Do Natural Sources of Odor Enhance Plum Curculio Attraction to Traps?

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In a preceding article in this issue of *Fruit Notes*, we suggested that addition of a powerful attractive odor might enhance the capturing power of a pyramid or cone trap to an extent that such a trap could become reliable for monitoring the abundance of plum curculios in commercial orchards. Here, we report on 1996 tests in which we evaluated plum curculio males, plum curculio females, whole stored mature apples, pieces of stored mature apples, and fresh immature apples as potential natural sources of attractive odor for plum curculios. We also evaluated ammonium carbonate (an attractant for apple maggot flies) as a potential attractant for plum curculios.

Experiments & Results

Curculios as Odor Sources. Curculios used as odor sources were separated by sex shortly after emergence in summer and then were held over winter in containers outdoors until ready for use here. For each experiment, they were confined in a plastic container in groups of 20 same-sex individuals per container. Each container was cylindrical, about 2 inches in diameter and 3 inches tall, covered at the top with a clear-plastic lid to prevent entry of rainfall, and covered at the bottom with window screen to allow odor to emanate from the cylinder. Each cylinder, including "check" cylinders containing no curculios, received eight fresh-picked immature apples (about 1/2 inch diameter), removed every other day. Traps with which these containers were associated were examined daily at 5 AM, at which time captured curculios were removed. On average, 15 of the 20

Table 1. Mean numbers of plum curculios captured per day in traps baited with either male, female, or no plum curculios.

Exp.	Location of bait containers	Bait source	Number of replicates	Average number captured per day
1	Base of pyramid trap	Males	27	4.9a
		Females	27	4.5a
		None	27	6.2a
2	Top of pyramid trap	Males	8	3.8a
		Females	8	1.9a
		None	8	5.1a
3	On boll weevil trap tops on twigs in tree canopy	Males	15	0.2a
		Females	15	0.6a
		None	15	0.4a

*In each experiment, numbers followed by a different letter are significantly different at odds of 19:1.

curculios per container remained alive during the course of an experiment.

In the first experiment, three containers of same-sex curculios were attached 8 inches above ground to the wings of pyramid traps, one container per wing. Traps were placed mid-way between trunks and perimeters of unmanaged apple trees from May 23 (full bloom) until June 12. Results (Table 1) show that traps baited with "check" containers devoid of curculios captured similar numbers of curculios than traps baited with live males or live females.

In the second experiment, one container of curculios was affixed to an open-trap boll weevil trap top capping a pyramid trap in such a way that odor could move from the container of curculios through the boll weevil trap top and down onto the pyramid. Traps were placed mid-way between trunks and perimeters of unmanaged apple trees from June 13 until June 21. Results (Table 1) show that traps baited with "check" containers devoid of curculios captured similar number of curculios than traps baited with live males or females.

In the third experiment, one container of curculios was affixed to a boll weevil trap top in the same manner as in the second experiment. Then, each was placed on the end of an upright twig at mid-height in the canopy of an unmanaged apple tree from May 23 until June 21. Results (Table 1) show that few plum curculios were captured by any of the traps, with no significant differences in captures among traps baited with males, females, or empty traps.

Apples as Odor Sources. Apples used as odor sources were either mature Fuji apples stored over winter under refrigeration and washed thoroughly before use or immature McIntosh apples (about 2/3 inch diameter) attached to freshly cut unsprayed branchlets.

In the first experiment, 16 whole mature Fuji apples were distributed evenly on the ground at the base of each pyramid trap. Traps were placed mid-way between trunks and perimeters of unsprayed apple trees from May 21 (early bloom) until June 1. Results (Table 2) show no enhancement of trap captures by additions of whole mature apples at bases of pyramid traps.

In the second experiment, a 2-inch wedge

Table 2. Mean numbers of plum curculios captured per day in traps baited with mature or immature apples or unbaited traps.

Exp.	Location of bait	Bait source	Number of replicates	Average number captured per day
1	Base of pyramid trap	Whole mature Fuji apples	12	2.0a
		Unbaited	12	2.5a
2	Boll weevil trap top capping pyramid trap	Wedge of mature Fuji apple	24	1.5a
		Unbaited	24	2.2a
3	Base of pyramid trap	Branchlets bearing immature McIntosh apples	16	4.3a
		Unbaited	16	6.0a

*In each experiment, numbers followed by a different letter are significantly different at odds of 19:1.

cut from a mature Fuji apple was placed inside a boll weevil trap top capping a pyramid trap in a way that odor could move down onto the pyramid. Wedges were renewed daily. Traps were placed mid-way between trunks and perimeters of unmanaged apple trees from June 3 until June 9. Results (Table 2) show no enhancement of trap captures by additions of apple wedges to boll weevil trap tops capping pyramid traps.

In the third experiment, 4 branchlets (each with 12 McIntosh apples) were distributed evenly on the ground at the base of each pyramid trap. Traps were placed mid-way between trunks and perimeters of unmanaged apple trees from June 15-22. Results (Table 3) show no enhancement of trap captures by additions of fresh-cut branchlets bearing immature apples at bases of pyramid traps.

Ammonium Carbonate as Odor Source. Ammonium carbonate crystals were distributed so as to cover screen bases of cylindrical containers of the type previously described for housing live plum curculios.

In the first experiment, three containers of ammonium carbonate were attached 8 inches above ground to the wings of each pyramid trap, one container per wing. Traps were placed adjacent to trunks of unmanaged trees from June 22 until June 24. Results (Table 3) show that ammonium carbonate did not enhance trap captures.

In the second experiment, a container of ammonium carbonate was affixed to an open-top boll weevil trap top capping a pyramid trap in such a way that odor could move from the container through the boll weevil trap top and down onto the pyramid. Traps were placed adjacent trunks of unmanaged trees from June 24 until June 26. Results (Table 3) show that ammonium carbonate had a significantly negative effect on trap captures.

Conclusions

Disappointingly, none of the sources of odor we evaluated led to an increase in numbers of plum curculios captured, either by pyramid traps placed on the ground beneath tree canopies or boll weevil trap tops placed within tree canopies. What might have been some causes of this lack of positive response of curculios to odor baits evaluated in conjunction with traps?

In the case of male or female curculios as bait, we were quite puzzled by results until we carried out some additional laboratory tests. The way in which we conducted our field tests was consistent with the way tests of potential odor attractancy of one sex of insect to another is normally evaluated in the field. We fully expected to find that odor of male or female curculios was attractive to individuals of the same or opposite sex. This expectation was

Table 3. Mean numbers of plum curculios captured per day in traps baited with ammonium carbonate (AC).

Exp.	Location of bait containers	Bait source	Number of replicates	Average number captured per day
1	Base of pyramid trap	AC	8	1.6a
		None	8	2.3a
2	Top of pyramid trap	AC	8	1.4b
		None	8	5.0a

*In each experiment, numbers followed by a different letter are significantly different at odds of 19:1.

heightened part-way through our field tests when a publication appeared by chemists in Illinois detailing the chemical structure of a pheromone (grandisoic acid) produced by male plum curculios that is equally attractive to both females and males, even when used in small amounts. This was indeed exciting news. Our follow-up laboratory tests showed, however, that when curculios are confined to small areas (such as the containers we used for curculios as odor sources), they emit stress sounds and/or odors alerting other curculios. These sounds or odors apparently mask or outweigh the luring power of attractive pheromone. This suggests that the most rewarding way to evaluate pheromonal odor in conjunction with traps in the field would be to use synthetic pheromone rather than a natural source of pheromonal odor.

In the case of apple odor as bait, it appears that if natural sources of odor are used in the amounts evaluated here, either such an amount is insufficient to compete with fruit odor sources on adjacent trees, or natural sources of apple odor lose attractiveness (odor composition changes) rapidly after employment. As with synthetic sex pheromones, synthetic apple odor hopefully will become an effective alternative to natural sources of apple odor for attracting plum curculios to traps (see following article).

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