EVALUATION OF TRAP TYPE AND COLOR FOR MONITORING *HYLOBIUS PALES* AND *PACHYLOBIUS PICIVORUS* IN FLORIDA

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Abstract

The pyramid-shaped Tedders trap was evaluated in north Florida for capturing the root weevils, *Hylobius pales* (Herbst) and *Pachylobius picivorus* (Germar) (Coleoptera: Curculionidae). Weevil response to Tedders traps of several colors was compared to the Fatzinger stovepipe trap and a new traffic cone trap. Traps were baited with a 1:1 ratio of the attractants ethanol and turpentine. Black or brown Tedders traps were more effective than yellow or white traps. The Tedders trap and the cone trap were as good as or more effective and easier to use than the stovepipe trap for monitoring weevil adults. Tedders traps also captured many other species of forest insects.

Key Words: *Hylobius pales, Pachylobius picivorus*, Tedders trap, Root Weevils, *Pinus* spp.

Resumen

Se evaluó la efectividad de la trampa piramidal Tedders para capturar a los escarabajos de raíces, *Hylobius pales* (Herbst) y *Pachylobius picivorus* (Germar) (Coleptera: Curculionidae), en el norte de Florida. La respuesta de los escarabajos a trampas Tedders de distintos colores se comparó con la trampa tipo "stovepipe" y con la trampa de cono de tráfico. El atrayente utilizado consistió de una mezcla de metanol y terpentina (1:1). Trampas Tedders de color café o negro fueron más efectivas que las amarillas o blancas. Las trampas Tedders y de cono fueron tan o más efectivas y fáciles de usar que las tipo "stovepipe" para monitorear escarabajos adultos. Las trampas Tedders también capturaron una gran variedad de insectos del bosque.

The pales weevil, *Hylobius pales* (Herbst), and the pitch-eating weevil, *Pachylobius picivorus* (Germar), are important pests of new pine and Christmas-tree plantations throughout eastern North America (Fettig 1998, Rieske and Raffa 1991, Lynch 1984, Ciesla and Franklin 1965). Adult feeding on pine seedlings causes girdling damage to bark and twigs which can result in seedling mortality (Lynch 1984, Ciesla and Franklin 1965). Adult weevils of both species are attracted to fresh pine resin (Hertel 1970, Ciesla and Franklin 1965). Eggs are laid on tree roots and weevil larvae feed in the roots of recently burned, damaged or cut pine stumps (Fox and Hill 1973). When sites are replanted before weevils emerge and disperse, emerging adults feed on the pine seedlings.

Sampling techniques for these weevils have used radial discs cut from fresh pine (Ciesla and Franklin 1965), freshly-cut pine bolts (Taylor and Franklin 1970), and traps baited with ethanol and/or turpentine: modified bounce-column, stovepipe traps

(Clements and Williams 1981, Fatzinger 1985, Phillips et al. 1988), PVC pitfall traps (Hunt and Raffa 1991, Fettig and Salom 1998) and pit traps (Fettig and Salom 1998). Fettig and Salom (1998) used both host material and a 5:1 ethanol:turpentine mixture in the pit trap.

Thomas and Hertel (1969) reported that pales weevils could detect hosts up to 6 m away by olfaction. Fatzinger (1985) and Fatzinger et al. (1987) reported that in Florida ethanol and turpentine attracted both root weevil species to a baited stovepipe trap modified after the bounce-column trap of Clements and Williams (1981). Siegfried (1987) found that turpentine was more attractive than specific terpenes from turpentine when tested individually. Phillips et al. (1988), using a stovepipe trap, showed that *P. picivorus* was attracted to turpentine, but was unaffected by ethanol. *H. pales* displayed greatest attraction to ethanol and turpentine when released side by side or as a 1:1 mixture from one dispenser (Phillips et al. 1988). However, Fettig et al. (1998) reported that both sexes of *H. pales* responded in highest numbers to a 5:1 mixture of ethanol:turpentine. Rieske and Raffa (1991) reported that within each species males and females of *H. pales* and *P. picivorus* responded similarly to individual ethanol-turpentine ratios, however, *P. picivorus* response across all tested bait ratios deviated significantly from 1:1.

Fatzinger (1985) reported that a black stovepipe trap baited with a 1:1 ethanol:turpentine mixture caught higher numbers of weevils than a trap with a white stovepipe. However, unbaited traps collected no forest Coleoptera (Fatzinger 1985). Hunt and Raffa (1991) in Wisconsin compared white, black and green pitfall traps made of PVC with a 45 cm above-ground silhouette and baited with ethanol and turpentine. White traps caught more weevils than black and green traps. Rieske and Raffa (1991) tested different release ratios (1:10, 1:5, 1:1, 5:1, 10:1, 75:1) of ethanol and turpentine in pitfall traps and found that pales weevil responded best to a ethanol:turpentine ratio of 5:1 and greater, while pitch-eating weevils responded in higher numbers to the 5:1 and 10:1 ratios. Fettig and Salom (1998) used white PVC traps modeled after traps of Tilles et al. (1985) baited with a mixture of 5:1 ethanol:turpentine and pit traps baited with natural host material and a 5:1 ethanol:turpentine mixture to determine the relationship between trap catch and seedling damage by *H. pales* in Virginia Christmas tree plantations. Fettig and Salom (1998) reported that the PVC trap was not as accurate as the pit trap in predicting *H. pales* abundance and phenology, therefore, they recommended use of the pit trap for monitoring *H. pales* in Virginia Christmas tree plantations. Fettig and Salom (1998) also found no effect of trap rotation on trap catch of *H. pales*.

Despite the successful collection of weevils in the stovepipe traps (Fatzinger 1985), the PVC pitfall trap (Hunt and Raffa 1991, Rieske and Raffa 1993) and the pit trap (Fettig and Salom 1998), weevil response behavior to traps is not fully understood and all traps do not accurately indicate weevil population dynamics (Fettig and Salom 1998). Improvements are needed to increase ease of use and trapping efficiency and accuracy. Further understanding of the relative functions of visual and odor cues in weevil trap response is needed. Traps with different designs may enable investigation of different weevil behaviors. Stovepipe traps require continuous labor and water-hauling to maintain supplies of soapy water. Through time they become full of debris and algae. PVC traps are placed in the ground and their efficacy is negatively impacted in Florida's sandy soils by rain and armadillos (this study). Many observed differences in trap response with different methods exist between experiments from the northern and southern U.S. (Phillips et al. 1988, Rieske and Raffa 1991). Collections of *H. pales* and *P. picivorus* in unbaited pyramidal traps (Tedders and Wood 1994, Tedders et al. 1996) (named the Tedders trap in Sherman and Mizell (1995)) in peach orchards and other non-pine habitats led to the experiments reported herein.

This study reports a series of experiments in north Florida under different site and harvesting conditions to evaluate the Tedders trap in different colors in comparison to the stovepipe trap (Fatzinger 1985) and other potential trap designs for their use in determining weevil behavior and for monitoring the dynamics in populations of *H. pales* and *P. picivorus.*

Materials and Methods

Tedders traps (Tedders and Wood 1994) modified by adding a bait dispenser were used in all experiments. Traps were painted with either Ace® acrylic flat latex house paint (brown = 159A214, white = 103A200, black = 103A105) or Glidden® alkyd industrial formula, 4540 safety yellow. Stovepipe traps were as described by Fatzinger (1985). Cone traps were modified 90 cm (height) traffic cones (SEC+ Safety Equipment CO., Jacksonville, FL 32216) painted black with a collection top (boll weevil trap top) similar to the Tedders trap. A triangle of masonite tightly fitting the boll weevil trap top's bottom interior and attached into a saw kerf in a dowel which snugly fitted into the cone's hollow tip held the collection top in place. Traps in each site were placed 10-12 m apart (Thomas and Hertel 1969) on a transect in a completely random design. Baits were dispensed from a 250 ml plastic bottle fitted with a dental wick and filled with a 1:1 mixture of 95% ethanol and turpentine (Parks Pure Gum Turpentine, Parks Corporation, Somerset, MA 02726) (Fatzinger 1985). Bottles were placed in a circular wire frame so as to fit over the top of the Tedders and cone traps. They were placed about 10 cm from the trap top and eluted 0.52 gms ± 0.13/h (mean ± SE) of the ethanol:turpentine attractant. Elution rate was determined by weighing a filled dispenser each hour for several days under a variety of sunlight, cloud and humidity conditions.

Traps were checked 1-3 times per week and the number of *H. pales* and *P. picivorus* were recorded and removed. For analysis, weevil counts were converted to the number of weevils per trap per day by species. Data from all experiments were analyzed by analysis of variance using Proc GLM procedures of SAS (SAS Institute 1998). Due to the large number of zero counts, weevil counts were transformed before analysis by taking the square root of the counts + 1; non-transformed means are reported. When significant treatment differences were indicated, means were separated by Duncan's New Multiple Range Test ($P = 0.05$) (SAS 1998, Proc GLM) because of the unequal treatment replication.

Experiment A. Tedders traps of three colors. Tedders traps were placed in an approximately 4 ha mixed pine-hardwood forest located near Monticello, Florida from 25 June-17 December 1993. Sawtimber-sized loblolly pines, *Pinus taeda* (L.), had been harvested from the site in March-April 1993 leaving pine stumps and slash among 50-70 percent remaining hardwoods. Three to seven replicates of white, brown and black Tedders traps were tested. One trap of each color was not baited and served as a control for the odor effects. Bait position was rotated randomly among traps at each visit so that a different trap, one of each color, remained without bait during each period.

Experiment B. Tedders traps of four colors. Three replicates each of white, yellow, brown and black Tedders traps were placed 10-12 m apart in a completely random design in a mixed pine-hardwood location on the North Florida Research and Education Center at Monticello, Florida from 21 February-16 April 1994. No harvesting had occurred in this location which was adjacent to an open field on one side. Traps were placed in the forest along a north-south transect. Two traps of each color were baited as described above and one was left unbaited. Bait dispensers were shifted so as to change the location of the unbaited trap at each visit.

Experiment C. Tedders trap colors, the stovepipe and cone traps. The location was an approximately 15 ha clearcut of loblolly pine in Jefferson County near Monticello, Florida. All traps were deployed from 2 April-26 August 1994. Tedders traps of yellow, white, brown and black were compared to the stovepipe trap (Fatzinger 1985) and one cone trap. Three replicates of each Tedders trap type, two stovepipe traps and the cone trap were placed along a transect 10-12 m apart in a completely random design. Traps were baited as described above. The two stovepipe traps and the cone trap were baited continuously, but one of each colored Tedders traps was left unbaited. Baits were shifted at each visit to the previously-unbaited trap. Data are presented for the baited traps only. Other insects found in the traps were collected and recorded to family, genus or species when a determination could be made.

Experiment D. Tedders trap colors and stovepipe trap. This location was a recently-harvested, mixed pine-hardwood site near Lloyd, Florida. A timber harvest had removed the loblolly pine sawtimber from the site leaving about 70% of the remaining area covered with mixed hardwood species, pine slash/stumps and harvest trails. From 27 August-15 December 1994, 3 replicates of brown, black, yellow and white Tedders traps and 2 replicates of the stovepipe trap were placed about 10-12 m apart in a completely random design along a east-west transect. All traps were baited as described above.

Experiment E. Tedders trap colors and two sizes, stovepipe trap and combinations of both. This location was a 20 ha clearcut of about 25 year old loblolly pine near Monticello, Florida. Trapping was conducted from 10 May-15 July 1996. Tedders traps, (2 replicates each of black, white, yellow, a half-size (60 cm) yellow (cut from bottom half of the Tedders trap), a regular stovepipe trap, and the stovepipe bottom—wading pool—containing a black or white Tedders trap. All traps were baited and checked as described above. The stovepipe traps modified with Tedders traps caught weevils in the water and in the typical Tedders trap top.

Experiment F. Black Tedders trap, stovepipe and cone trap. This location was an approximately 20-year-old loblolly pine stand of about 5 ha that had been thinned and harvested in corridors. Remaining trees were in groups of 5 rows of trees separated by bare ground and slash residue where the 5 rows of trees had been removed. The site was harvested in March-April. Trapping was conducted from 13 May-3 November 1997. Two replicates of a 3 × 3 Latin Square design were used with traps placed 50 m apart. The stovepipe trap, the black Tedders trap and the black cone trap were tested. All traps were baited as described above.

Results

Experiment A. Seventy-six *H. pales* (65/11, baited/unbaited) and 70 *P. picivorus* (65/5) were captured at this location (Table 1). There was no significant difference between trap colors for either weevil species (*H. pales*, $F_{(3,470)} = 0.36$, $P = 0.78$; *P. picivorus*, $F_{(3,470)} = 1.18$, $P = 0.32$). Weevil abundance patterns indicated a peak in July similar to that reported by Fatzinger (1985) (Fig. 1).

Experiment B. Fifty one *H. pales* (46/5, baited/unbaited) and 5 *P. picivorus* (baited) were captured in 12 traps during the 55 days of the experiment (Table 1). The black traps caught 25 *H. pales*, twice as many as any other color, but too low for statistical significance ($F_{(3,255)} = 1.2$, $P = 0.31$).

Experiment C. Sixty-nine *H. pales* (66/3, baited/unbaited) and 184 *P. picivorus* (172/12, baited/unbaited) were captured (Table 1) during the 5 month trapping period. Significant differences in trap captures were detected for both species: *H. pales*, $F_{(5,248)} = 3.05$, $P = 0.01$; *P. picivorus*, $F_{(5,248)} = 6.67$, $P = 0.0001$. For *H. pales,* the one cone trap captured 13 weevils (0.13 ± 0.05, mean weevils/trap/day ± 1 standard error), greater

TABLE 1. THE TOTAL NUMBER OF *HYLOBIUS PALES* (H. P.) AND *PACHYLOBIUS PICIVORUS* (P. P.) WEEVILS CAUGHT IN EACH STUDY SITE IN EACH TRAP TYPE. MEAN NUMBERS PER TRAP PER DAY ARE STATED IN THE TEXT. CAPTURES IN SITES A AND B WERE NOT SIGNIFICANTLY DIFFERENT AMONG TREATMENTS.

	Exp. A		Exp. B		Exp. C		Exp. D		Exp. E		Exp. F	
	H. P.	P. P.	H. P.	P. P.	H. P.	P. P.	H. P.	P. P.	H. P.	P. P.	H. P.	P. P.
Treatment	Trap Totals[1]		Trap Totals[1]		Trap Totals[2]		Trap Totals		Trap Totals		Trap Totals	
Tedders Brown	17	11	3	0	18B[3]	31B	38A	4				
Tedders Black	36	25	25	3	14B	41B	22AB	2	9AB	25	112A	177A
Tedders Yellow	17	27	11	0	7B	29B	6B	0	4ABC	13		
Tedders White	6	7	12	2	4B	1C	16B	2	0C	12		
Stovepipe					10B	52A	9B	3	11A	31	19C	31C
Cone					13A	18B					78B	98B
Yellow Half-size									4ABC	13		
Stovepipe + White Tedders									1BC	27		
Stovepipe + Black Tedders									9ABC	28		

[1]Totals for baited and unbaited since no treatment differences are present.
[2]Totals for baited traps only.
[3]Number totals in columns not followed by the same letter have means which are significantly different.

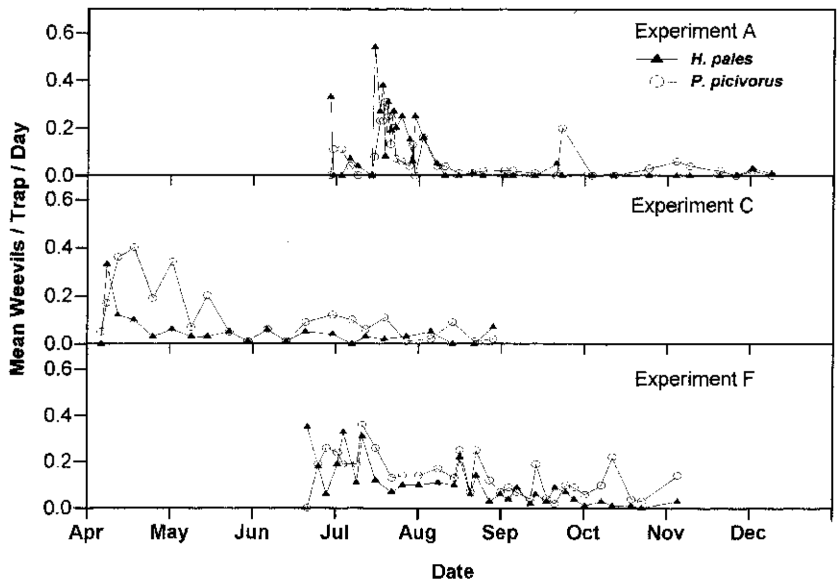

Fig. 1. Mean number of *Hylobius pales* and *Pachylobius picivorus* weevils per trap per day from experiments A, C, and F. Means were computed from total catch from all traps in each of these experiments.

than twice as many per trap per day as the other traps (brown - 0.06 ± 0.02, black - 0.05 ± 0.03, stovepipe - 0.05 ± 0.02, yellow - 0.03 ± 0.01, white - 0.01 ± 0.01) which had two replications. For *P. picivorus,* the pool trap captured significantly more weevils per trap per day (0.27 ± 0.07) (total = 52) and the white (0.01 ± 0.01) (total = 1) Tedders trap captured significantly less than the other trap types, P = 0.05 (Table 1). Seasonal abundance of weevils differed (Fig. 1) from the patterns observed by Fatzinger (1985). All of the traps captured numerous other wood-inhabiting insects commonly associated with conifers or slash residue as observed by Fatzinger (1985) as well as miscellaneous other species. One or more species of Cerambycidae, Buprestidae, Cleridae, Trogositidae, Siricidae, Mordellidae, Lycidae, Scarabaeidae, Elateridae, Tenebrionidae and Silphidae were commonly captured in the traps, often in large numbers.

Experiment D. Ninety-one *H. pales* and 11 *P. picivorus* were captured during the 89-day fall trapping period. The low numbers of *P. picivorus* did not respond significantly to trap color or type ($F_{(4, 266)}$ = 1.25, P = 0.29). *H. pales* did respond significantly ($F_{(4, 266)}$ = 4.18, P = 0.0027) to trap type with the highest response to the brown ((total = 38) 0.64 ± 0.13) and black ((total = 22) 0.39 ± 0.13) Tedders traps (Table 1).

Experiment E. Thirty eight *H. pales* and 149 *P. picivorus* were captured by traps from 10 May-15 July 1996. No significant differences were observed in the response of *P. picivorus* to the traps ($F_{(6, 231)}$ = 1.59, P = 0.15). However, the stovepipe and modified stovepipe traps, along with the black Tedders trap, captured more than twice as many as the yellow and white Tedders traps (Table 1). The modified stovepipe traps, which were wading pools containing soapy water with Tedders traps in place of the stovepipe, enabled weevils to be captured in the bottom water and in the Tedders' top as weevils landed on the trap and walked upwards. *P. picivorus* were captured in equal numbers in the top and bottom of the traps: the black traps captured 16 in the top and 12 in the water while the white traps captured 12 in the top and 15 in the water. This result indicated that some weevils land and walk on the "bounce column" when it is a Tedders trap and as reported by Fatzinger (1985). Capture of *H. pales* was low in this location, but significant differences in trap response were evident ($F_{(6, 231)}$ = 2.91, P = 0.009). White traps captured the lowest number (Table 1).

Experiment F. A total of 730 weevils was captured in this site in the 12 traps from May-November 1997. Technical difficulties precluded the accurate species identification of the first 215 captured weevils. Therefore, the data from the 515 weevils (209 *H. pales* and 306 *P. picivorus*) correctly identified to species were analyzed and reported. Significant differences in trap catch were detected for *H. pales* ($F_{(2, 566)}$ = 15.89, P = 0.0001) and for *P. picivorus* ($F_{(2, 566)}$ = 18.33, P = 0.0001). For both species, *H. pales* (total = 112) (0.15 ± 0.02/trap/day), *P. picivorus* (total = 177) (0.23 ± 0.03/trap/day), the Tedders trap caught significantly higher numbers than the cone trap (*H. pales* (total = 78) 0.12 ± 0.02 /trap/day, *P. picivorus* (total = 98) 0.13 ± 0.02/trap/day), which was significantly higher than the stovepipe trap (*H. pales* (total = 19) 0.03 ± 0.01/trap/day, *P. picivorus* (total = 31) 0.05 ± 0.05/trap/day) (Table 1). Trap catch as an indication of seasonal abundance of both weevil species was similar to the variable patterns observed by Fatzinger (1985) (Fig. 1). Unlike the findings of Fettig and Salom (1998) all three traps indicated similar seasonal abundance patterns (data not shown).

Discussion

The PVC pitfall trap (Tilles 1985, Rieske and Raffa 1991, Fettig and Salom 1998, Fettig et al. 1998) was evaluated in a preliminary test and was determined to be very inefficient in Florida's sandy soils. Even light rain events splashed sand onto the trap closing all the entrance holes. Armadillos often disturbed the traps by digging around them. Therefore, PVC traps were judged unacceptable for use in Florida's sandy soil and rain conditions and were not tested further.

Tedders traps were tested from 1993-1997 during most seasons of the year and in a variety of site types to provide weevils for study under a range of conditions and population levels. Using trap response to determine the effects of harvest practices on weevil populations was not an objective of this study. Populations of the two weevil species detected and presumably present in the test locations varied from low to high. Fatzinger (1985) using higher numbers of the stovepipe traps during 1980-1981 in Baker and Union County, Florida, captured much higher numbers of weevils (7,393 *H. pales* and 2490 *P. picivorus*), but also reported marked differences in numbers of both species of weevils captured in 1980 and 1981. Populations of weevils are likely affected by site characteristics such as the density of stumps available for colonization, time of year of harvest as it affects stump suitability, and weather following harvest which would affect the ability of weevils to colonize available food material.

In comparison to the stovepipe trap, the Tedders trap can be moved more easily, but it does require time and effort. Fettig and Salom (1998) indicated that position of traps had no significant impact on trap catch of *H. pales* in PVC traps. In these tests we moved the baits instead of the traps to eliminate any potential positional effects. However, in hindsight this appears unnecessary, but did indicate positive weevil response to unbaited traps.

We used a 1:1 ratio of ethanol:turpentine after Fatzinger (1985) and Phillips et al. (1988), because Fatzinger (1985) was the standard trap for comparison. We did not determine the components or ratio of the components of the turpentine because Siegfried (1987) reported that turpentine was more attractive to these weevils than the individual constituents. All traps were baited with the same ethanol:turpentine attractant and dispensers so that the volatiles released from all traps should have been equivalent. Evaluating attractant ratios and the potential for differential response by *P. picivorus* (Rieske and Raffa 1991) was not an objective of this study, but merits testing with the Tedders trap.

While odor cues serve as the primary attraction, it is clear that visual cues are also important in weevil behavior (see below) and deserve more research. Unlike in previous studies, both weevil species (*H. pales* 19, *P. picivorus* 17) were captured in unbaited traps of every color (total all tests: brown 15, black 6, yellow 11, white 4) in every test, as well as in open fields away from pine hosts (in other experiments). We observed a significantly higher response to darker colors in most tests, however, the yellow and white traps also caught both weevil species. Fatzinger (1985) reported that a black stovepipe captured statistically significant higher numbers of weevils than a white stovepipe (8.3 vs 7.2/trap/3 days), although the numbers were very close. Hunt and Raffa (1991) reported capturing significantly higher numbers of weevils in white as opposed to black or green PVC pitfall traps. Weevils are clearly responsive to visual cues and perhaps traps of any color present dark silhouettes under certain light conditions that mimic tree trunks (Tedders et al. 1996). Fettig and Salom (1998) reported aggregation of weevils at the base of tree stumps.

Fatzinger (1985) used the stovepipe in the trap as a "bounce column", implying that weevils fly into the stovepipe and bounce into the water trap below. However, weevils land and walk on the vertically projecting parts of traps (Fatzinger 1985). We occasionally observed weevils on the traps, and caught equal numbers of weevils in the Tedders and the water when the Tedders trap was substituted for the stovepipe in the stovepipe trap (Exp. F.). This observation, combined with the trap catch in unbaited Tedders traps, further indicates the importance of visual cues in weevil behavior. This behavior likely also explains the difference in trap captures between the cone and the Tedders trap (Exp. F, Table 1). While the cone does provide a visible surface for weevils to land on, the round flat surface allows walking in any direction and the opportunity to fly away. With the Tedders trap, the perpendicular orientation of the four vanes and the 62° angle of the planar edges are such that, once insects land on the trap, they are arrested and have a high probability of walking upwards. This phenomenon has been observed with other weevils and phytophagous stink bugs (Mizell and Tedders 1996).

Weevils that are attracted by odors to the vicinity of a trap without landing on the trap would be excluded from the stovepipe trap, but not the Tedders, PVC pitfall, pit or the cone traps. The PVC pitfall traps with 46 cm of PVC above ground used by Hunt and Raffa (1991) would also allow weevils that oriented to trap odor and then visually to silhouettes to land, walk upwards and fly away without entering the trap. This perhaps explains why these traps did not collect root weevils without attractive baits. Rieske and Raffa (1991) modified the PVC trap such that only 6 cm were above ground to simulate a stump image which probably directed the weevils more towards the capturing area of the trap.

In this study we did not evaluate the effect of Tedders trap height except in Exp. E. with the yellow color. The half-size 61 cm (2') trap and the full size 122 cm (4') traps each caught the same number of both species of weevils (Table 1). This warrants more research because smaller traps would cost less and weevils may use visual cues to land on traps. Moreover, this suggests that the quality (effect on weevil behavior and the trap's ability to capture these landing/walking weevils) is also important in determining trap efficiency and in accurately comparing trap color effects. However, the ability to detect the results from this behavior by trapping will depend on trap design. PVC pitfall or pit traps would not capture the weevils landing on the above ground portion of the trap that could possibly walk or fly away and not enter the trap.

The Tedders trap captured many other species of tree-colonizing insects and their associates. Fatzinger (1985) used the stovepipe trap to collect black turpentine beetles, *Dendroctonus terebrans* (Olivier) and *Ips* spp. The Tedders trap did not collect these species in these tests. Fatzinger (1985) also caught *Monochamus titillator* (F.) and *M. carolinensis* (Olivier), Cerambycidae, in large numbers. The Tedders trap also caught large numbers of these species along with several species of Pentatomidae, Reduviidae, Buprestidae, Cleridae, Elateridae, Scarabaeidae, Chrysomelidae, Nitidulidae, Mordellidae, Trogositidae, Siricidae, Tenebrionidae, Lycidae and Silphidae. In addition, we have caught over 75 other species of Curculionidae, including many important agricultural pests, in the Tedders trap in a variety of habitats (R. Mizell, W. Tedders and C. O'Brien 1993-1998, unpublished data). Use of the Tedders trap as a detection and monitoring tool for these species should be further investigated.

Tedders traps and the experiments in these tests are the first trapping methods that provide an indication of root weevil behavior in response to color and trap surface and a means to fully exploit weevil flight and walking behavior together. Unbaited Tedders traps often trap weevils in low numbers in areas without host plants. Root weevils respond to host odors as simulated by ethanol:turpentine as primary attractants. Comparing the trap qualities in the results from Experiment F indicate that these weevils secondarily respond to visual cues provided by a trap. However, they may land on the trap and walk, fall down, fly away or perhaps they may land short of the trap and walk towards the odor source. The stovepipe trap would capture weevils that land and/or hit the trap and fall; it would not capture weevils that land, walk up and fly away, nor would it capture weevils that land away from the trap and walk to the odor source. The cone trap can capture weevils behaving in any manner, but apparently loses efficiency (relative to the Tedders trap) by not arresting weevils that land and then directing them exclusively vertically into the capturing top. The Tedders trap exploits all of these weevil behaviors and indicates that a black or dark colored trap may provide the best trap efficiency for *H. pales* and *P. picivorus*.

In comparison to the standard stovepipe trap, the Tedders trap is cheaper to make and easier to use. While the species collected in both traps overlap, the two traps do not collect all the same species. Further research with the Tedders trap is necessary to determine weevil response to ethanol:turpentine ratios and to determine if any relationship exists between trap capture and seedling damage. The differential response to trap color by weevils in Wisconsin (Rieske and Raffa 1991) and weevils in the Southeast (Fatzinger 1985, this study) remains to be fully explained.

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