Influence of Odor-bait, Cultivar Type, and Adjacent Habitat Composition on Performance of Perimeter Traps for Controlling Apple Maggot Flies

Sara Hoffmann, Robin Mittenthal, Brad Chandler, Gerald Lafleur, Starker Wright, Paul Appleton, Max Becker, Sara Dynok, and Ron Prokopy
Department of Entomology, University of Massachusetts

Apple maggot flies (AMF) that immigrate into commercial apple orchard blocks from surrounding areas containing unmanaged host trees are the flies responsible for the great majority of infestation of fruit in commercial orchards. Previously, we have found that using perimeter-row, odor-baited red spheres to intercept immigrating AMF is an effective control method. More specifically, our findings have suggested that surrounding an apple orchard block with spheres baited with butyl hexanoate (BH) and placed 5 m apart will effectively prevent AMF from penetrating into the block.

Here, we present the results of experiments conducted in 2000 and 2001 designed to determine whether (1) spacing spheres 10 m apart on perimeter-row apple trees is as effective as spacing spheres 5 m apart in preventing AMF penetration into orchard blocks, (2) perimeter-row spheres baited with a five-compound blend of fruit odor volatiles are more effective than traditional BH-baited spheres in preventing AMF penetration into interiors of blocks, (3) the presence of AMF-susceptible compared with AMF-tolerant cultivars comprising front-row apple trees affects front-row-trap captures and AMF penetration into interiors of blocks, and (4) adjacent habitat affects AMF population numbers immigrating into commercial orchards.

Materials & Methods

In 2001, 10 Massachusetts commercial orchard blocks were involved in our experiment (initially, we used 12 commercial orchard blocks in 2001, but for the purpose of this article, we excluded two of them due to unusually high AMF populations that would blur data trends in the remaining 10 blocks). Five blocks had front-row cultivars that were comparatively susceptible to AMF (Gala, Jonagold, or Fuji) and five blocks had comparatively tolerant front-row cultivars (McIntosh or Empire). Each orchard block had an adjacent habitat of woods, hedgerow, or open field. Each block in the 10 commercial orchards was divided into three plots (Figure 1). Plots A and B had a 45m length of front row and a depth of seven rows. The front row in plots A and B contained five sticky red spheres, spaced 10m apart. Each was baited with either the five-compound blend (BH, hexyl butanoate, butyl butanoate, pentyl hexanoate, and propyl hexanoate) or BH alone. Plots A and B received no insecticide spray to control AMF. Plot C (termed grower sprayed) had a 30m length of front row and a depth of seven rows. It was sprayed by the grower two or three times with an organophosphate insecticide to control AMF. Each of the two sides of plots A and B, as well as the back row (row 7), contained red spheres spaced 5 m apart, baited with butyl hexanoate. Plot C had no perimeter, side, or back-row spheres. Rows 3 and 4 contained six unbaited sticky red spheres (four in the grower-sprayed plot due to the smaller size) to monitor AMF penetration into the interior of plots. Traps were deployed in late June and remained through the beginning of October. Every 2 weeks, traps were cleaned and captured AMF were counted.

The protocol for our 2001 experiment was based on results of a test conducted in 2000, in which we evaluated AMF penetration into orchard blocks by

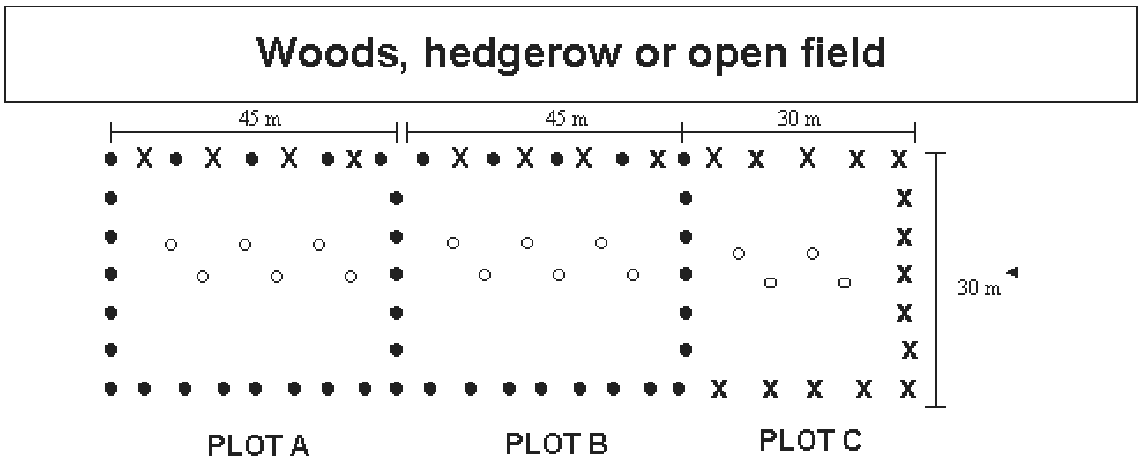

Figure 1. Schematic illustration of the 2001 season block layout for evaluation of sticky red sphere traps for controlling AMF: ? = odor-baited traps, wherein front-row traps in Plot A were baited with a five-component blend, front-row traps in Plot B were baited with butyl hexanoate, and all other baited traps received butyl hexanoate; ? = unbaited interior monitoring traps in rows three and four; x = unbaited apple trees. No insecticide was applied to any tree in Plot A or Plot B, but was applied two to three times to all trees in Plot C in July and August.

comparing AMF captures on red spheres baited with the five-compound blend and placed either 5 or 10 m apart on front-row trees. Methods were, in general, similar to those for 2001 with the following differences: (1) for 2000, we included data for all 12 orchard blocks initially considered for 2001, (2) in 2000, the perimeter row of each plot was only 30 m long, and (3) in 2000, traps placed on sides and back rows were spaced 10 m apart. Results of that study are also presented in this article.

Results

Results from 2000. Experiments that we conducted in 2000 show that across all five sample periods and all 12 orchard blocks, about 26% more wild AMF were captured per trap on front-row traps that were spaced 5 m apart (mean=27) than 10 m apart (mean=22), but there was virtually no difference in wild AMF penetration into interiors of the plots (respective means of 9 and 8/trap/plot) (Figure 2A). Thus, front-row traps that were spaced at 5 m or 10 m apart captured about three times more wild AMF per trap than interior monitoring traps. Interior-row traps in grower-sprayed plots captured 33 and 12% fewer AMF, respectively, than interior-row traps in plots with perimeter traps 5 or 10 m apart. The ratio of front-row/interior-row trap captures was markedly higher for tolerant cultivars (3.8:1) than for susceptible cultivars (2.3:1) (Figure 2C and E). For susceptible cultivars, interior monitoring traps in trapped plots captured about 45% more AMF than interior monitoring traps in grower-sprayed plots (Figure 2C). For tolerant cultivars, interior traps in trapped plots captured about 6% fewer AMF than interior traps in grower-sprayed plots (Figure 2E).

Overall AMF captures in 2001. In 2001 (with much higher AMF population numbers than in 2000), across all six sample periods and all 10 orchard blocks, 57% more wild AMF per trap were captured by front-row traps baited with the five-compound blend (termed blend plots) than by front-row traps baited with BH (termed BH plots)(Figure 2B). Unbaited interior monitoring traps in BH plots captured about 13% more AMF than interior traps in blend plots and about 47% more AMF than interior traps in the grower-sprayed plots (about 7/trap/plot). About seven times more wild AMF per trap were caught by front-row traps in blend plots than by interior monitoring traps, whereas only about five times more wild AMF were caught by front-row traps in BH plots than by interior traps.

The effect of front-row cultivar type on AMF

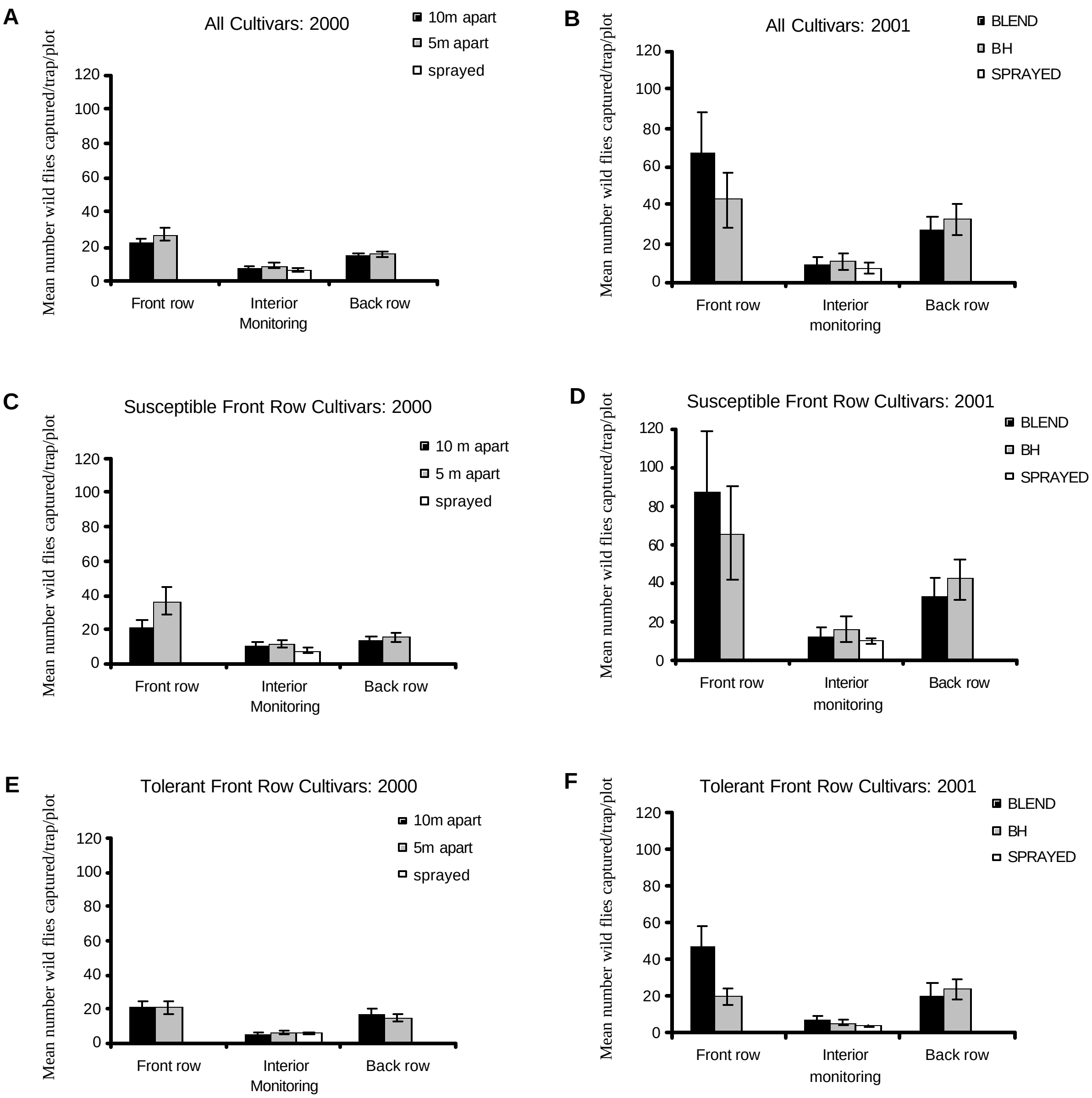

Figure 2. For 2000 and 2001, across all sample periods, sum of mean numbers of wild AMF captured by odor-baited spheres placed on front rows or back rows of plots or unbaited spheres placed at interior of plots for all plots (A and B) and for plots where the front rows were composed of susceptible (C and D) or tolerant cultivars (E and F). In 2000, only the five-compound blend was evaluated. In 2001, all front-row traps were placed 10 m apart.

captures in 2001. For susceptible cultivars, front-row traps in blend plots captured somewhat more wild AMF per trap than front-row traps in BH plots (about 33% more), whereas for tolerant cultivars, front-row traps in blend plots captured substantially more (136% more) wild AMF than front-row traps in BH plots (Figure 2D and F). Front-row traps in blend and BH plots of susceptible cultivars captured substantially more AMF (85% and 228% more, respectively) than front-row traps in corresponding plots in tolerant cultivars. When averaged across both types of trapped plots and grower-sprayed plots, interior monitoring traps in susceptible cultivars captured substantially more (130% more) wild AMF than in tolerant cultivars. The ratio of front-row-trap/interior-row-trap captures in blend and BH plots was the same within each cultivar type as it was for both cultivars together (about 7:1 for blend and about 5:1 for BH).

Effects of adjacent habitat in 2000 and 2001. In 2000, of the total number of AMF captured by all traps in all orchards, 41% were captured in blocks adjacent to woods (Figure 3). A similar percentage (37%) was captured in blocks bordering hedgerows. The smallest percentage of total captured flies was found in blocks bordering open fields (21%).

In 2001, blocks bordering hedgerows had the highest percentage (47%) of total fly captures, followed by orchard blocks bordering woods (32%), and blocks that were adjacent to open fields (21%) (Figure 3).

Conclusions

In 2000, in the same orchards studied in 2001, data suggested that there was virtually no difference in AMF penetration into orchard blocks when front-row traps baited with the five-compound blend were placed either 10 m or 5 m apart. In 2001 (with front-row traps spaced 10 m apart), front-row traps in blend plots captured more flies than front-row traps in BH plots. Although there was little difference in the mean number of wild AMF that penetrated into the interior of the two baited plots, the ratio of front-row to interior-row-trap captures was higher when front-row traps were baited with blend. Inasmuch as blend appears to be more capable than BH of drawing AMF to the vicinity of traps (based on front-row-trap captures), these data suggest that blend odor-bait is better than BH in preventing AMF from penetrating into the interior of orchards.

Orchard blocks with tolerant front-row cultivars experienced substantially more AMF captures on front-row traps baited with blend than BH. The difference was much less for blocks with susceptible front-row cultivars. This suggests that baiting front-row traps with blend in tolerant cultivars attracts many more flies than baiting tolerant trees with BH. In both 2000 and 2001, and in trapped as well as grower-sprayed plots, more total AMF were captured in orchard blocks with susceptible front-row cultivars than in those with tolerant front-row cultivars. However, the ratio of front-row to interior-row-trap captures remained the same regardless of cultivar. This suggests that each odor bait is just as effective in one cultivar type as it is in the other cultivar type in preventing AMF penetration into the orchard interior.

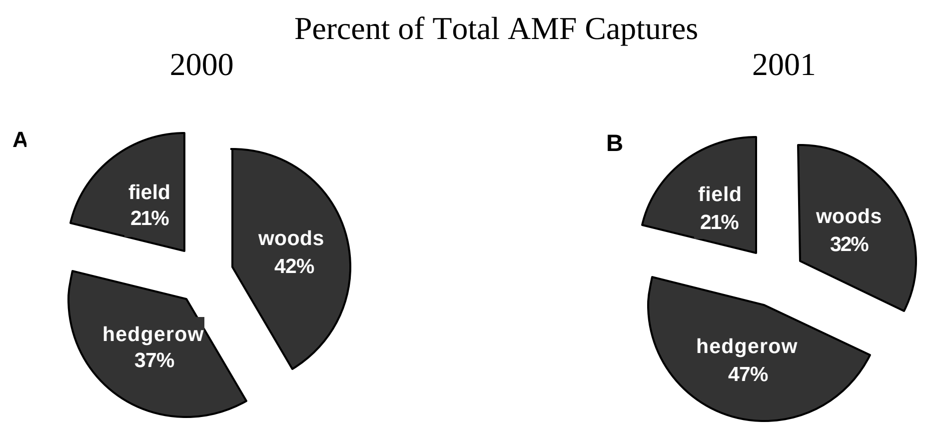

Figure 3. In 2000 and 2001, across all blocks, all traps, and all sample periods, percentage of the total AMF captures according to adjacent habitat (woods, hedgerow, or open field). For the purpose of this figure, all 12 orchard blocks were considered in 2001.

Results from both 2000 and 2001 show that orchard blocks that have woods or hedgerow as adjacent habitat are subject to higher AMF pressure than blocks bordered by open field. Orchard blocks that bordered an open field had consistently lower fly captures than blocks that bordered either woods or hedgerow (habitats that typically support wild host plants).

Based on our findings, it appears that odor-baited red sphere traps are effective in preventing AMF penetration into orchard blocks when they are spaced at 10 m apart on the perimeter row, especially when baited with blend. Regardless of cultivar type, the blend bait appears to be better than the BH bait at preventing flies from penetrating into the interiors of orchard blocks. In 2002, we plan to evaluate further the capability of different odors on perimeter-row traps for intercepting wild AMF immigrating into commercial orchards.

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 Management Funds, Northeast Regional Competitive Integrated Pest Management Funds, and Northeast Regional Sustainable Agricultural Research and Education Funds.

* * * * *