Chapter 5

Evaluation of Traps and Olfactory Attractants

Introduction

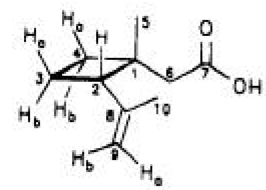
Plum curculio is a pest of pome and stone fruits in the eastern and central United States (Racette et al. 1992) and Canada. There are two strains: a univoltine strain, found in the north, and a multivoltine strain, found in the south (Chapman 1938, Bobb 1952, Racette et al. 1992). Adults overwinter in hedgerows, woodlots, and unmanaged orchards (Butkewich and Prokopy 1993, Prokopy et al. 1999). In the spring the adults invade orchards with the males entering shortly before the females (Chapman 1938). The adults feed on twigs, leaves, and branches until fruit is formed. Both males and females feed on the immature fruit and the females oviposit in them. Feeding and oviposition damage worsen early abscission (June drop) and cause corky scars on the fruit remaining in the tree (Chapman 1938, Bobb 1952, Racette et al. 1992), making them unmarketable. In addition, the fruit remaining on the tree may contain live larvae at harvest in areas where a multivoltine strain occurs, resulting in the potential for exportation of this pest to other states or countries where plum curculio is not present. This prospect has caused trade barriers to be raised against states like Virginia that are suspected or known to have a multivoltine strain of plum curculio in fruit growing regions.

Because of plum curculio's cryptic coloring and scotophasic habits, scouting for plum curculio is often unsuccessful and its presence in the orchard is not noticed until the fruit has been damaged. Currently there is no reliable monitoring system for detection of plum curculio populations in an orchard.

Much work has been done with host-plant volatiles that are attractive to the northern strain of plum curculio. Leskey and Prokopy (2000) reported that in still air olfactometer tests plum curculio adults were more attracted to hexane extracts of immature plum and McIntosh fruits than to hexane extracts of honeysuckle fruit. Prokopy et al. (2000) identified 30 components of the odor of unripe apple and plum fruits and evaluated them in field tests. Eight components showed good evidence of attractiveness: benzaldehyde, benzyl alcohol, decanal, ethyl isovalerate, geranyl propionate, hexyl acetate, limonene and trans-2-hexenal. The degree of attractiveness of these compounds varied in accordance with rates of release. Leskey et al. (2001) showed that linalool, 2-hexanone and 3-hydroxy-2-butanone also showed significant attractiveness in laboratory tests, but they reported that under field conditions only ethyl isovalerate and limonene were attractive.

Eller and Bartelt (1996) isolated a male-produced aggregation pheromone, (+)-(1*R*, 2*S*)-1-methyl-2-(1-methylethenyl) cyclobutaneacetic acid (Figure 17). Due to its similarity to the aggregation pheromone of the boll weevil, *Anthonomus grandis grandis* (Boheman), (+)-grandisol (Figure 5), the compound was given the trivial name, grandisoic acid.

I.



II.

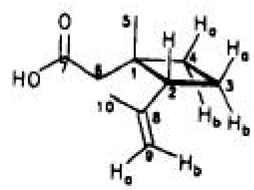


Figure 17. I. is the major component of the male specific pheromone in plum curculio and is the carboxylic analog of II. (+)-grandisol, the major component of the boll weevil pheromone.

Eller and Bartelt (1996) isolated this compound from both northern strain and the southern strain plum curculio adults. Therefore, this pheromone may be tested in all areas, regardless of the strain of curculio present. Landolt (1997) noted that host plant volatiles are often synergistic with pheromones produced by males. Because of this possible synergy, these studies were conducted with plant volatiles in the presence and absence of grandisoic acid to ascertain if this synergy plays a role in attracting plum curculio adults to host plants.

Figure 18. Pyramid traps designed by Tedders and Wood in an apple orchard for trapping plum curculio. Summer 1999. Photo by Jessica Metzger.

Figure 19. Branch mimic trap designed by Prokopy et al. (1998a, 1998b) for trapping plum curculio. Summer 2001. Photo by Michelle M[c]Clanan.

Methods and Materials

I tested three traps: the Tedders trap (Figure 18), designed originally to be used for *Conotrachelus schoofi* Papp by Tedders and Wood (1994). These traps are black pyramids, mimicking a tree trunk. Each stands on the ground with an inverted wire cone trap, adapted from the boll weevil trap, on top. The Circle trap developed by Edward Circle for use in pecan orchards is an inverted wire cone trap with a “skirt” of aluminum insect netting attached to the bottom. The third trap was a branch mimic (Figure 19) designed by Prokopy et al. (1998a, 1998b). These traps consist of pieces of PVC pipe (25 cm long and 7.5 cm diam), painted flat black with inverted wire cone traps at the top. The grandisoic acid was tested in both a racemic blend (1999 and 2000) and a single isomer (2001) with the host plant volatiles described by Leskey and Prokopy (2001) and Lesky et al. (2001) as being attractive to the plum curculio.

1999. Plum curculios were collected in Tedders Traps (Tedders and Wood 1994). Traps were placed under trees in apple and peach orchards in Augusta and Orange Counties during the summer of 1999 (all trees were of fruit bearing age). These traps were set out in May and removed in October. Each trap was placed at the base of an edge row tree. In Augusta County two replicates of each treatment were placed in each of two blocks of apples. In Orange County one replicate of each treatment was placed in the apple block and two replications were placed in the adjacent peach block. The following baits were compared with an unbaited control: grandisoic acid (racemic blend; IPM Technologies, Raleigh; Scenturion, Clinton), ethyl isovalerate (IPM Technologies), limonene (IPM Technologies) and plum essence (IPM Technologies). Traps were checked weekly and plum curculios in each trap were counted and recorded. In Augusta County, grandisoic acid from IPM Technologies was compared with the other treatments. In Orange County, grandisoic acid from both sources was compared with the treatments. Data were analyzed using a generalized random block design to account for block treatment interactions as well as differences in the treatments. Tukey's HSD was used to separate statistically significant means.

2000. Plum curculios were collected in Circle trap. The traps were attached to a branch with a length of bailing twine in edge row trees in apple blocks in Augusta County and apple and peach blocks in Orange County. Traps were deployed from May until September. In Augusta County, two replicates of each treatment were conducted in two blocks of apples. In Orange County, one replicate of each treatment was conducted in the apple block and two replications were conducted in the peach block. The following treatments were compared with the unbaited control: plum essence (IPM Technologies), sour cherry essence (IPM Technologies), plum essence with grandisoic acid (racemic blend; IPM Technologies), and sour cherry essence (IPM Technologies) with grandisoic acid (racemic blend). Traps were checked weekly and plum curculios in each trap were counted and recorded.

2001. During 2001, plum curculio adults were collected in branch mimic traps. The traps were attached to branches using zip ties, in four abandoned apples trees and one abandoned plum tree in Craig County. The treatments were a blend of limonene, ethyl isovalerate, trans-2-hexenal, and benzaldehyde (supplied by Dr. Tracy Leskey, USDA-ARS, Kearneysville) released at low, medium, and high concentrations, with or without grandisoic acid (IPM Technologies). The treatments were replicated once per tree, with each tree constituting a block. These six treatments were compared with a control. Traps were checked weekly and plum curculios were counted and recorded. The data were analyzed as a completely randomized 3 (release rate) x 2 (with or without grandisoic acid) factorial block design.

Results

1999. Due to low capture rates, only the first eight weeks of captures were analyzed. In the Augusta County orchard, significantly more plum curculios were caught in the control or in traps baited with grandisoic acid than with plum essence or limonene; ethyl isovalerate was intermediate, and was not significantly different from either group (Table 8). The fact that significantly more plum curculios were caught in the control than in traps baited with limonene could be explained if limonene functioned as a deterrent at the rate of release employed in this study, although this possibility has not been tested. Plum essence should not have been a deterrent however, unless the attractive volatiles were not present in the extract or the ratio of volatiles within the mix was not optimal. In Orange County, there were no significant differences among the treatments (Table 8).

Table 8. Mean trap catches of plum curculio for first 8 weeks of trapping in orchards in two counties (1999)

Treatment	Augusta	Orange
grandisoic acid	5.0b	4.0a
limonene	0.5a	1.0a
ethyl isovalerate	2.2ab	2.7a
plum essence	0.8a	2.7a
unbaited control	3.5b	1.0a

Generalized Randomized Block Design ANOVA. Means within columns followed by the same letter are not significantly different (Tukey's HSD; p= 0.016, df=4).

2000. Due to the lack of captures from this experiment, further analysis was not warranted. Total trap capture was two adult plum curculios.

2001. Trap captures were low for the summer, 43 individuals were caught during the 12 weeks the traps were in the field. However, analysis of the data showed that the interaction between the plant essences and the pheromone was significant (Table 9). Trend-analysis showed a quadratic trend (Figure 20) toward the high release rate.

Table 9. ANOVA for trap captures of plum curculio in 2001

	degrees of freedom	sum of squares	mean squares	p-value
release rate	2	27.8000	13.9000	.189
pheromone (+/-)	1	3.33	3.33	.5195
interaction a	2	76.8666	38.4333	.0161

ANOVA for 3x2 factorial. Interaction between release rate (of plant volatiles) and pheromone is significant.

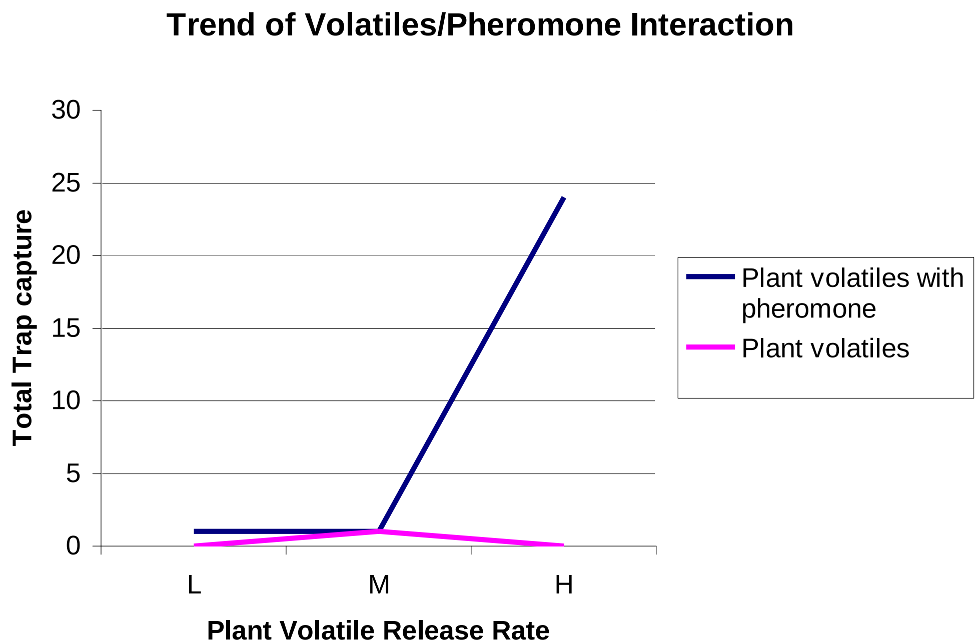


Figure 20. Trend analysis of the release rate of plant volatiles with the pheromone. Total trap capture was defined as total number of captures for all traps with a given treatment. (LP=low release rate of plant volatiles with pheromone, MP=medium release rate of plant volatiles with pheromone, HP= high release rate of plant volatiles with pheromone)

Discussion:

Leskey and Prokopy (2000) reported that hexane fruit extracts of wild plum and McIntosh apple were attractive to plum curculio adults. Leskey et al. (2001) isolated several chemical compounds from the extracts and tested them in the laboratory and field. The most attractive compounds were ethyl isovalerate, trans-2-hexenal, and limonene. However, our data did not verify the effectiveness of these compounds as lures. One explanation for this may be that, at the levels of plant volatiles/pheromones tested, plum curculios could not distinguish the lures from the background host plant volatiles.

Most of the research into attractiveness of compounds has been done with the univoltine strain of plum curculio (Leskey and Prokopy 2000, Prokopy et al. 2000, Leskey and Prokopy 2001, Leskey et al. 2001). It is very likely that the multivoltine strain will follow the already described behaviours in the early spring. However, the behaviour of the newly emerged adults of the multivoltine strain may be very different during the summer. Because newly emerged multivoltine females begin to lay viable eggs soon after emergence, it is likely that they respond to different visual and olfactory cues than they do earlier the season.   It is also likely that the univoltine plum curculios will not respond to these cues, since they must under go a diapause before the females can lay viable eggs.

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