day.

Traps were deployed in four plots of apple trees in each of 12 commercial 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 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.

All traps were deployed at pink (May 2-4). Traps were examined for captured PC's beginning at petal fall (May 14-16) and every 3-4 days thereafter for 7 weeks until June 28-30. Vials of benzaldehyde and dispensers of grandisoic acid were renewed on May 28-30 (about mid-way through the experiment). At each trap examination, 10 fruit on each of the six trapped trees per plot (= row 1 trees) and five fruit on each of six corresponding but untrapped trees on interior rows 3, 5, and 7 were examined for PC oviposition scars. In all, 102,800 fruit were examined for PC injury. All plots received two or three sprays of azinphosmethyl or phosmet to control PC.

Results

Figure 1 shows that across the entire PC season, Circle traps baited with benzaldehyde plus grandisoic acid (GA) captured numerically more PC's than any other type of baited or unbaited trap, although not significantly more than unbaited Circle traps in the

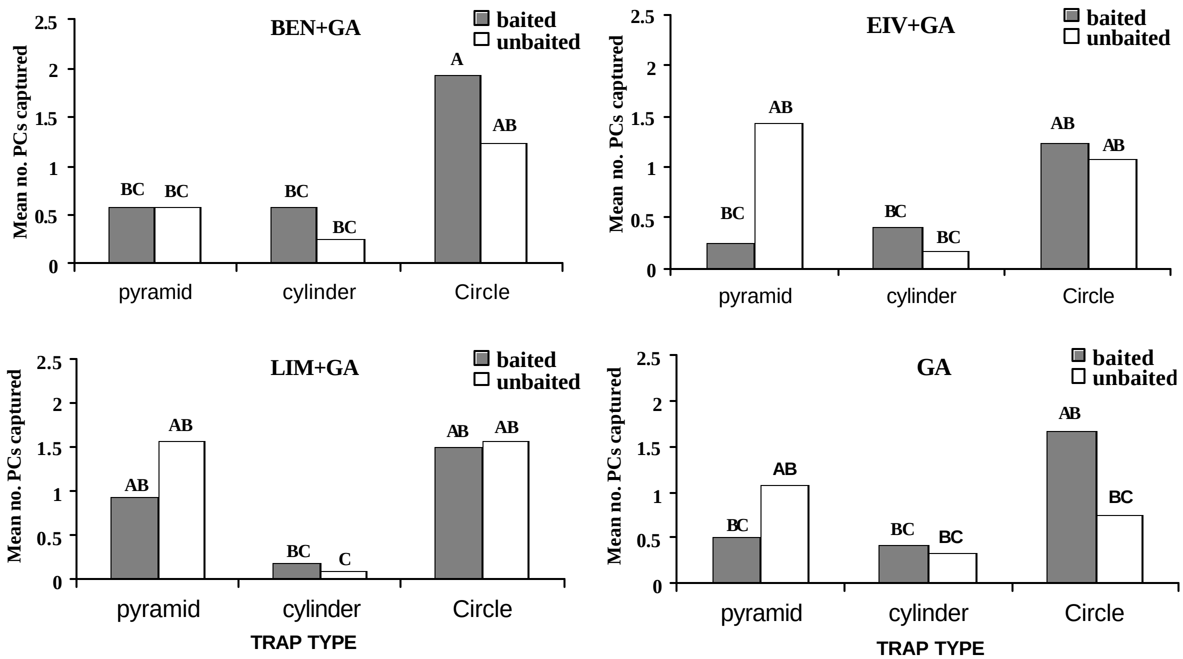

Figure 1. Mean number of PC's captured by each type of odor-baited and unbaited trap placed on perimeter-row trees. Among all bars in this figure, those superscribed by the same letter are not significantly different from one-another at odds of 19 to 1.

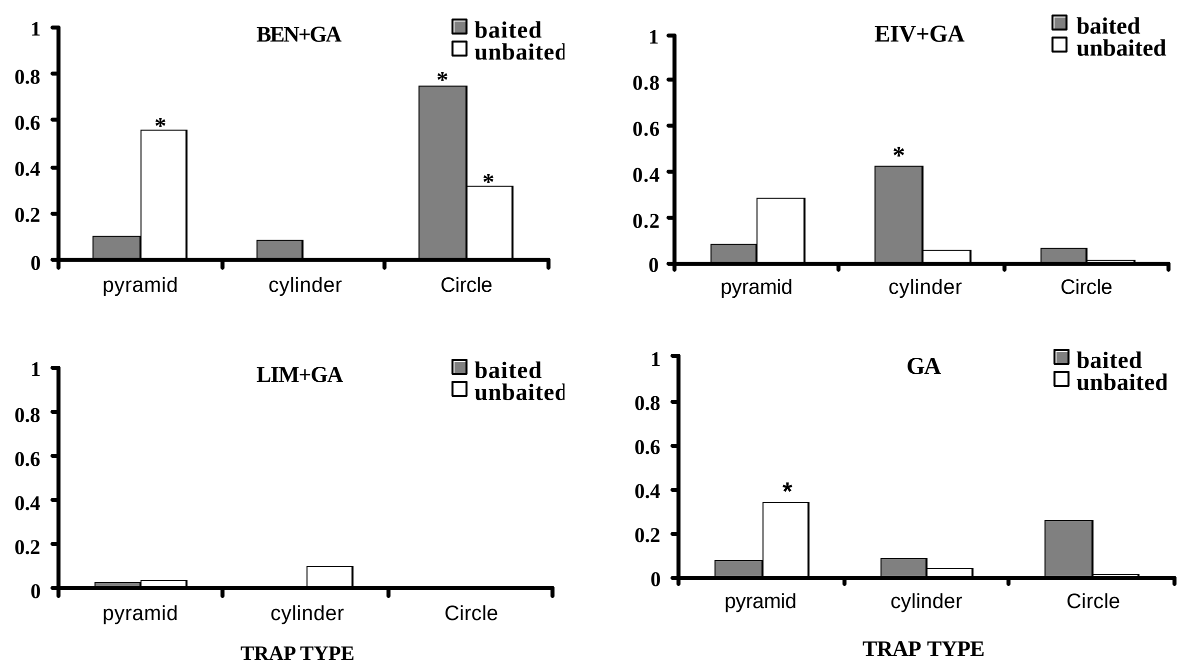

Figure 2. For each trap type, degree of correlation between total amount of PC captures on perimeter-row traps and percent sampled PC injury to fruit on perimeter-row trees in plots having that odor. The higher the R^2 value, the greater the extent of the correlation. An asterisk (*) indicates a statistically significant correlation at odds of 19 to 1.

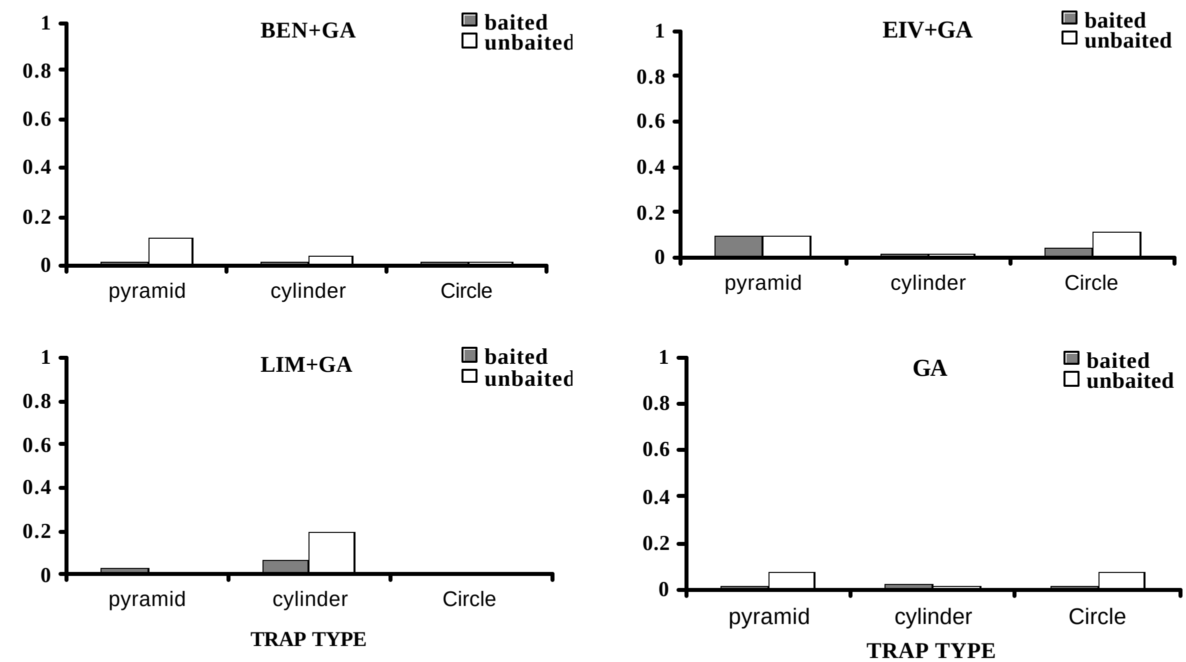

Figure 3. For each trap type, degree of correlation between phenology (time during the season) of PC captures on perimeter-row traps and phenology of injury to fruit on perimeter-row trees in plots having that odor. The higher the R^2 value, the greater the extent of the correlation. There were no statistically significant positive correlations.

same plots, or Circle traps baited with ethyl isovalerate plus GA, limonene plus GA, or GA alone. For each type of odor bait, pyramid and cylinder traps captured numerically fewer PC's than Circle traps.

Figure 2 shows, for each odor and trap type, the degree of correlation between the total (season-long) amount of PC captures and the percent sampled perimeter-row fruit injured by PC's in plots having that odor and trap type. A significant positive correlation would indicate that orchards which showed comparatively many captures for a given odor and trap type also showed a comparatively large amount of PC injury, whereas orchards which showed comparatively few captures also showed a comparatively small amount of PC injury. Among all odors and trap types, Circle traps baited with benzaldehyde plus GA showed the highest degree of positive correlation (0.75) between trap captures and injury. What this means is that after the PC season has ended, one can look back and say with high confidence that the extent of PC captures by Circle traps baited with benzaldehyde plus GA reflected quite well the extent of PC injury that occurred on trapped and other trees in the same plot.

Figure 3 shows, for each odor and trap type, the degree of correlation between the phenology (time of season) of PC captures and the phenology of PC injury to perimeter-row fruit in plots having that odor and trap type. A significant positive correlation would indicate that a sampling period during which comparatively many trap captures occurred also was a sampling period in which a comparatively large amount of injury was initiated, whereas a sampling period during which comparatively few (or no) trap captures occurred was a sampling period in which comparatively little (or no) fruit injury was initiated. Among all odor and trap types, no trap showed a significant positive correlation between phenology of captures and phenology of injury. In fact, the highest degree of positive correlation for any trap type was only 0.20, and the correlation for Circle traps baited with benzaldehyde plus GA was a mere 0.01. What this means is that during the PC season, one could not have any confidence whatsoever that the extent of PC captures during any particular 3- to 4-day period reflected the amount of PC injury that was initiated during that period, even for the best-performing trap.

A deeper look into the phenology of captures by Circle traps baited with benzaldehyde plus GA and the

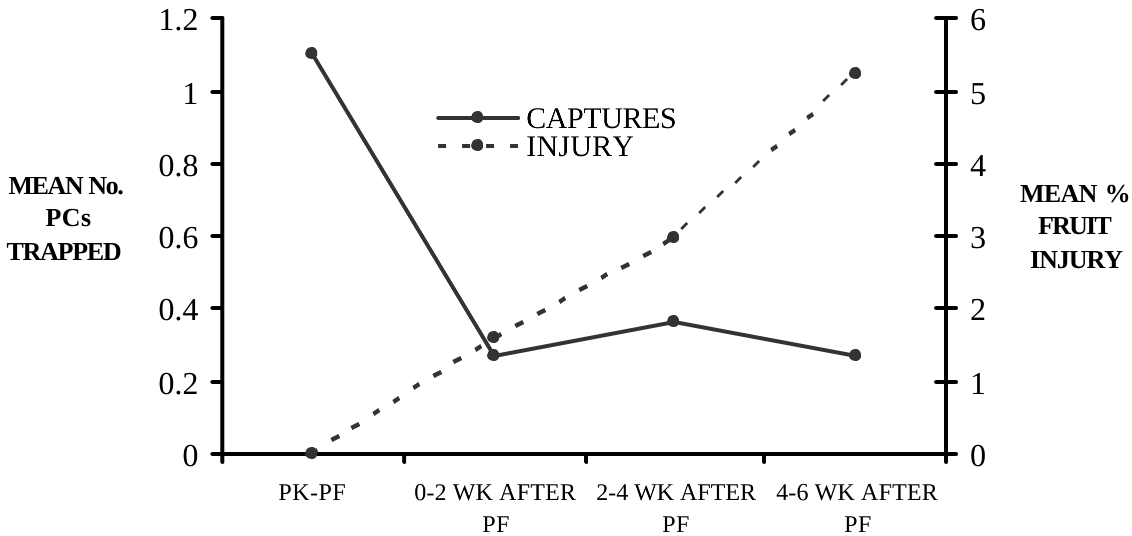

Figure 4. For Circle traps baited with benzaldehyde plus GA, a graphic display of PC captures and amount of PC injury to fruit during each of four 2-week periods from pink (PK) to 6 weeks after petal fall (PF).

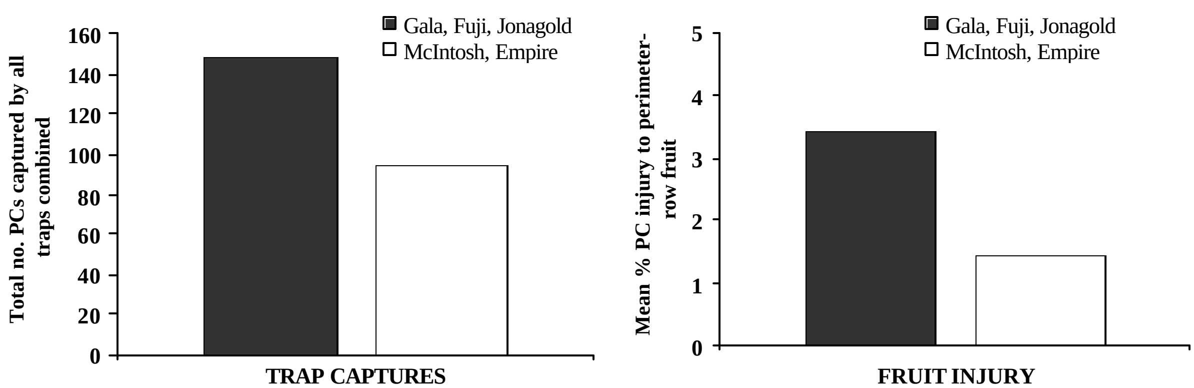

Figure 5. Total captures of PC's on perimeter-row traps and PC injury to perimeter-row fruit in six blocks of apple trees comprised of Gala, Fuji, or Jonagold as perimeter-row cultivars versus six blocks comprised of McIntosh or Empire as perimeter-row cultivars.

phenology of PC injury is helpful in understanding the lack of relationship between these two entities. As shown in Figure 4, PC captures were greatest during the period of pink to petal fall but were low during each 2-week period thereafter. Conversely, PC injury to fruit was low (about 1.5%) during the first 2 weeks after petal fall, but increased in essentially a linear fashion until 4 to 6 weeks after petal fall, when it reached about 5.3%. Thus, the trends depicted in Figure 4 show clearly that the steady rise in PC fruit injury on perimeter-row trees from petal fall to 6 weeks thereafter was not accompanied by a rise in PC captures by perimeter-row Circle traps baited with benzaldehyde plus GA, accounting for the lack of correlation between these variables.

Figure 5 shows that PC captures by all perimeter-row traps combined and PC injury to perimeter-row fruit were about 60% and 140% greater, respectively,

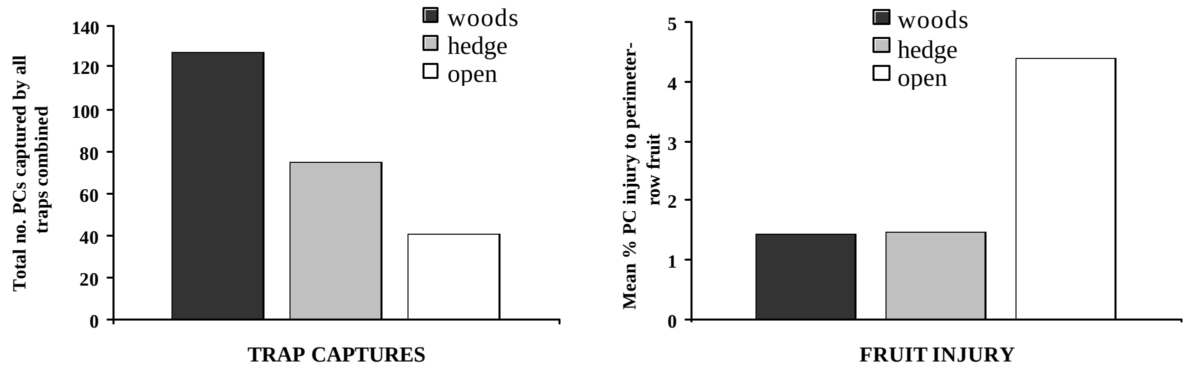

Figure 6. Total captures of PC's on perimeter-row traps and PC injury to perimeter-row fruit in blocks of apple trees whose front rows bordered woods, hedgerow, or open field (four blocks of each type).

in blocks having Gala, Jonagold, or Fuji as perimeter-row cultivars, compared with blocks having McIntosh or Empire as perimeter-row cultivars. The average number of insecticide sprays applied against PC was the same in each case (2.7).

Figure 6 shows that PC captures by all perimeter-row traps combined were greatest for blocks bordered by woods, intermediate for blocks bordered by hedgerows, and least for blocks bordered by open field. However, PC injury to perimeter-row fruit was greatest for blocks bordered by open field. The average number of insecticide sprays applied against PC was about the same in each case (2.8, 2.8, and 2.5, respectively).

Figure 7 shows that season-long PC injury to fruit on perimeter-row trees (row 1) averaged about 12 times greater than on trees of interior rows 3, 5, or 7.

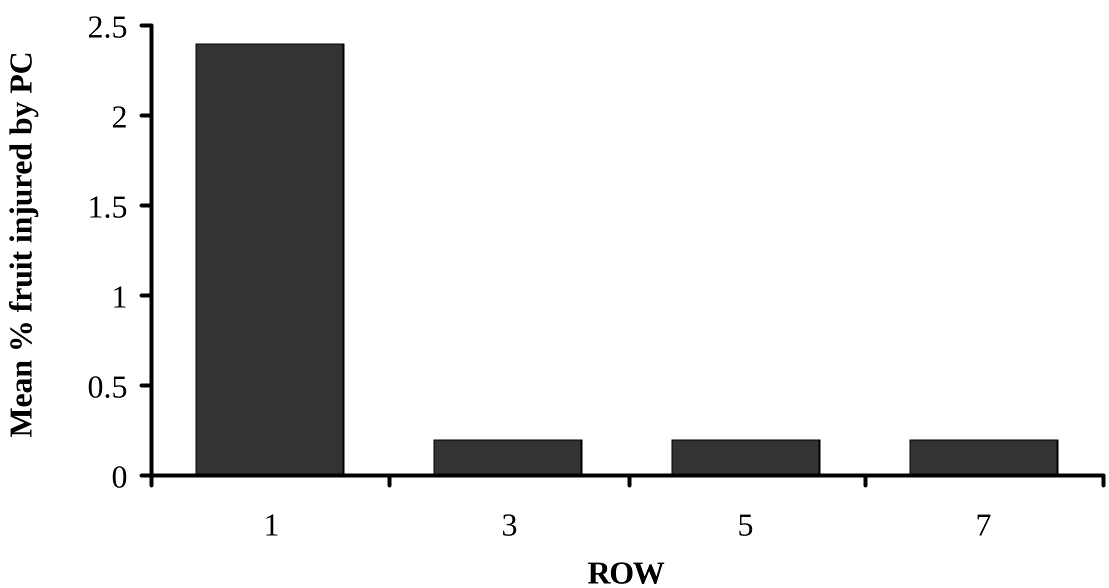

Figure 7. Mean percent PC-injured fruit on perimeter-row trapped trees(row 1) compared with injury on non-trapped trees of interior rows 3, 5, and 7.

Conclusions

Circle traps baited with benzaldehyde plus GA, when positioned so as to completely surround trunks of perimeter-row apple trees, captured numerically more PC's than any other trap type and afforded a strong positive correlation between total amount of trap captures and total amount of PC injury to perimeter-row fruit. The year 2001 was the first year we used Circle traps in this position on a tree (formerly they were placed on lower limbs near the trunk and provided a weaker correlation between total captures and total injury). The strong correlation obtained in 2001 suggests that tree-trunk Circle traps baited with benzaldehyde plus GA, if distributed along perimeter-row apple trees, can be an excellent indicator of "hot spots" requiring special attention for controlling PC as well as "cool spots" requiring lesser attention.

Unfortunately, no trap type showed even a moderate positive relationship between the time of occurrence of PC captures and the time of occurrence of PC injury to fruit. As depicted in Figure 4, even for our best trap type (tree-trunk Circle traps baited with benzaldehyde plus GA), captures fell off dramatically soon after petal fall, whereas fruit injury rose steadily. Thus, even for this best trap, the data obtained in 2001 indicate that low trap captures after petal fall cannot be relied upon as indicative of the lack of need to spray against PC.

As revealed by other studies that we conducted in 2001, there are at least three reasons why all three types of traps used here may fail to capture representative numbers of PC's active in canopies of commercial orchard trees after petal fall. First, organophosphate insecticide spray droplets falling on traps can be repellent to PC's for 10 days or more after application. Such droplets can also be repellent when on tree limbs and branches, but repellency apparently is substantially overcome by positive chemical stimuli inherent to surfaces of limbs and branches. Such positive stimuli are lacking on surfaces of current traps. Second, at temperatures greater than about 70°F, especially when accompanied by sun, PC's tend to fly directly into tree canopies, thereby bypassing Circle and pyramid traps associated with tree trunks. Temperatures tend to be higher than 70°F after petal fall. Third, the release rate of benzaldehyde from vials placed inside of trap tops (10 milligrams per day) is sufficient to attract PC's from a distance, but may be repellent at close range. As tree fruit grow and themselves release increasing amounts of benzaldehyde and other attractants, there may be an increasing tendency for attractive volatiles from the fruit to outcompete attractive volatiles placed in traps. Our attempts to increase the amount of benzaldehyde used in association with traps, so as to be more competitive with fruit volatiles, have been accompanied by a decrease (rather than an increase) in PC captures owing to repellency. Together, these three shortcomings may limit the usefulness of Circle, pyramid, and cylinder traps placed at or within canopies of commercial-orchard trees for monitoring the extent of threat by PC's after petal fall.

Both cultivar composition of perimeter-row trees and border area composition had an influence on extent of trap captures and fruit injury by PC. As in 2000, perimeter-row trees of Gala, Jonagold, or Fuji experienced considerably more PC pressure than perimeter-row trees of McIntosh or Empire, even though there was no difference in frequency of insecticide applications. Also, as in 2000, trap captures were greater in blocks bordering woods than in blocks bordering hedgerows or open field. Finally, PC injury to fruit on trees that received traps was far greater than PC injury to fruit on interior trees, suggesting that attractive odor placed on perimeter-row trees acts to concentrate PC's there and reduce penetration into the orchard interior.

Acknowledgments.

We are grateful to the following growers for participating in this study: Keith Arsenault, Gerry Beirne, Bill Broderick, Dave Chandler, Tom Clark, Don Green, Tony Lincoln, Joe Sincuk, Mo Tougas, and Steve Ware. This work was supported by Massachusetts State Integrated Pest Management Funds, Northeast Regional Competitive Integrated Pest Management Funds, Northeast Regional Sustainable Agricultural Research and Education Funds, and the New England Tree Fruit Growers Research Committee.

* * * * *