Establishing Characteristics of Odor-baited Trap Trees for Monitoring Plum Curculio

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In the three preceding articles in this issue of *Fruit Notes*, evidence was presented that enough plum curculio (PC) adults are present on interior rows of apple trees at petal fall to justify a petal fall application of insecticide to all rows of an orchard block rather than just peripheral rows. In the first article, evidence was also presented to suggest that following a petal fall application of insecticide, subsequent insecticide applications against PC (first/second cover sprays) can provide effective block-wide control if confined only to perimeter rows 1 and 2. The question now arises as to which blocks in an orchard require cover-sprays for perimeter rows and what is the best timing for such perimeter-row sprays.

In the 2003 Winter issue of *Fruit Notes*, we reported that perimeter-row apple trees baited with a combination of synthetic attractive pheromone (grandisoic acid) plus synthetic attractive fruit odor (benzaldehyde) could function as "trap trees" that aggregated PC injury. We suggested that sampling for PC injury to ascertain where and when to apply perimeter-row sprays could be restricted to trap trees rather than spread out among many different trees in a block.

Here, we present results of 2003 experiments addressing five questions relevant to practical implementation of an odor-baited trap tree approach to monitoring PC: (1) what are optimum amounts of grandisoic acid (GA) and benzaldehyde (BEN) to deploy per trap tree; (2) over what distances do trap trees act to aggregate injury to fruit by PCs; (3) does a trap tree at the intersection of two perimeter rows (i.e., at a corner) outperform one midway along a perimeter row; (4) within a trap tree, is fruit injury likely to be greatest in the vicinity of the odor source; and (5) within a trap tree, where should a grower or consultant examine fruit to gain a representative sample of injury?

Materials & Methods

For all experiments, odor-baited trap trees were located on perimeter rows of blocks of commercial-orchard apple trees in Massachusetts. Tree size, spacing, and cultivar composition were the same for all treatments within a replicate, but these characteristics varied among replicates and experiments. Perimeter-row trees received three or four grower-applied sprays of Guthion or Imidan at label-recommended rate for PC control. Applications commenced in late May, shortly after petal fall and ended in mid or late June.

BEN was introduced into 15 ml capped polyethylene vials in the amount of 8 ml of liquid per vial: 9 parts BEN plus 1 part of 1, 2, 4-trichlorobenzene as stabilizing agent. Each vial was suspended by wire inside of an inverted red plastic drinking cup to minimize potential negative impact of ultraviolet light on the stability of BEN. Both cup and vial were suspended by wire protruding through the bottom of the inverted cup. Vials deployed in this manner were found to release about 10 mg per day of BEN per vial. Each dispenser of pheromone was designed by the manufacturer to release about 1 mg per day of GA. All dispensers of attractive odor were deployed during bloom of apple trees (mid-May) and remained (unrenewed) for 7 weeks (through late June), when all experiments ended. Unless indicated otherwise, each trap tree received four dispensers of BEN plus one dispenser of GA hung at head height near the tree trunk.

In all experiments, PC response to treatments was assessed by examining fruit for signs of ovipositional injury, which comprises 90% or more of all injury to apples by PC. Sampling in each experiment occurred once during each of 4 weeks in June, beginning when fruit averaged 9 mm diameter and ending when fruit averaged 31 mm diameter. Unless indicated otherwise, sampling was accomplished by selecting haphazardly (at approximately head height and in an evenly-spaced manner as possible) 20 fruit from the outer half of the canopy and 20 fruit from the inner half of the canopy of each designated tree. Unless indicated otherwise, a fruit was classified as injured if an ovipositional scar was fresh. Fresh scars were those considered to have been made within the past 7 days (see pictures in the last article in this issue of *Fruit Notes)*. We chose to record only fresh scars because it is the appearance of fresh scars (not older scars) that ought to drive a grower's decision to apply insecticide for PC control.

Experiment 1: Amount of Odor. In 13 blocks of orchard trees, each having a perimeter row at least 225 yards long bordered by continuous woods or hedgerow, we selected nine treatment trees spaced 33 yards apart for evaluation of optimum amount of odor to deploy in a trap tree. Four of the trees received one dispenser of GA plus one, two, four or eight dispensers of BEN. Four other trees received two dispensers of GA plus one, two, four or eight dispensers of BEN. One tree remained unbaited. Within each block, treatments were randomized in position.

Experiment 2: Distance of Response. In 18 blocks of orchard trees, each having a perimeter row at least 90 yards long bordered by continuous woods or hedgerow, we chose one tree at the approximate center of the perimeter row to be the odor-baited trap tree (no other tree received odor bait). The degree to which ovipositional injury on perimeter-row trees was aggregated on the trap tree was determined by comparing the proportion of sampled fruit injured on the trap tree with that injured on each of four perimeter-row trees to the right and each of four perimeter-row trees to the left of the trap tree. Such trees were 7-9, 15-17, 25-27, or 34-36 yards the right or left of the trap tree.

Experiment 3: Trap Tree Location along Perimeter Row. In 10 square blocks of orchard trees, each having three perimeter rows about 90 yards long bordered by continuous woods or hedgerow, we chose as odor-baited trap trees two corner trees and two other perimeter-row trees midway between and about 45 yards from corner trees. We compared incidence of fresh ovipositional injury on corner trees vs. midway trees.

Experiment 4: Nearness of Injury to Odor Source. In eight blocks of large orchard trees (M.7 rootstock), each having a perimeter row bordered by continuous woods or hedgerow, we chose four perimeter-row trees as trap trees. For each of the 32 trees, we randomly assigned one quadrant to receive BEN plus GA and the opposite quadrant to remain

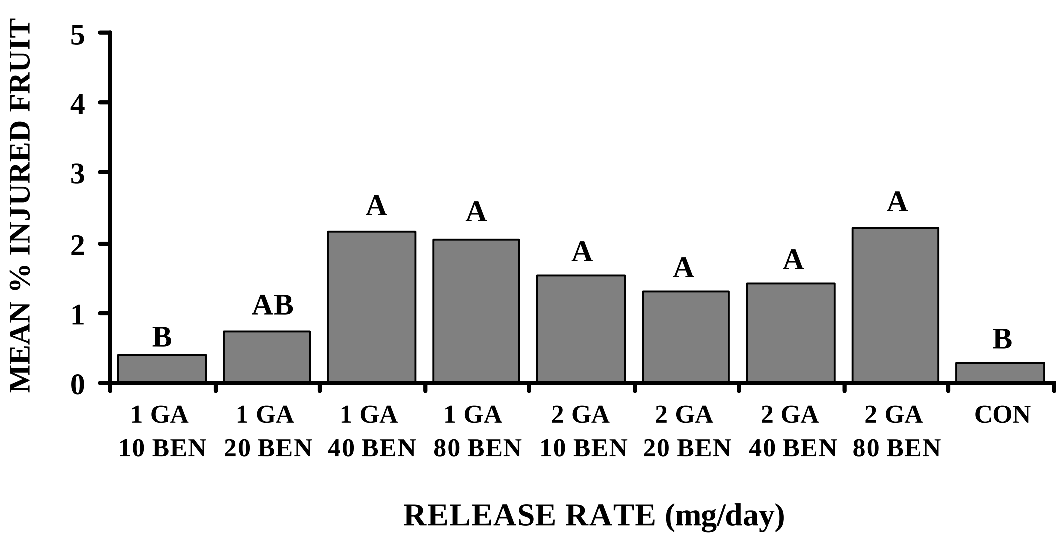

Figure 1. Mean percent of sampled fruit on perimeter-row trap trees baited with different amounts of grandisoic acid (GA) and benzaldehyde (BEN) or unbaited (CON) that received fresh ovipositional injury by plum curculio. Means superscribed by the same letter are not significantly different at odds of 19:1.

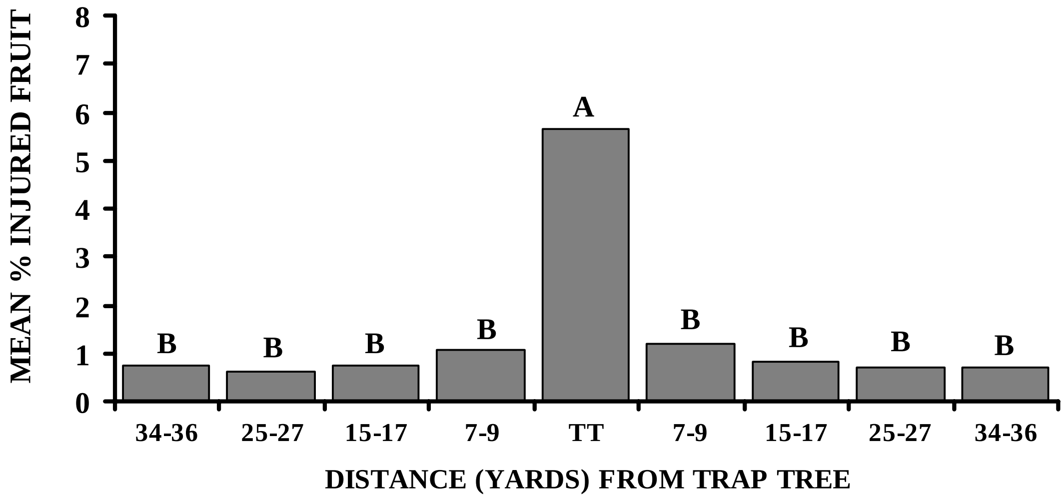

Figure 2. Mean percent of sampled fruit on a perimeter-row trap tree (TT) baited with grandisoic acid (1 mg/day) plus benzaldehyde (40 mg/day) and on perimeter-row unbaited trees at varying distances from the trap tree that received fresh ovipositional injury by plum curculio. Means superscribed by the same letter are not significantly different at odds of 19:1.

unbaited. Within a quadrant, lures were positioned at head height within an imaginary circle about 1 yard from the outermost canopy foliage and 4-5 yards distant from a corresponding imaginary circle on the opposite side of the tree. To assess incidence of ovipositional injury near and far from the source of odor, we examined 20 apples in each of the two imaginary circles.

Experiment 5: Representative Sample of Injured Fruit within Trap Trees. In each of eight blocks of 18 large-size (M.7 rootstock) apple trees, we chose three perimeter-row trap trees. We examined 20 fruit at head height in the outer half of the canopy, 20 fruit at head height in the inner half of the canopy, and 20 fruit in the upper central part of the canopy in each tree for evidence of ovipositional injury. Sampling was confined to the last week of June. For this experiment, fruit with fresh as well as older damage was counted as injured.

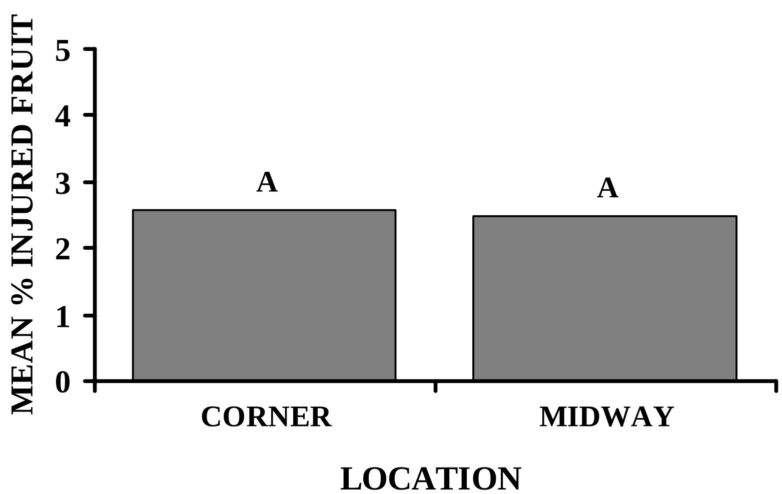

Figure 3. Mean percent of sampled fruit on perimeter-row trap trees baited with grandisoic acid (1 mg/day) plus benzaldehyde (40 mg/day) located at corners of orchard blocks (intersection of two perimeter rows) vs. midway between and at least 45 yards distant from corner trees that received fresh ovipositional injury by plum curculio. Means superscribed by the same letter are not significantly different at odds of 19:1.

Results

In the first experiment, there were no significant differences in amounts of fresh injury among trap trees baited with one dispenser of GA plus four or eight dispensers of BEN and trap trees baited with two

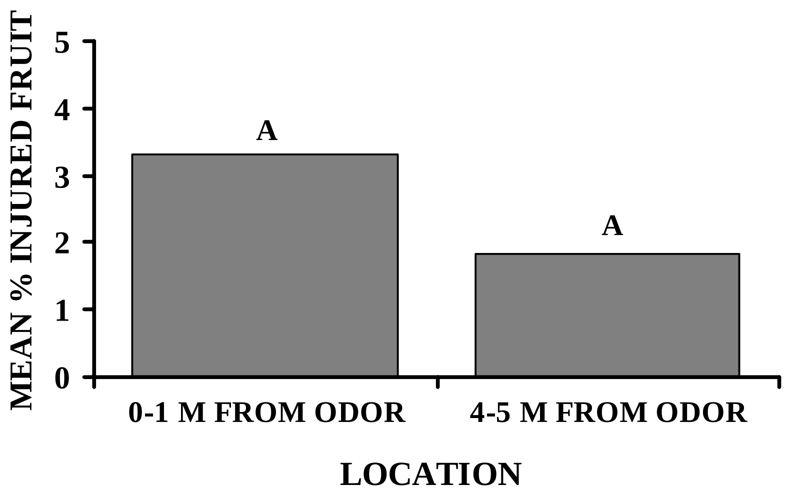

Figure 4. Mean percent of sampled fruit on perimeter-row trap trees that received fresh ovipositional injury by plum curculio when sampled fruit were within an imaginary circle (1 yard diameter) containing grandisoic acid (1 mg/day) plus benzaldehyde (40 mg/day) or within an imaginary circle (1 yard diameter) lacking odor bait on opposite side of the tree (4-5 yards from odor source). Means superscribed by the same letter are not significantly different at odds of 19:1.

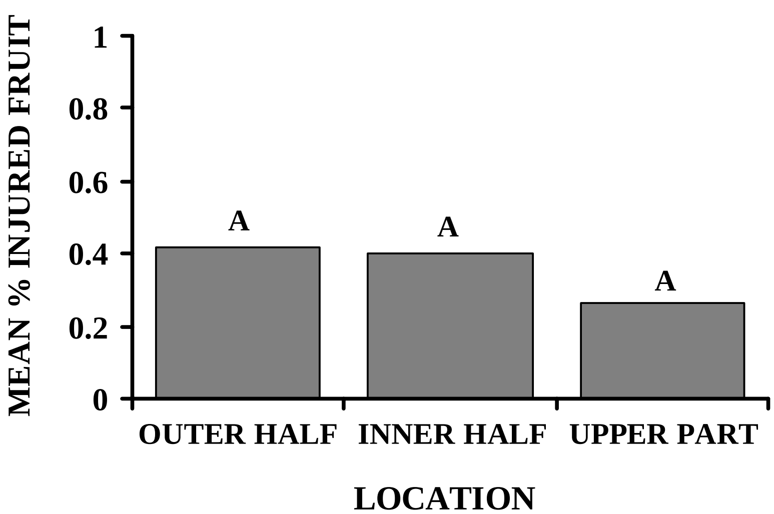

Figure 5. Mean percent of sampled fruit on perimeter-row trap trees baited with grandisoic acid (1 mg/day) plus benzaldehyde (40 mg/day) (both positioned near the center of the tree) that received ovipositional injury (fresh and older injury combined) to fruit at head height in the outer half of the canopy, at head height in the inner half of the canopy and in the upper central part of the canopy in samples taken during the last week of June. Means superscribed by the same letter are not significantly different at odds of 19:1.

dispensers of GA plus one, two, four, or eight dispensers of BEN (Figure 1). All six of these treatments received significantly more fresh injury than trap trees baited with one dispenser of GA plus one dispenser of BEN and than unbaited trees. Numerically, just as much fresh injury occurred on trap trees baited with one dispenser of GA (releasing 1 mg/day) plus four dispensers of BEN (releasing a total of 40 mg/day) as on trees of any other treatment, with injury on trees receiving this treatment about eight-fold greater than on unbaited trees.

In the second experiment, the amount of fresh injury on trap trees was significantly greater (about eight-fold greater) than on unbaited trees 34-36 or 25-27 yards distant from trap trees, and was likewise significantly greater (about seven-fold and five-fold greater, respectively) than on unbaited trees 15-17 or 7-9 yards distant from trap trees (Figure 2).

In the third experiment, perimeter-row trap trees located at corners of orchard blocks received an almost identical amount of injury (no significant difference) as perimeter-row trap trees located midway between corner trees (Figure 3).

In the fourth experiment, there was only a slight (and insignificant) tendency for within-canopy injury on trap trees to be greater in the vicinity (within 1 yard) of the source of attractive odor compared with 4-5 yards distant from the odor source (Figure 4).

In the fifth experiment, a nearly identical amount of injury on trap trees was found among fruit sampled at head height at the outer half of the canopy as among fruit sampled at head height at the inner half of the canopy, with injury among fruit sampled in the upper part of the canopy (above head height) being slightly though not significantly less (Figure 5). In this experiment, odor sources were positioned at head height and near the tree trunk.

Conclusions

Our findings indicate that perimeter-row trap trees baited with one dispenser of GA plus four dispensers of BEN performed as well as or better than trap trees baited with greater or lesser amounts of these attractants. They also indicate that the distance over which a trap tree baited with such an amount of odor is effective in luring PCs extended to at least 34-36 yards along a perimeter row of apple trees and that trap trees at corners of orchard blocks were equally as alluring to PCs as perimeter-row trap trees midway between corner trees. Further, our findings suggest that within the canopy of a trap tree, PC injury to fruit tended only slightly (and not significantly) to be concentrated near the source of attractive odor when such odor was positioned at the periphery of the canopy. When attractive odor was positioned near the center of the canopy, fruit injury tended to be rather evenly distributed among various sectors of the canopy.

Together, these findings set the stage for an experiment to determine a threshold of injury to fruit on a trap tree that would justify spray applied to perimeter rows 1 and 2 to control PC following application of a petal fall spray to all rows.

Acknowledgements

This work was supported by funds from a USDA Northeast Regional IPM grant, a USDA Northeast Regional SARE grant, a USDA Crop at Risk grant, a USDA Specialty Crops Research grant, the Massachusetts Society for Promoting Agriculture, and the New England Tree Fruit Research Committee.

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