Immigrants or Re-colonizers? Studying Plum Curculio Movement Using Odor-baited Traps

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In the preceding article of *Fruit Notes*, we presented results of a 5-year study aimed at establishing the relationships between timing of plum curculio (PC) immigration, weather factors, and phenological tree stage. One of our findings was that most PCs (59% on average) were captured by traps by the end of the petal-fall period, with the remaining 41% being captured after petal fall. Therefore, an important aspect to consider because of its implications for management is whether those PCs captured after petal fall are either immigrants or re-colonizers. One way of addressing this and other questions concerning PC immigration and movement

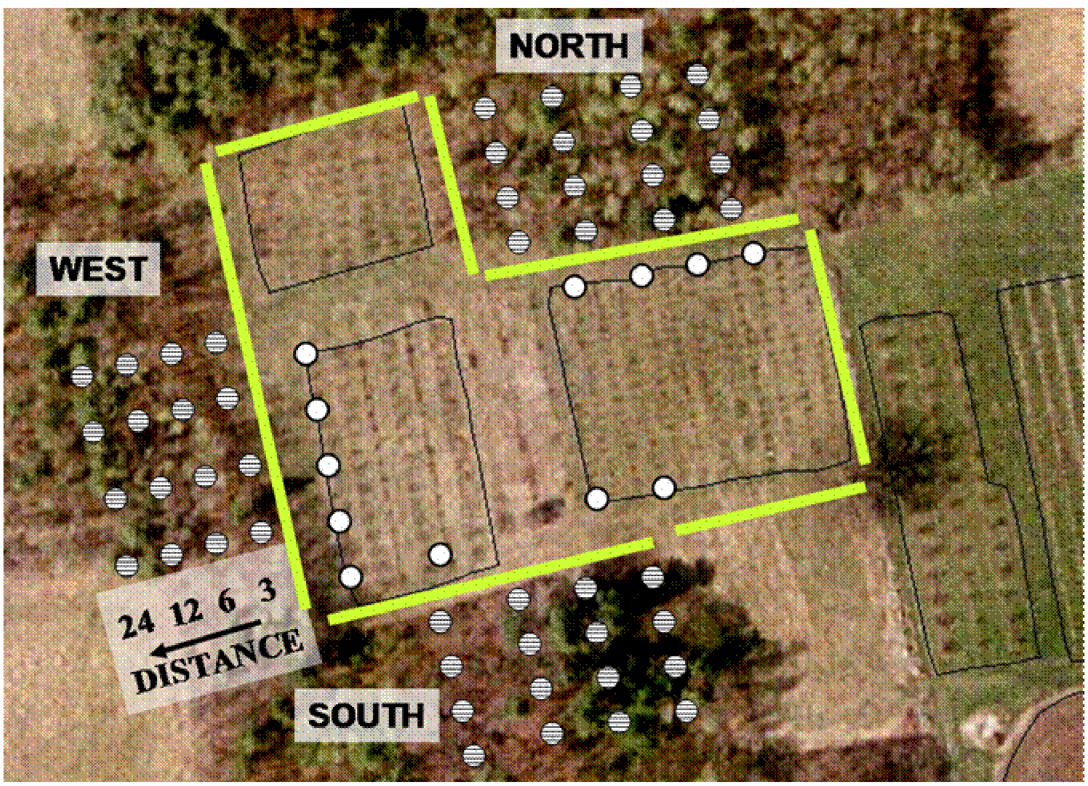

Figure 1. Unsprayed section of the commercial orchard used for this study (UMass Cold Spring Orchard Research & Education Center, Belchertown, MA). Hollow circles represent the 12 release points of color-marked PCs beneath perimeter-row trees. Dashed circles represent the 48 points at which color-marked PCs were released (at 3, 6, 13, and 24 yards inside the woods) in 2002. Picture courtesy of Jon Clements (UMass Extension).

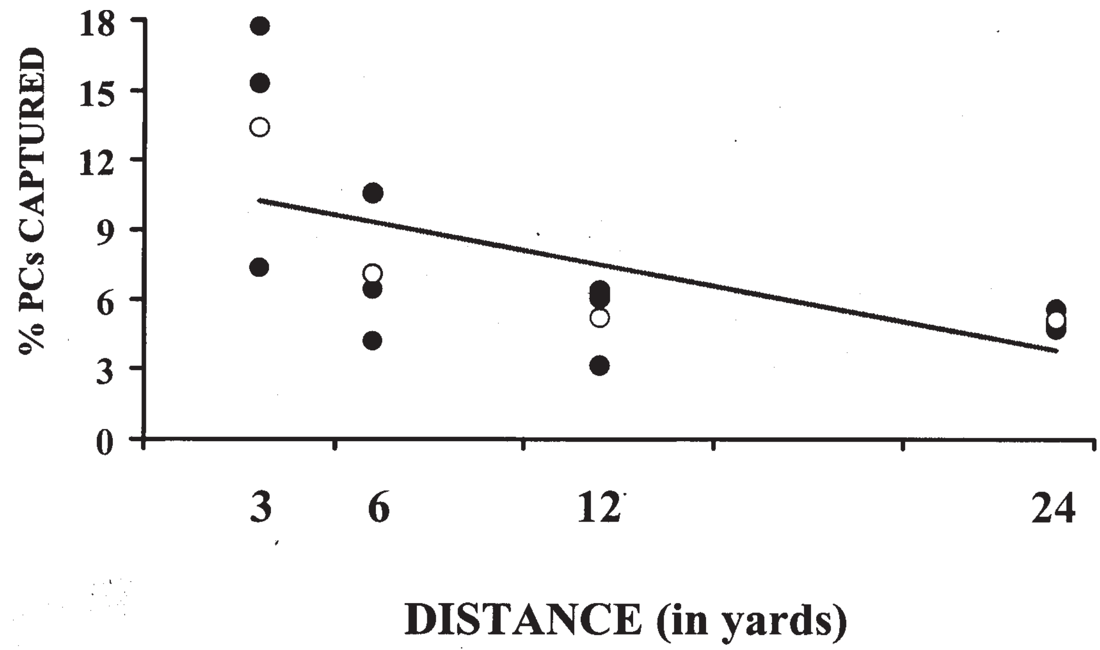

Figure 2. For the 2002 study, percentages of color-marked adult PCs captured by panel and pyramid traps at different distances (3, 6, 12, and 24 yards) from the woods edge. For each distance, solid circles denote PC captures occurring at each of the three release areas (N, W, and S). Hollow circles represent the mean percent value.

is by means of mark-capture studies using odor-baited traps.

Here, our objectives were to determine (1) the distance from which odor-baited traps are attractive to overwintered PCs immigrating into an apple orchard block from forested areas; (2) the relative attractiveness of odor-baited traps to PCs immigrating from woods versus PCs already present on orchard trees; and (3) the extent of back-and-forth PC movement between orchard trees and woods as determined by trap captures. In this article, we also discuss the findings presented in the preceding *Fruit Notes* article, in relation to the female maturity stage and mating status of the PC females captured by odor-baited traps over a 5-year period.

Materials & Methods

This study was conducted during 2002 and 2004 at the University of Massachusetts Cold Spring Orchard Research & Education Center located in Belchertown, MA.

The first two questions were addressed in 2002. For the 2002 study we used adult PCs that were raised from infested fruit collected in Amherst area in the summer of 2001 and kept over the winter in plastic containers with a layer of soil (5 inches), overlaid by 5 inches of maple leaves. Containers were then buried into the ground outdoors and protected from rainfall. Before being overwintered, adult PCs were separated by sex and marked on the elytra with different color combinations using acrylic paint.

Of the 938 color-marked PCs that were recovered in the spring of 2002 after overwintering, 168 were released beneath 12 perimeter-row trees (14 PCs per tree) next to the tree trunks, and 770 PCs were released in the woods, at 3, 6, 12, and 24 yards from the woods edge (Figure 1). Color-marked PCs were released in the woods in the northern, southern, and western areas of the orchard block. Within each release area, 16 different release points of about 48 color-marked PCs each were established (Figure 1). Overwintered PCs were not fed prior to release. For the releases, each group of PCs was placed on the ground after removing some leaves and then were covered with a boll weevil trap top that was slightly buried into the ground. This protected PCs from potential predators and at the same time allowed them to exit from the open end of the funnel whenever they chose to do so. To assess the extent of response of wood-released versus orchard-released PCs to synthetic odors, 48 panel and 48 pyramid traps were baited with benzaldehyde (attractive synthetic host plant odor) in association with grandisoic acid (attractive PC pheromone). Traps were deployed at the periphery of the orchard block and were inspected for PC captures on a ~daily basis for a 8-week period starting on May 16 (at bloom).

Our third question, concerning the extent to which PCs exhibit some sort of back-and-forth movement between orchard trees and woods, was addressed in 2004 in a straightforward way by putting sticky on both sides of 14 panel traps deployed along the periphery of the orchard block. We then contrasted numbers of wild PCs captured on a daily basis in the wood-facing side or in the orchard-facing side of the panels.

Results

For the first question, Figure 2 shows that the greater capture rates (13.4%) of color-marked PCs occurred for PCs released 3 yards from the traps (which also correspond to the wood's edge). Fewer PCs were captured as the distance from traps (i.e., woods edge) progressed. A capture rate of 5.1% was achieved for PCs released 24 yards inside the woods.

For the second question, Figure 3 reveals that, without taking into account the distance at which color-marked PCs were released inside the woods, substantially more PCs (almost seven times more) were captured by panel and pyramid traps when they were released from the woods (7.9% on average) than from orchard trees (1.2%).

For the third question, Figure 4 shows that before petal fall, most wild PCs were captured by the woods-facing side of panel traps and very few PCs were captured in the back of panels. However, during and about 2 weeks after petal fall, PC captures in the back of panels increased substantially, suggesting that during this period there were high rates of back-and-forth movement between woods and orchard trees. PC captures beyond the 2-week period after petal fall period were in general low.

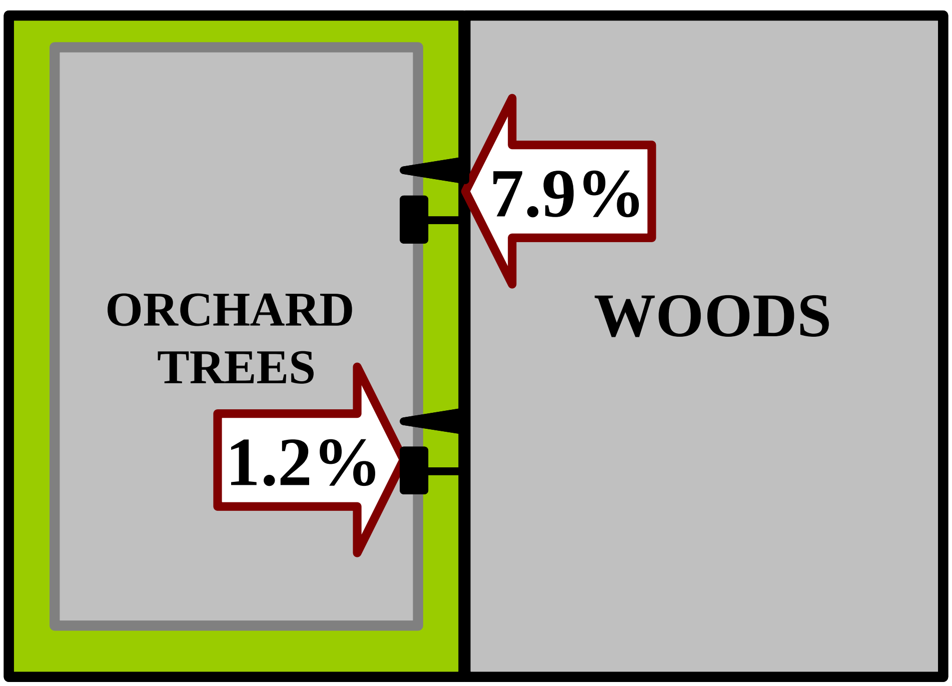

Figure 3. For the 2002 study, overall capture rates (in %, shown inside the arrows) of color-marked PCs released in the woods (n= 770) and beneath perimeter-row trees (n= 168).

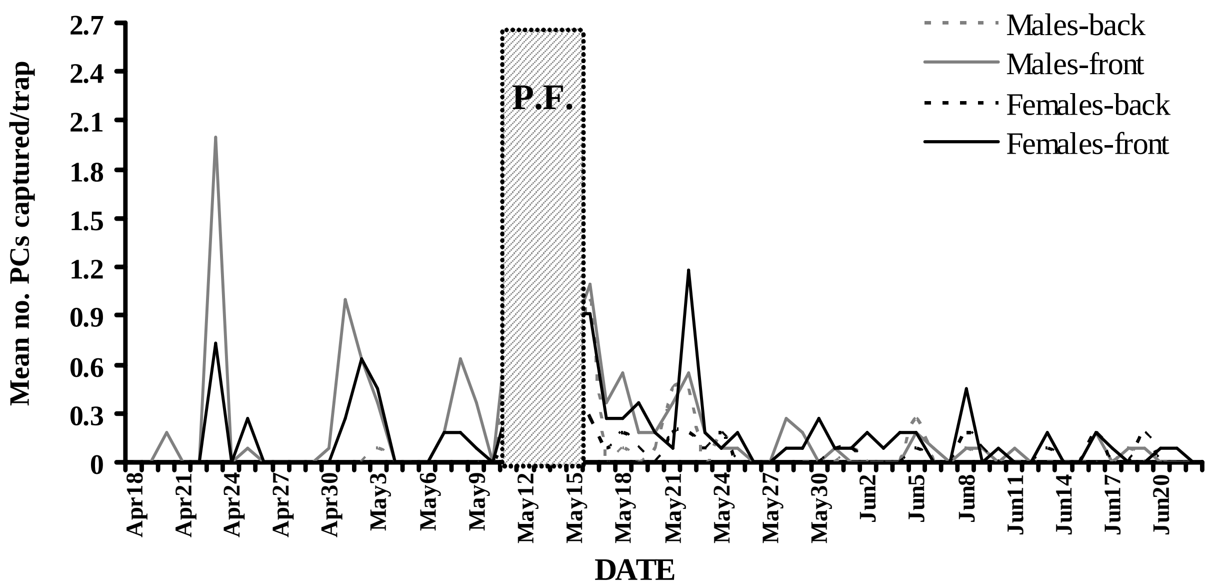

Figure 4. For the 2004 study, mean number of male and female PCs captured per trap (only panel traps) according to date. Panel traps were coated with Tangletrap in the woods-facing side (i.e., front) as well as in the orchard-facing side (i.e., back). The area delimited by a dashed line and filled with diagonal lines represents the duration of the petal-fall period in 2004.

Conclusions

From the 2002 study, we learned that adult PCs are attracted to the odor emitted by traps baited with benzaldehyde and grandisoic acid from at least 24 yards inside the woods. The maximum distance considered for this study represents the area more likely to be serving as overwintering sites for PCs (Lafleur and Hill 1987). From the 2002 study, we also determined that, once PCs are present on orchard trees, their degree of responsiveness to odor-baited traps decreases substantially, compared to PCs released in the woods that had not been exposed to stimuli provided by a host tree. Similarly, Leskey and Wright (2004) also determined that the responsiveness of southern-race PCs to traps baited with benzaldehyde and grandisoic acid decreased significantly in the presence of apple trees.

From the 2004 study we determined that, before petal fall, nearly all overwintered PCs trapped were captured in the woods-facing side of panel traps. This supports the notion that, early in the season, overwintered PCs moving into the orchard by means of flight are, most likely, immigrants. We also determined that, during and about two weeks after petal fall, there seem to be high rates of movement by PCs from host trees to woods and vice versa. This finding suggests that some PCs may be moving from orchard trees to woods (and vice versa) by the time of petal fall onwards. However, the exact proportion of PCs that may exhibit this behavior has yet to be determined.

In the preceding *Fruit Notes* article we reported that nearly all females captured by traps by the end of petal fall were already mated and ready to lay eggs. If PCs captured by traps after petal fall were actually immigrants that had just emerged from overwintering sites and were moving into the orchard block, then we would expect some of those trapped females to be sexually immature or unmated. Results from another study that involved use of pyramidal emergence traps in the same orchard block showed no emergence of PCs beyond two weeks after petal fall.

Altogether, the evidence presented above, gathered under unsprayed conditions, lead us to the conclusion that some of the PCs potentially found inside orchard blocks immediately after petal fall may be re-colonizers rather than true immigrants, although the exact proportion is still unknown. Under this scenario, some of the damage by PC to fruit sampled at harvest may be as a consequence of re-infestations that occurred after the petal-fall spray of insecticide. It would be very important to determine, under sprayed conditions, the extent to which PCs show this type of back-and-forth movement after the petal-fall application of insecticide. More research is also needed to determine what type of factors (e.g., weatherand tree size) influence this behavior.

Acknowledgments

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