How Do Plum Curculios Approach Host Trees and Pyramid Traps?

Ronald Prokopy and Starker Wright
Department of Entomology, University of Massachusetts

The means by which plum curculios approach host trees, whether by flight or by crawling, can provide important background information leading toward optimization of design and location of traps for monitoring and possibly even controlling curculios. We report here on several studies conducted during 1996 aimed at learning more about movement patterns of curculios toward host trees and pyramid traps under varying sorts of weather conditions.

Experiments & Results

Movement Toward Host Trees. In our first experiment in a small unmanaged orchard of 36 semi-dwarf trees owned by Hardigg Industries of South Deerfield, MA, we wanted to determine whether curculios entered the tree by flying, by crawling, or by both means, and whether mode of entry depended on weather conditions. We coated the trunks of 12 trees (every third tree) with a thick 1-inch-wide band of Tangletrap about 2 feet above ground to prevent curculios from crawling up the trunk and into the canopy. Direct observation of curculios attempting to cross this sticky band indicated that they were unsuccessful in doing so. None of the tips of branches of these or any other trees in the orchard reached closer than 2 feet above ground, thereby precluding curculios from crawling onto branch trips to reach the canopy. Height of grass was maintained below 4 inches. Another set of 12 trees (every third tree) was not treated with Tangletrap to permit curculio arrival both by crawling and by flight. Every evening at 8 PM from May 19 (full bloom) to June 7, we tapped the branches of each of these 24 trees over white cloth sheets placed on the ground beneath the canopy and collected all fallen curculios. We also obtained an hourly record of temperature at a nearby location for each day from May 19 to June 7.

Results (Table 1, experiment 1) show that that total number of curculios collected from trees having a band of Tangletrap was nearly equal to that of trees without a band of Tangletrap. Results (Table 1, experiment 1) also show there was a significant positive correlation between daily numbers tapped from trees having a Tangletrap band, as well as from trees without Tangletrap, and daily high temperature.

These results provide two valuable pieces of information. First, a band of Tangletrap around the tree trunk is of no apparent value in preventing curculios from accessing host trees and causing injury to fruit. One reason for this lack of deterring effect may be that those curculios which crawl up tree trunks and are unable to pass beyond a sticky barrier subsequently fly into the tree canopy, provided the temperature is warm enough to permit flight. We did, in fact, observe directly some curculios behaving in this manner on warm days. Second, our prediction at the outset that numbers of curculios in tree canopies would be equal on trees with and without a Tangletrap band on warm days (signifying movement into canopies largely or solely by flight) but would be greater on trees without than with a Tangletrap band on cool days (signifying movement into canopies largely solely by crawling) was not supported by the data. On warm days, numbers were large on both types of trees, indicating that curculios were prone to fly into tree canopies on warm days. On cool days, numbers were few on both types of trees, indicating little tendency of curculios either to fly or to crawl into trees on cool days.

Table 1. Numbers of plum curculios found in daily collections at 8PM in each of three experiments in Hardigg's unmanaged orchard, May 19 - June 7, 1996, South Deerfield, MA.

Exp.	Treatment	Number of replicates	Average number of curculios*	Value of correlation with temperature
1	Trees with a Tangletrap band	12	100a	0.56
	Trees without a Tangletrap band	12	107a	0.46
2	Clear Plexiglas, low position	12	16a	0.43
	Clear Plexiglas, high position	12	14a	0.48
3	Pyramid traps with a Tangletrap band	6	7b	0.73
	Pyramid traps without a Tangletrap band	6	20a	0.39

*Numbers in each experiment followed by a different letter are significantly different at odds of 19:1.
**A perfect positive correlation between daily numbers of curculios found in each treatment and daily high temperature would be 1.00. Each correlation value shown here (except pyramid traps without Tangletrap) indicates a significant positive relation at odds of 19:1.

In our second experiment, conducted in the same orchard, we wanted to gain more direct information on the extent of curculio flight into tree canopies on warm versus cool days. Therefore, on the remaining 12 trees in the orchard (every third tree not involved in the first experiment), we positioned two squares of clear Plexiglass (2 feet by 2 feet) vertically on a pole about 2 feet to the outside of the perimeter foliage of each tree: one square at base height of foliage and one square at top height of foliage. The entire surface of each square facing away from the canopy (but not the surface facing toward the canopy) was coated with Tangletrap to capture curculios flying toward the canopy. Traps were emplaced on the same dates and examined for captured curculios at the same time (daily at 8 PM) as in the first experiment.

Results (Table 1, experiment 2) show that there was no significant difference in numbers of captured curculios between the low-positioned and the high-positioned traps. Results (Table 1, experiment 2) also show there was a significant positive correlation between daily numbers captured at each position and daily high temperature. Furthermore, there were significant positive correlations between daily captures on high or low traps and daily numbers of curculios tapped from canopies of trees with or without a Tangletrap band (data not shown).

Together, these findings constitute strong evidence that on warm days, curculios fly directly into tree canopies, whereas on cool days there is much less tendency to do so.

Movement Toward Pyramid Traps. In our first experiment, we placed an unbaited pyramid trap midway between the trunk and canopy edge of each of the 12 trees that received sticky-coated squares of Plexiglas at the Hardigg orchard. Every other pyramid trap received a band of Tangletrap 4 inches above the base to prevent curculios from crawling to the top. The remaining six traps did not receive Tangletrap. All traps were in place from May 25 to June 7 and were examined daily at 8 PM for captured curculios.

Results (Table 1, experiment 3) show that

traps with Tangletrap captured about one-third as many curculios as traps without Tangletrap, signifying that about two-thirds of the curculios captured by traps without Tangletrap arrived on the traps by crawling onto them rather than by flying onto them.

As with crawling curculios that encountered a Tangletrap band at the base of a tree trunk, crawling curculios that encountered a Tangletrap band at the base of a pyramid trap likewise subsequently may have taken flight, temperature permitting. Such flight apparently did not result in landing on the middle or upper part of a pyramid trap, however. Results (Table 1, experiment 3) also show there was a significant positive correlation between daily numbers captured by pyramid traps with Tangletrap (but not traps without Tangletrap) and daily high temperature.

In our second experiment, conducted in association with three large unmanaged trees near Prokopy's home in Conway, we studied in greater depth curculio captures by unbaited pyramid traps that received a band of Tangletrap at the base and traps that did not. In all, there were two traps of each type beneath each tree, midway between the trunk and edge of canopy. Grass beneath each tree was maintained below 4 inches in height. Captured curculios were counted daily at 5AM and 10PM from June 29 to July 14.

Results (Table 2) show that across the entire 24-hour period of a day, traps with Tangletrap captured about one-third as many curculios as traps without Tangletrap, corroborating results of the preceding experiment at Hardigg. Interestingly, traps without Tangletrap captured about twice as many curculios from 5AM to 10PM as from 10PM to 5AM, whereas traps with Tangletrap captured more than 20 times as many curculios from 5AM to 10PM as from 10PM to 5AM. These results signify that about twice as many curculios arrive on pyramid traps during daylight as during darkness, that about half of those arriving on pyramid traps during daylight do so by flying and half by crawling, and that almost all of those arriving on pyramid traps during darkness do so by crawling. There may be two reasons why very few curculios fly onto pyramid traps during darkness: first, on most nights, temperature during darkness may be too cool to permit flight; and second, curculios in flight during darkness may be unable to see pyramid traps.

In our third experiment, beneath a plum tree at Prokopy's in Conway, we released a group of 40 field-collected plum curculios on the ground mid-way between the tree trunk and edge of the canopy. We did this on 12 evenings at 7:30 PM between June 22 and July 14 when the temperature was about 70°F and there was no rain falling. Four of the releases were made north of the tree on ground covered by 4 inches of grass, four north of the tree on bare ground (the grass was covered with soil), and four south

Table 2. Numbers of plum curculios captured by pyramid traps beneath unmanaged apple trees at different times of day, June 29 - July 14, 1996, Conway, MA.

Traps	Number of replicates	Average number captured*	
		5AM - 10PM	10PM - 5 AM
With a band of Tangletrap	6	4.3b	0.2c
Without a band of Tangletrap	6	7.8a	3.5b

*Numbers followed by a different letter are significantly different at odds of 19:1.

of the tree on bare ground. We placed one unbaited pyramid trap next to the tree trunk and one at the north edge of the canopy (when releases were north) or south edge of the canopy (when releases were south).

Results revealed that about 20% of released curculios were captured by the trap at the trunk and about 4% by the trap at the edge of the canopy, irrespective of where released. Further results revealed that of all released curculios, about 15% eventually flew into the tree canopy, about 15% flew toward open space, about 1% flew onto the tree trunk, about 2% flew onto the trunk trap, and about 1% flew onto the edge trap. Interestingly, about 40% of released curculios crawled toward the tree trunk, with no more than 4% crawling in any other direction. This was true irrespective of whether curculios were released north or south of the tree trunk.

These results support results reported in a preceding article in this issue showing that several times more curculios were captured by pyramid traps next to tree trunks than by pyramid traps more distant from tree trunks. Results here also indicate that when evening temperatures are moderate (somewhat conducive to flight but not highly so), only a very small proportion of curculios that does fly alights on pyramid traps. The great majority in flight bypasses the traps. On the other hand, a very high proportion of crawling curculios moves toward the tree trunk, where they encounter and ascend either the tree trunk or an adjacent pyramid trap.

Conclusions

Perhaps the most important general conclusion from this array of studies is that when temperature is high enough to permit plum curculio flight, curculios may fly directly into tree canopies (either from overwintering sites or from ground beneath trees). In so doing, it appears that most are likely to bypass unbaited pyramid traps, irrespective of trap location. Unbaited pyramid traps, especially when located next to tree trunks, appear to be very good at capturing curculios that are crawling toward the greatest area of darkness in the habitat (that is, toward the center of the tree). Substantial numbers of curculios appear to crawl toward tree trunks and adjacent pyramid traps when temperatures are too low and/or the amount of light is too little to permit flight. Hence, unbaited pyramid traps at tree trunks may afford an accurate representation of curculio populations in orchard trees during periods that favor curculio arrival in trees by crawling but not during periods that favor curculio arrival in trees by flight. Overall, as shown here, a band of Tangletrap around the tree trunk is of little value in preventing curculios from achieving substantial numbers in tree canopies.

Acknowledgments

This work was supported by grants from the USDA Northeast Regional IPM Competitive Grants Program, the USDA SARE Program, the New England Tree Fruit Growers Research Committee, and State/Federal IPM funds. We thank Jim Hardigg of South Deerfield, MA for permission to work in his orchard.

* * * * *