Managing Plum Curculio Using an Attract-and-kill Approach: 2018 On-farm Research Results

Jaime C. Piñero
Stockbridge School of Agriculture, University of Massachusetts;

Tracy C. Leskey
USDA ARS Appalachian Fruit Research Laboratory

To successfully manage plum curculio (PC) in a reduced-spray environment, it is imperative that alternative management strategies consider the ecology and behavior of the target pest. Previously, extensive field research that aimed at screening compounds for attractiveness to PC led to the identification of a synergistic two-component lure. This dual lure, comprised of the plant volatile benzaldehyde (BEN) in association with grandisoic acid (GA), the synthetic PC pheromone, was used successfully by the late R.J. Prokopy to develop an effective monitoring system for PC involving odor-baited trap trees. More recently, odor-baited trap trees were evaluated for direct control of PC. This new approach calls for baiting the branches of several perimeter-row trees, which results in aggregations of adult PCS on those trap trees, and then confining insecticide applications to those trees only.

Here, we assessed the efficacy of odor-baited trap trees as an 'attract-and-kill' system to manage PC populations after the full-block petal fall insecticide spray in three commercial apple orchards in 2018.

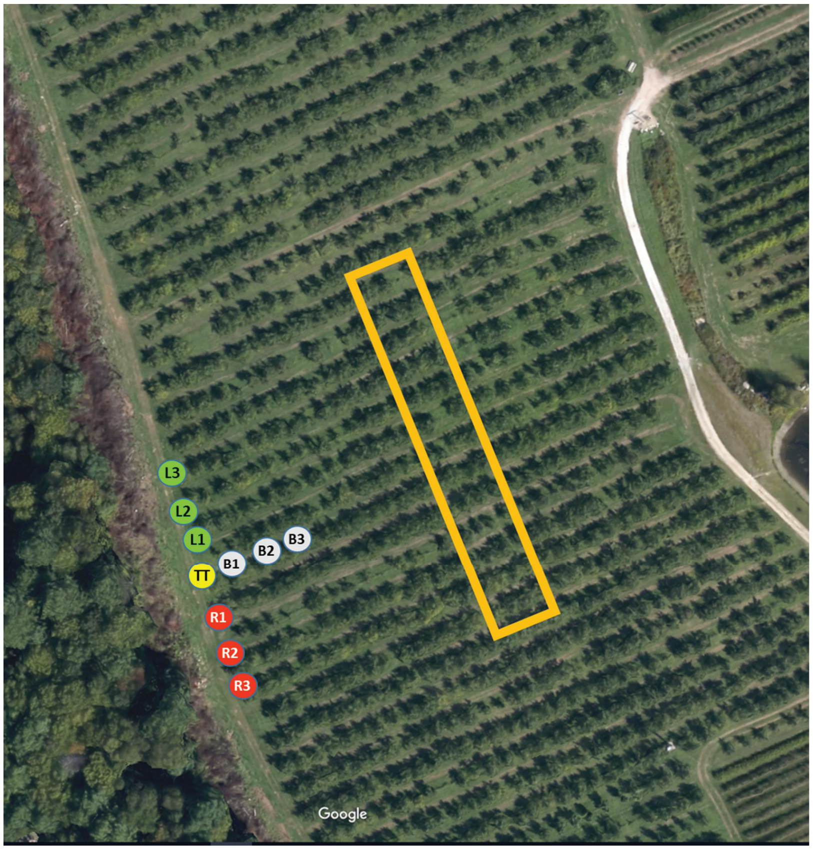
Materials & Methods

Study sites. This study was conducted from mid-May to mid-August 2018, in three commercial orchard blocks, one located in in Massachusetts (Clarkdale, in Deerfield) and two in New Hampshire (Poverty Lane Orchards in Lebanon; Apple Hill Orchard in Concord).

Treatments. Each block was divided into two plots. One plot was used to evaluate the attract-and-kill system involving spraying insecticides to odor-baited traps trees only (= TT plots), and the second plot was assigned to perimeter-row sprays (= PR plots). Our grower cooperators have been implementing IPM for many years; therefore, they were more interested in comparing the trap tree approach versus the perimeter-row approach rather than comparing trap tree plots against the conventional approach involving three full block insecticide sprays against PC.

Table 1. For each cooperating orchard block, area of perimeter-row (PR) and trap-tree (TT) plots, number of trap trees established in the TT plots, and trap tree densities.

Orchard	PR plot area (acres)	TT plot area (acres)	Number of trap trees established	Trap tree density (#/Acre)
Clarkdale	1.6	1.6	11	ca. 7/acre
Poverty Lane	2.7	6.2	22	ca. 4/acre
Apple Hill	3.7	9.0	25	ca. 3/acre



For one of the orchard plots, depiction of the approach taken to fruit sampling to assess the effectiveness of two management strategies to protect fruit from PC injury. *Trap trees were deployed along the entire perimeter, but only one trap tree and its neighboring trees are being shown*. Twenty fruit were sampled from each trap tree (TT, denoted as a yellow circle), and from each of nine neighboring (three on the left, three on the right, three behind) trees. Sampling in PR plots mirrored this approach, except that the 'control' trees were unbaited. For the analyses, data from L1 and R1, from L2 and R2, and from L3 and R3, were combined to generate values for 'Perimeter-1', 'Perimeter-2', and 'Perimeter-3', respectively, as shown in Figure 2A. The orange rectangle represents the approximate area were 20 fruit from each of 20 interior trees were sampled.

Experimental approach. At full bloom, trap trees were baited with the synergistic PC lure consisting of four dispensers of benzaldehyde and a single dispenser of grandisoic acid. Trap trees were spaced 35-38 yards apart along the entire perimeter of each TT plot. At petal fall, each grower applied a full block insecticide application. The protocol called for one to two additional insecticide sprays, as deemed necessary by the growers, confined to trap trees or to the plot perimeter. Information on the experimental area of each PR and TT plot, the number of trap trees established in TT plots, and trap tree densities is presented in Table 1.

To evaluate the plot-wide outcome of insecticide application against PC in TT plots and in PR plots, in mid-August 2018 we quantified the level of fruit injury caused by PC based on a sample of 20 fruit per tree in trap trees in the TT plot and in 'control' trees in the PR plot. The 'control' trees consisted of randomly selected perimeter-row trees that did not receive any lures. We also sampled 20 fruit from the three most immediate perimeter-row trees neighboring (on the left and right sides) each trap tree and each 'control' tree. In addition, we sampled 20 fruit from three trees located behind each trap tree and each 'control' tree. To measure the level of injury to fruit located in the plot interior, we sampled 20 fruit from each of 20 interior trees, for a total of 400 interior fruit per plot. In all, 11,640 fruit were sampled across all experimental orchard plots.

To assess the effectiveness of the two PC management strategies being evaluated here, for the analyses we compared percentage of PC injury in (1) trap trees (in TT plots) and unbaited 'control' trees (in PR plots); (2) the three nearest lateral trees surrounding each trap tree (in TT plots) and 'control' tree (in PR plots), combining data from the left and right sides of each trap tree and each 'control' tree; (3) three trees behind the trap trees and behind 'control' trees in TT plots and PR plots, respectively, and (4) interior trees within TT plots and PR plots.

Results

About 10 times more injury by PC was found within trap trees (17.2% on average) in TT plots compared with unbaited 'control' trees (1.5% on average) in PR plots (Figure 1). This result confirms findings from previous studies indicating that the synergistic lure composed on benzaldehyde and grandisoic acid, the PC aggregation pheromone, results in significant aggregations of PC adults and fruit injury in trap trees.

Figure 2(A) shows that more PC injury was record-

Figure 1. Percentage of PC injury to fruit (mean ± standard error of the mean [= SEM], *a measure of how precise the estimate is*) in odor-baited trap trees (in TT plots) and unbaited 'control' trees (in PR plots). Different letters above bars denote statistically significant differences between treatments at odds of 19:1.

ed (5.3% on average) in fruit sampled from perimeter-row trees that were adjacent (= Perimeter-1) to the trap tree in TT plots compared to similarly located 'control' tress in PR plots (1.6% injury, on average). Such an effect was lost as the sampled trees were located farther (i.e., Perimeter-2, Perimeter-3) away from the trap tree. No differences in the level of injury were recorded in fruit sampled from any of the trees that were located behind the trap tree (in TT plots) and 'control' trees (in PR plots) (Figure 2B).

The percentage of PC injury to fruit (1.1 on average) recorded in the interior of plots managed using the trap tree approach was not different from the percentage of injury (1.2 on average) noted in plots managed with perimeter row sprays (Figure 3).

Conclusions

Our findings confirm that the presence of the synergistic dual lure (grandisoic acid and benzaldehyde) deployed within the canopies of perimeter-row apple

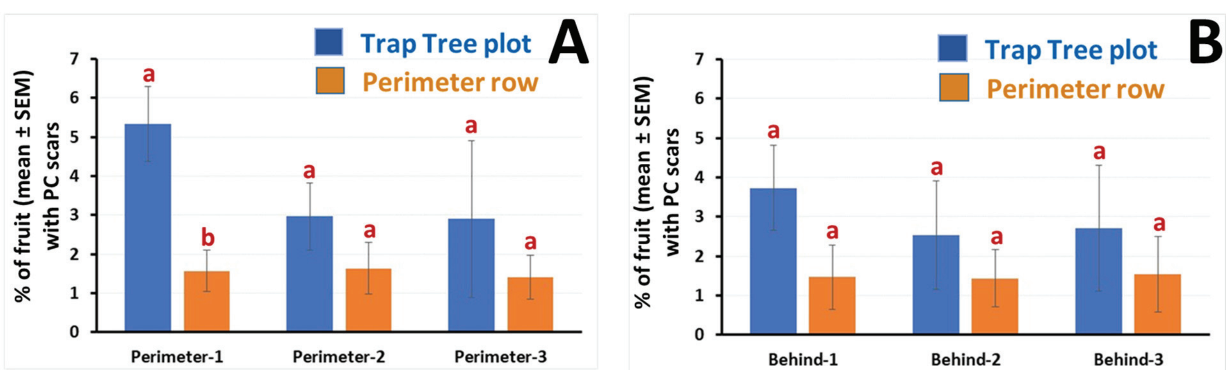


Figure 2. Percentage of PC injury to fruit (mean ± SEM) recorded in (A) three nearest lateral trees surrounding each trap tree (in TT plots) and each unbaited 'control' tree (in PR plots), and (B) three trees behind trap trees and 'control' trees in TT plots and PR plots, respectively. For the comparison of TT versus PR treatments, different letters above bars denote statistically significant differences between treatments at odds of 19:1.

trees at bloom results in significant aggregation of fruit injury in those specific canopies compared with unbaited trees. These specific insecticide-treated trap tree canopies function as an "attract-and-kill" trap crop for adult PCs. Application of insecticides only to trap trees resulted in the same level of PC control that was achieved with perimeter-row sprays, with a concomitant reduction in insecticide use.

Figure 3. Percentage of fruit injury by PC (mean ± SEM) to fruit sampled from the plot interior according to treatment. Different letters above bars denote statistically significant differences between treatments at odds of 19:1.

Acknowledgments

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