# Influence of Insecticide on the Ability of Traps to Capture Plum Curculios

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Several factors may influence the effectiveness of different types of traps for capturing and monitoring plum curculios (PCs). We have determined, for example, that temperature is an important factor influencing the ability of both Plexiglas panels (traps capturing flying PCs) and pyramid traps (traps capturing crawling PCs) to monitor extent and timing of PC immigration when traps are deployed at the edges of an orchard, in close proximity to woods. We found that panel traps are more effective than pyramid traps on warm days and, conversely, that pyramid traps outperform panel traps on cool days.

For both branch-mimicking cylinder traps (which are positioned vertically on apple tree branches) and Circle traps (which are wrapped around orchard tree trunks), weather may have a lesser effect because the purpose of such traps is either to capture PCs already present within tree canopies (cylinder traps), or to intercept adults crawling up tree trunks into canopies (Circle traps). However, as indicated in the 2002 Winter issue of Fruit Notes, odor-baited cylinder traps have yet to demonstrate value for predicting extent of PC injury to fruit when deployed in commercial orchards. Similarly, odor-baited Circle traps, although able to capture numerous PCs under unsprayed orchard conditions, have not proven to be effective as a tool for predicting, in commercial orchards, the timing of PC injury to fruit based on extent of PC captures.

The principal aim of this study was to determine the influence of insecticide presence (via orchard spray application) on surfaces of cylinder, pyramid, and Circle traps on trap performance.

## *Materials & Methods*

***Field studies.*** Studies were performed from May 16 to June 28 (2001) at the UMASS Cold Spring Orchard Research & Education Center, and from May 22 to June 6 (2002) at Atkin's Farm. Both orchards are located in Belchertown, MA. The UMASS orchard block consisted of Delicious/M.7 and Cortland/M.7. The Atkins' block consisted of Idared/M.7.

***2001 Field study.*** In 2001, we evaluated two trap types: (1) a black cylinder trap (3 inches diameter x 12 inches tall) and (2) a reduced version of a pyramid trap (6.5 inches at base x 12 inches tall). Cylinders were made from PVC pipe. Pyramids were made from plywood. Both trap types were painted black using flat black latex paint.

On May 16, just after petal fall, 14 traps of each type were deployed on branches of perimeter-row trees. Only one trap was used per tree. For every tree bearing a trap (central tree), there were two trees without traps (adjacent trees), one on either side (Figure 1). A few hours before an insecticide application was made (using a tractor-driven mist blower delivering 150 gallons of water per acre), seven traps of each type were covered with plastic bags. Traps were uncovered the morning after spray application. These traps will be referred as "unsprayed" traps. The remaining 14 traps, along with all tree canopies, received an application of Imidan® (70% WSB) at 3/4 pound per 100 gallons water. These traps will be referred as "sprayed" traps. This procedure (trap covering and uncovering) was repeated three times, once in association with each insecticide application against PC: May 16, May 25, and June 14.

Each trap was baited with one 1-ml white, low-density polyethylene vial containing 1 ml of benzaldehyde (release rate: ~2.5 mg per day) and one dispenser releasing PC pheromone (1 mg of grandisoic acid per day). Both baits were placed inside the trap tops that capped cylinder traps. Benzaldehyde and pheromone dispensers were replaced once (on June 11).

All traps were inspected twice per week (11 inspections in total) to determine PC captures. At every inspection, 20 fruit were sampled for PC injury in each trap-bearing tree and each of two adjacent trees (Figure 1). For presentation of results, we arranged data on

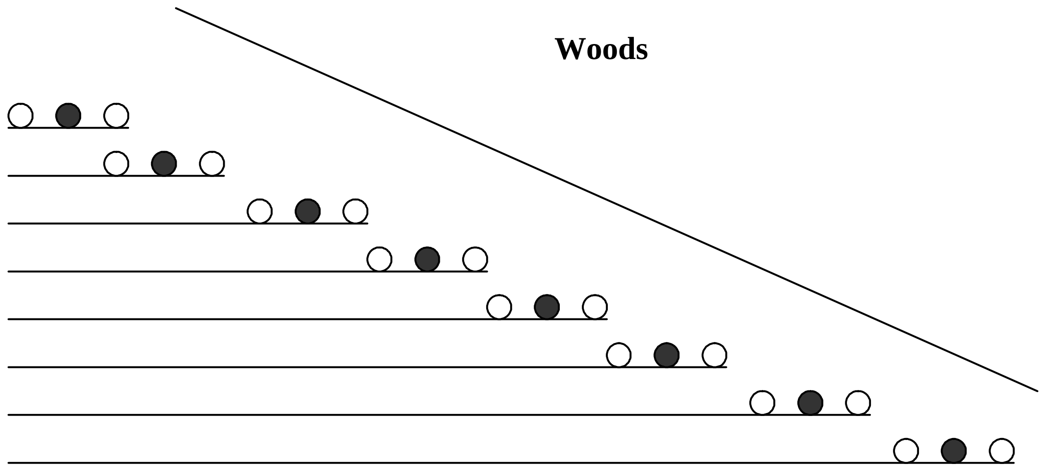


Figure 1. Schematic illustration of the plot used for the experiment. Trees were Cortland and Delicious in alternating rows. For each row, the first three perimeter-row trees were used. A small pyramid or cylinder trap was placed in the central tree (black dot). Twenty fruit were inspected for PC damage in each trap-bearing tree and each adjacent non-trapped tree (white dots).

captures and PC damage in the following manner: (1) 1-10 days after an application of insecticide, (2) 11-20 days after application, and (3) more than 20 days after application.

***2002 Field study.*** In 2002 we evaluated four trap types: (a) black cylinders, (b) small black pyramids, (c) Circle traps made of aluminum screen and wrapped entirely and tightly around tree trunks, and (d) Circle traps as above but made of plastic screen.

On May 24, just after petal fall, eight traps of each type were deployed on apple trees located in a sprayed section of the orchard that received an application of Imidan® (as above). After application, all traps were removed and deployed, along with unsprayed traps, on branches (cylinders and small pyramids) or tree trunks (Circle traps) of perimeter-row trees located in an unsprayed section of the orchard. Traps were deployed in pairs (i.e., one sprayed trap of one type adjacent to one unsprayed trap of the same type). There were eight replicates for each trap type and insecticide regime.

In 2002, all traps were baited with one 15 ml white low-density polyethylene vial containing 15 ml of benzaldehyde (release rate: ~10 mg per day) and one dispenser releasing PC pheromone (~1 mg of grandisoic acid per day). To protect benzaldehyde from sunlight and rainfall, each vial was hung by the neck using a wire and placed inside an inverted plastic cup. Each plastic cup was suspended from the tree trunk using wire in such a way that its base was ~10 cm above each trap top. Each pheromone-releasing dispenser was placed inside the trap top. Benzaldehyde and pheromone dispensers were not replaced during the study.

All traps were inspected on a daily basis for 12 days after application of insecticide. On June 10, all sprayed traps were removed and transported to the sprayed section of the orchard, where they received a second spray of Imidan®. Afterwards, traps were deployed again in the unsprayed section of the orchard but the position of each member of pair of sprayed and unsprayed traps was inverted.

This study differed from the 2001 study in that 1) all traps were inspected on a daily basis for 12 days after application of insecticide, and 2) we did not inspect fruit to determine injury by PC. For presentation of results, we organized data on PC captures in the following manner: (1) 1-6 days after an application of insecticide, (2) 7-12 days after application.

***Laboratory observations***. Behavioral observations were conducted in a laboratory during July 2000 and July 2001 to assess the effects of insecticide application

Table 1. Total PC captures by sprayed (Imidan®) and unsprayed small pyramid and cylinder traps (field study, 2001). Data are presented according to the number of days elapsed after an application of insecticide.

| Days after spray | Pyramid unsprayed | Pyramid sprayed | Cylinder unsprayed | Cylinder sprayed |
|---|---|---|---|---|
| 0-10 | 5 | 1 | 1 | 0 |
| 11-20 | 3 | 2 | 2 | 3 |
| > 20 | 0 | 0 | 0 | 1 |
| TOTAL | 8 | 3 | 3 | 4 |

on the propensity of PCs to crawl upon sprayed traps. For comparative purposes, in 2000 the insecticide evaluated was Guthion®, and in 2001, Imidan® was used (same dose as above). PC behavior was observed inside of Plexiglas cages with no top. Traps evaluated were as described above, but we also evaluated sprayed and unsprayed apple tree limbs (diameter: 2 inches; length: 12 inches). No attractive odors were used in these tests. In all instances, observations were performed 1-3 days after traps or limbs (taken from trees in the orchard) received an application of insecticide. For the observations, we placed a PC on the floor facing one of the test traps and recorded, for a time period of up to10 minutes, whether the PC was able to reach the top of the trap.

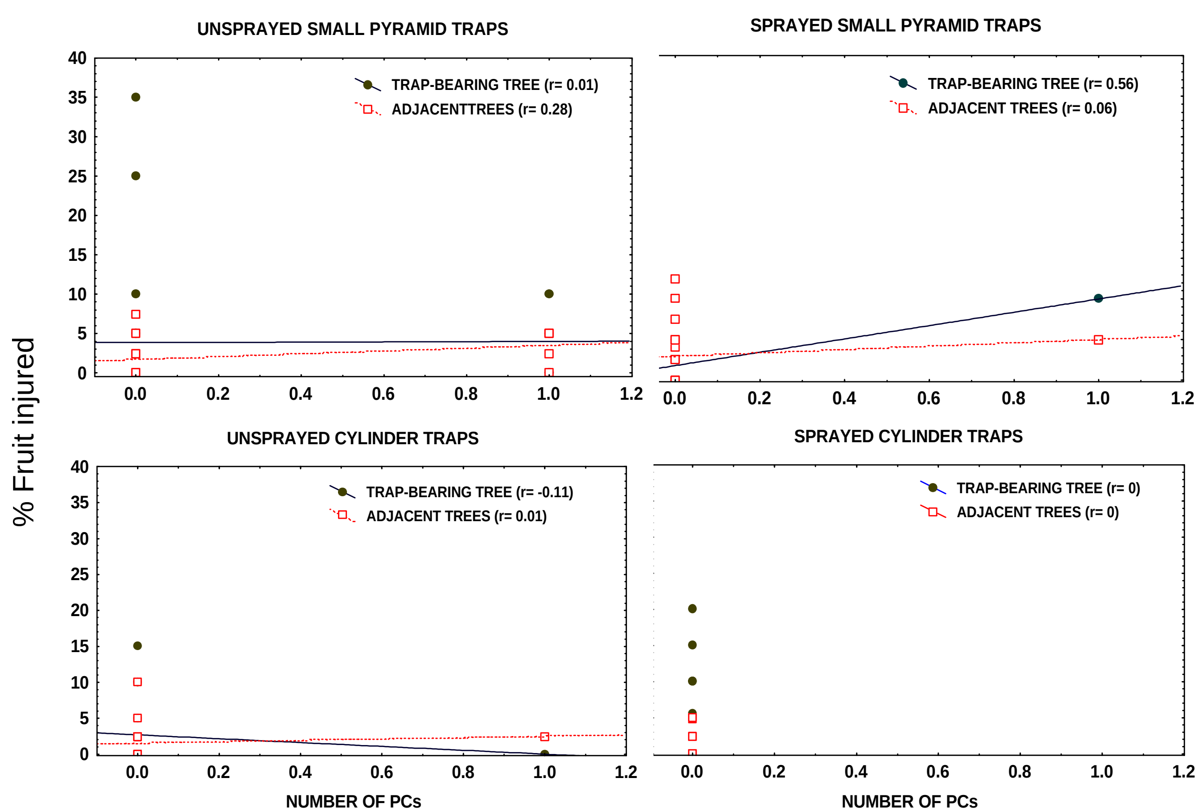


Figure 2. Degree of correlation between the total number of PCs captured by traps of each type and the percent fruit injured by PCs in trees bearing a trap and in adjacent trees. The higher the *r* value, the greater the extent of correlation.

## Results

***2001 Field study.*** Table 1 shows that within the first 10 days after spraying, unsprayed traps (particularly pyramids) captured more PCs than sprayed traps. From 11 to 20 days after insecticide application, all traps captured similar numbers of PCs. Only one PC was captured after 20 days (by a sprayed cylinder trap). Overall, at least twice as many PCs were captured by unsprayed small pyramid traps than by any other trap type.

Figure 2 depicts, for the first 10 days after insecticide application, the degree of correlation between the extent of PC captures by a trap and the

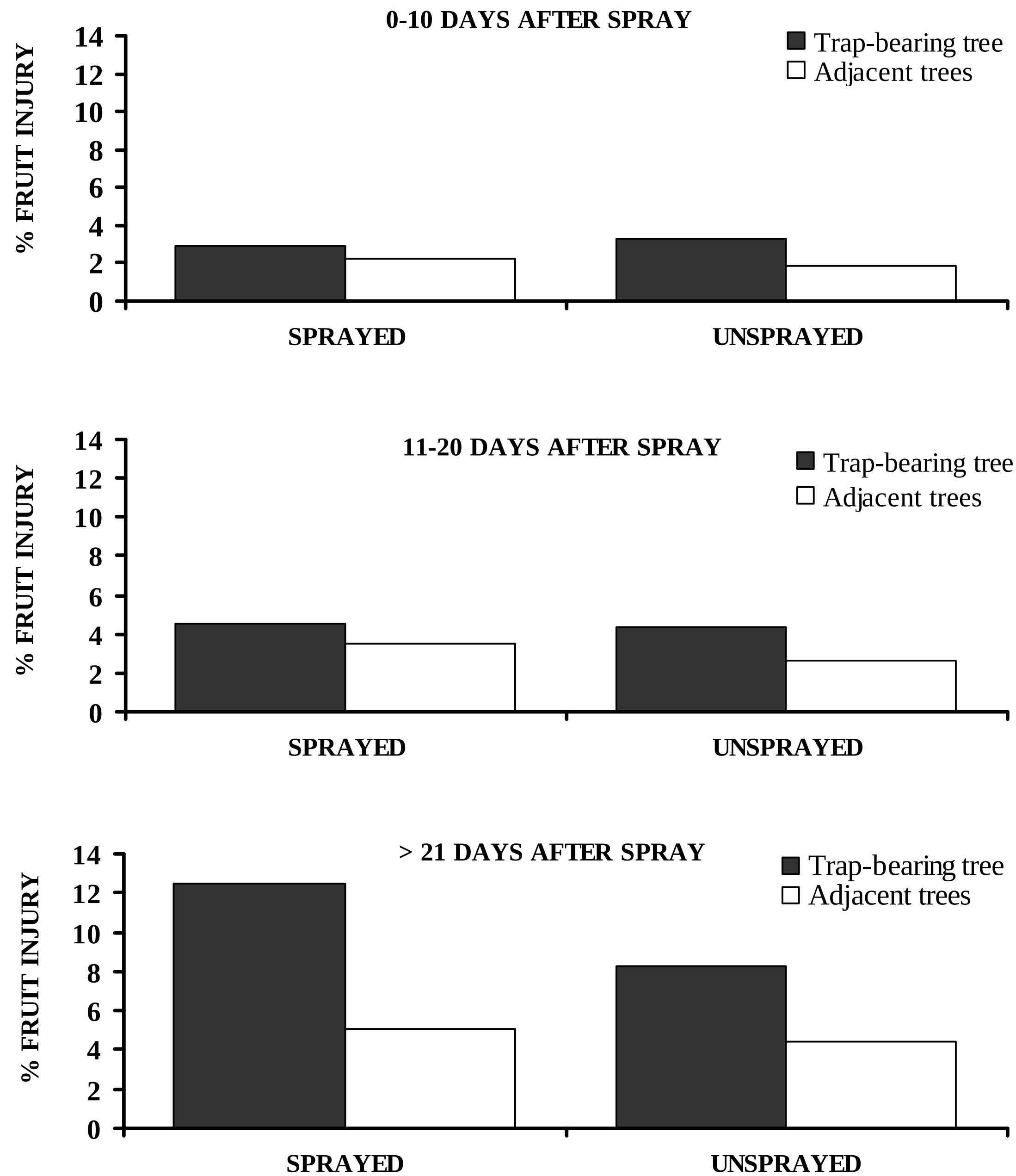


Figure 3. Amount of fruit injured by PCs on perimeter-row apple trees having a trap (i.e., trap-bearing tree) or on two adjacent non-trapped trees (adjacent trees). Data combined for pyramid and cylinder traps (2001 field study).

amount of PC injury to fruit located in trees having a trap or in adjacent trees. A strong positive correlation (i.e., a value close to 1) would indicate that high PC captures reflect high damage to fruit by PC, and that low PC captures reflect low damage to fruit. If a strong correlation were found, we would be able to predict fruit injury based on trap captures. However, we found that all trap types (even the unsprayed ones) showed a poor ability to predict injury to fruit by PCs based on captures. Even though the strongest correlation (0.56) was found in the case of sprayed pyramid traps, the fact that few PCs were captured by traps of this type during the first 10 days does not allow us to consider such a correlation as convincing.

Figure 3 shows that, in each one of the three time periods after insecticide application, fruit located in trees bearing both sprayed and unsprayed traps received consistently more damage than fruit located in adjacent trees. Such a pattern was especially pronounced after 20 days, when fruit injury was 2.4 times greater on trees bearing sprayed traps than on adjacent trees and about 1.9 times greater on trees bearing unsprayed traps than on adjacent trees.

***2002 Field study.*** Figure 4 reveals that regardless of the time period elapsed since insecticide spray, the application of Imidan® seems to have had little influence on the ability of any trap type to capture PCs. Both types of Circle traps captured similar numbers of PCs, and these two trap types captured substantially more PCs than small pyramid or cylinder traps.

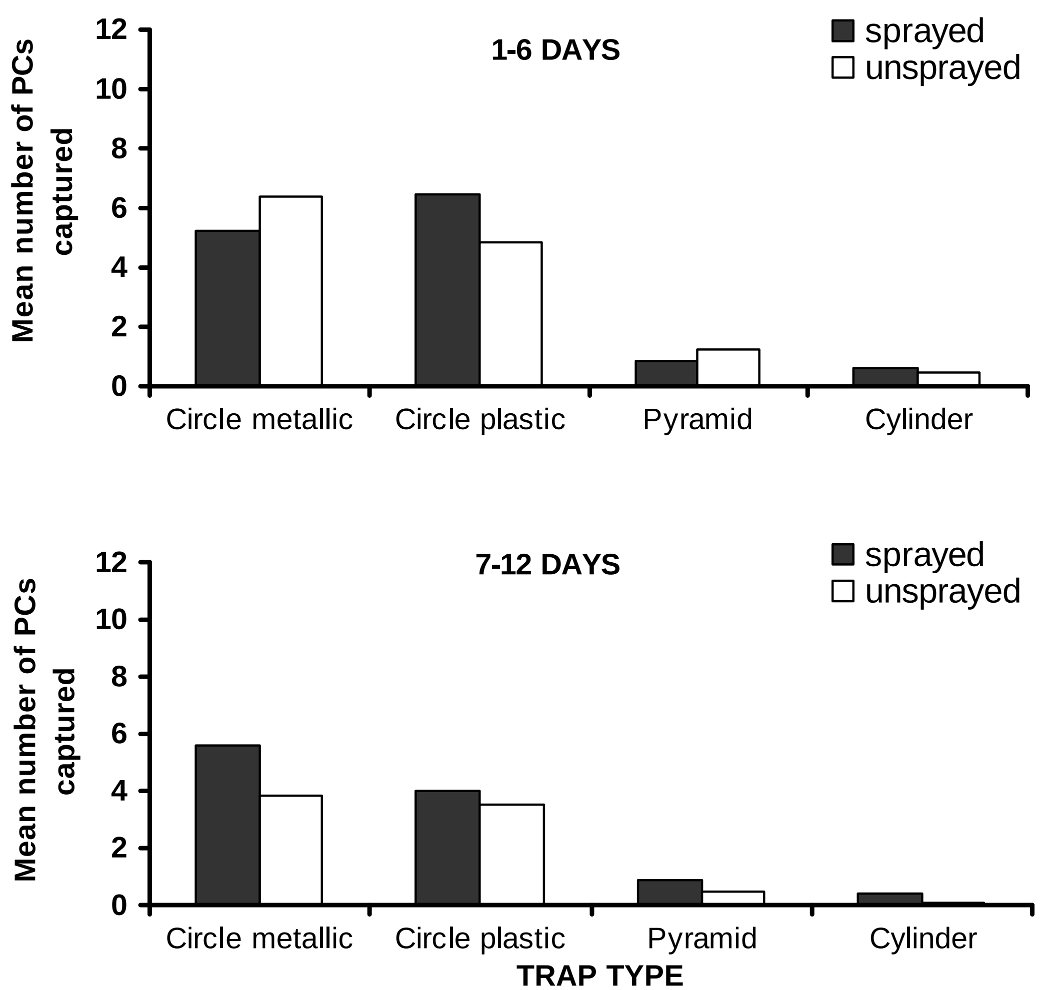


Figure 4. PC captures by each type of odor-baited trap placed on perimeter-row trees (2002 field study).

Table 2. In laboratory tests, proportions of PCs that reached the top of unsprayed and sprayed tree limbs, small pyramid traps, and black cylinders. The insecticide evaluated in 2000 was Guthion®, and in 2001 was Imidan®.

| | 2000 | | 2001 | |
|---|---|---|---|---|
| Trap type | % TOP | No PCs tested | % TOP | No PCs tested |
| Limb unsprayed | 91% | 11 | 100% | 16 |
| Limb sprayed | 44% | 16 | 65% | 20 |
| Pyramid unsprayed | 67% | 6 | 100% | 17 |
| Pyramid sprayed | 0% | 12 | 59% | 22 |
| Cylinder unsprayed | 75% | 4 | 94% | 16 |
| Cylinder sprayed | 25% | 4 | 50% | 22 |

***Laboratory observations***. Table 2 shows that in 2000 (when Guthion® was evaluated), 91, 67, and 75 % of total PCs reached the top of unsprayed limbs, pyramids, and cylinders, respectively, whereas for sprayed counterparts, only 44, 0, and 25%, respectively, reached the top. Table 2 also reveals that in 2001 (when Imidan® was evaluated), 100, 100, and 94% of total PCs reached the top of unsprayed limbs, pyramids, and cylinders, respectively, whereas for sprayed counterparts, only 65, 59, and 50%, respectively, reached the top. Comparatively, Guthion® exerted a greater negative effect than Imidan® on the propensity of PCs to crawl up the structures evaluated.

## Conclusions

Results from the 2001 field experiment suggest that when orchard trees are sprayed with Imidan® to protect against PC damage, PC captures by cylinder traps are strongly compromised during the first 10 days after application. This suggests that, particularly during this period of time, PC captures by cylinder traps would be very poor indicators of PC population levels in tree canopies, with a remarkably poor ability to forecast PC injury to fruit. In 2001, the negative effects of insecticide application were not apparent after 10 days following an application of Imidan®.

Several of our studies have shown that odor-baited cylinder traps, when deployed in commercial orchards, offer little or no value for predicting extent of PC injury to fruit, which we have attributed, in part, to the presence of insecticide on the trap surface. As found in the 2001 study, even unsprayed traps failed to reflect the amount of PC injury to fruit located in trap-bearing or adjacent trees. Such poor ability could have been due then to the possibility that very few PCs were present on sprayed trees. Even so, PC presence was sufficiently great to inflict damage to fruit.

In both 2001 and 2002, unsprayed black pyramids captured numerically more PCs than unsprayed black cylinders, which suggests that small pyramids offer a stronger visual stimulus to PCs than cylinders.

Results from the laboratory observations confirmed the negative effect of organophosphate insecticide application on trap performance found in the 2001 field study. Here, there was strong evidence that, in the absence of any odor bait, PCs are reluctant to crawl upward on traps sprayed with Guthion® or Imidan®. Nonetheless, tree limbs sprayed with organophosphate insecticide proved considerably less deterrent to PCs, possibly because tree limbs possess positive contact stimuli that tend to override negative effects of insecticide.

Results from the 2002 field study, however, failed to show an effect of insecticide application on trap captures even when the same insecticide (Imidan®) and dose (3/4 pound per 100 gallons water) was utilized as in the 2001 study. This may be due to the fact that the amount of benzaldehyde used to bait traps in 2002 was four times greater than in 2001 (2.5 mg/day vs. 10 mg/day in 2001 and 2002, respectively). Therefore, in 2002 PCs may have been more strongly drawn to enter the trap tops, overcoming the negative effect of insecticide.

Combined results suggest that, in the absence of any odor (as in our lab study), PCs are substantially repelled from climbing up organophosphate-sprayed traps. However, such negative effect seems to be less pronounced as the amount of odor bait (i.e.

benzaldehyde) is increased, as found in the field studies. As mentioned, the amount of benzaldehyde used in the field studies was increased from 2.5 mg/day (in 2001) to 10 mg/day (in 2002), which seems to have overcome negative effects of the presence of insecticide on the trap surface.

Based on our findings, we conclude that (1) unsprayed cylinder or small pyramid traps may be more effective in capturing PCs than sprayed cylinder or small pyramid traps, and (2) even though Circle traps may offer more promise for capturing PCs than unsprayed cylinders or small pyramids, other approaches to monitoring PC, such as an 'odor-baited trap tree' approach (see the 2002 winter issue of Fruit Notes), may be much more rewarding.

## *Acknowledgments*

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