Effects of Trap Color and Bait Type on Collection of Coleoptera in Pyramid Traps in Commercial Nurseries[1]

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Abstract Pyramid-shaped traps were evaluated in Georgia for capturing potentially harmful coleopterans in ornamental plant nurseries. Beetle response to two colors and four bait types was compared. Four species of Buprestidae, 22 species of Cerambycidae, and three species of Curculionidae were captured in sufficient numbers for analysis during the 2-yr study. Coccinellidae, Carabidae, Trogositidae, Cleridae, and Chrysomelidae were also captured with frequency. Trap color did not have a significant effect on capture of pine-infesting weevils, although these weevil species were as much as five times more abundant in traps containing turpentine alone or a 1:1 mixture of turpentine: ethanol than ethanol alone or unbaited traps. *Odontopus calceatus* (Say), however, a weevil that attacks the foliage of tuliptree, sassafras and magnolia, was captured five times more frequently in yellow than in gray traps, although no influence of bait was observed for this species. Cerambycidae in general were not affected by trap color or bait. However, the banded hickory borer, *Knulliana cincta* (Drury), a cerambycid, was captured more frequently in gray traps as were buprestids in the genus *Chrysobothris. Buprestis lineata* was more commonly captured in traps baited with turpentine or ethanol/turpentine mixture. Chrysomelids (*Altica* sp.) were not affected by trap color or bait type. Timing of occurrence of adult beetles of 23 species of beetles are presented. The beneficial Coleoptera captured in the traps were either not affected by color or bait type (Carabidae) or were primarily attracted by yellow traps (Coccinellidae). Traps of the type used in this study can be easily constructed or may be purchased commercially and offer the nursery grower a practical monitoring tool for a variety of Coleoptera that attack woody plants.

Pyramid-shaped traps have been evaluated for capturing the root weevils, *Hylobius pales* (Herbst) and *Pachylobius picivorous* (Germar); the pecan weevil, *Curculio caryae* (Horn); and stink bug (Heteroptera) complexes in pecan orchards (Mizell and Tedders 1996, 1999, Tedders and Wood 1994, Tedders et al. 1996). When traps were baited with a 1:1 ratio of ethanol and turpentine attractants, black or brown Tedders traps were more effective than yellow or white traps in capturing *H. pales* and *P. picivorous* (Mizell and Tedders 1999). Pecan weevils were preferentially attracted to brown rather than white pyramid traps. Tall traps (121.8 cm) collected more pecan weevils than short traps (91.4 cm) containing the same surface area (Tedders and

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Wood 1994). In each case, the pyramid traps were as effective and much easier to use than other trap types and collection methods.

In each previous study, many arthropods were collected in addition to the target insects of interest. Knowledge of timing of emergence and flight activity of insect borers provides a powerful management tool for nursery growers. This study was undertaken to determine the potential usefulness of the Tedders trap in early detection of pest species of importance in ornamental plant nursery production in Georgia. We investigated the effect of trap color and bait combination on the attractiveness of traps to buprestid and cerambycid borers. Here we report the results of monitoring at two cooperating nurseries in central Georgia for 2 yrs.

Materials and Methods

Inexpensive traps were constructed as described in Tedders and Wood (1994) from triangular pieces of masonite, each measuring 55 cm wide at the base and 122 cm high. One triangular piece of each trap was partially bisected with a 1.0 cm wide vertical saw cut from the apex to one-half way to the base. The second piece was partially cut from the center of the base to one-half way to the apex. The two triangular pieces were then put together to form a free standing pyramid trap base. A screen funnel made from a modified boll weevil trap top was placed upside down on top of each pyramid base and served as the collection container.

Half of the pyramid bases were painted canary yellow; and the other half were painted gray using a 1:9 ratio of white:black paint. A container for attractant solution was attached to each trap with a metal ring. Fluid was placed in 500 mL glass jars that had a cotton wick inserted through a hole in the metal jar lid. The experimental design was a factorial comprised of four baits and two trap colors. Bait solutions were either 70% ethanol, turpentine, or a 1:1 mixture of each and were compared with unbaited traps. Twenty-four traps were placed at each of two nurseries in central Georgia in a randomized complete block design with three replications of each color and bait combination. Traps were placed within the rows at each nursery with a minimum of 6 m between adjacent traps. Each trap was anchored with metal stakes. New traps were constructed for use in the second year of the study.

Trap captures were checked weekly from 22 Feb to 31 Aug 1994 and from 24 Feb to 24 Aug 1995. Contents were transferred to 132 mL plastic containers with 70% ethanol as a preservative and returned to the laboratory for identification. All taxa were identified in 1994. During 1995, only buprestids, cerambicids and pine-infesting weevils were collected and identified.

The effect of trap color and bait type was examined by subjecting data to analysis of variance using the general linear models (GLM) procedure in SAS (SAS Institute 1985). Means were separated using the least significant difference (LSD) procedure following a significant ANOVA.

Results

Cerambycids identified from samples collected in Meriwether and Morgan counties, GA during 1994 and 1995 included *Aegomorphus modestus* (Gyllenhal), *Ancylocera bicolor* (Olivier), *Anelaphus parallelus* (Newman), *Asemum striatum* (L.), *Astyleiopus variegatus* (Haldeman), *Ataxia crypta* (Say), *Clytus ruricola* (Olivier), *Eburid quadrigeminata* (Say), *Ecyrus dasycerus* (Say), *Knulliana cincta* (Drury), *Leptostylus* *albescens* (Haldeman), *Monochamus carolinensis* (Olivier), *Neoclytus acuminata* (F.), *Neoclytus caprea* (Say), *Phymatodes amoenus* (Say), *Rhagium inquisitor* (L.), *Stenosphenus notatus* Olivier, *Typocerus zebra* (Olivier), *Xylotrechus colonus* (F.) and two unidentified species. The buprestids that were captured included *Buprestis lineata* (F.), *Buprestis rufipes* (Olivier), *Chrysobothris dentipes* Germar and *Chrysobothris* sp. prob *femorata* (Olivier). Curculionids captured in the greatest numbers included *Hylobius pales* (Herbst), *Pachylobius picivorous* (Germar) and *Odontopus calceatus* (Say). Additional coleopteran families that were well represented in trap catches in Meriweather County included Carabidae, Coccinellidae, Cleridae, Trogositidae and Chrysomelidae.

Cerambycids were captured in traps from March through August during 1994 and March through July during 1995 in Meriwether Co. (Table 1). Buprestids were collected from April through August 1994 and April through July 1995 in Meriwether Co. Beetles collected earliest in the season were *Rhagium inquisitor, Phymatodes amoenus*, and *Anelaphus parallelus* all collected during the first week of March 1995. The majority of beetle species were captured during April, May and June. The most frequently captured beetles at the Meriwether Co. site were *Knulliana cincta* (41), *Buprestis lineata* (32), *Chrysobothris* spp. (23) and *Anelaphus parallelus* (19). Of the 18 species of cerambycids and buprestids that were captured in Meriwether Co., only five were collected during both years of the study: *Knulliana cincta, Asemum striatum, Anelaphus parallelus, Ancylocera bicolor*, and *Buprestis lineata*.

There were no significant interactions between trap color and bait type for any taxon on any date ($P > 0.05$). Trap color significantly influenced the number of *Chrysobothris* spp. collected during 1994 ($F = 16.09$, df = 9,619, $P = 0.0001$, Table 2). The buprestid *B. lineata* was equally common in yellow and gray traps ($F = 2.68$, df = 9,619, $P = 0.10$), but was more often collected in traps baited with turpentine or turpentine/ethanol mix during 1994 ($F = 2.59$, df = 9,619, $P = 0.05$) only (Table 2). Although total Cerambycidae were unaffected by trap color, the species *K. cincta* was more than four times as common in gray traps as yellow traps ($F = 4.37$, df = 9,619, $P = 0.03$). This was the only cerambycid influenced by either trap color or bait type during both years of the study (Tables 2 and 3). Coccinellidae were more often collected in yellow traps ($F = 28.25$, df = 9,619, $P = 0.0001$), but were not influenced by bait type. Carabids were unaffected by either trap color or bait type (Table 1). The pine root weevils, *H. pales* and *P. picivorous*, were equally abundant in yellow and gray traps, but were three to ten times more common in traps baited with turpentine or turpentine/ethanol combination than no bait or ethanol alone (during 1994 $F = 9.72$, df = 9,619, $P = 0.0001$ and during 1995 $F = 11.15$, df = 9,619, $P = 0.0001$, Tables 2 and 3). Poplar weevils, *O. calceatus*, were approximately five times more commonly collected in yellow traps ($F = 5.88$, df = 9,619, $P = 0.01$) (Table 2), but were not influenced by bait type.

Discussion

The only wood boring beetles demonstrating a clear color preference in this study were the buprestids in the genus *Chrysobothris*, and the cerambycid banded hickory borer *K. cincta.* Both groups were more commonly collected in gray traps than in canary yellow traps. Leaf feeding poplar weevils were most numerous in yellow traps, as were the predaceous coccinellids. Although previous work (Mizell and Tedders 1999) has shown that black or brown Tedders traps were more effective than white or

Table 1. Seasonal occurrence of Buprestidae and Cerambycidae collected in Tedder Traps in a Meriweather County, Georgia tree nursery from March through August 1994 (X) and 1995 (0)

		WEEKS																									
		March					April					May				June					July			August			
Species	N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Rhagium inquisitor	14	0		0	0	0	0							0						0							
Neoclytus caprea	8		X																								
Phymatodes amoenus	2	0																									
Knulliana cincta	30				X	X	X		X	X		X	X				X										
	11				0				0		0		0														
Asemum striatum	10				X		X																				
	11					0																					
Anelaphus parallelus	9					X	X		X	X	X																
	10	0			0	0					0	0	0														
Stenosphenus notatus	1							X																			
Clytus ruricolus	5								X					X													
Chrysobothris spp.	23								X	X	X	X	X	X	X	X	X		X								
Ancylocera bicolor	11									X	X	X	X	X		X	X										
	4												0	0													
Buprestis lineata	17											X		X		X	X	X	X	X		X			X		
	15									0			0						0		0	0	0				
Leptostylus albescens	3												X									X					
Ataxla crypta	1															X											
	4												0	0													
Buprestis rufipes	1																	X									
Xylotrechus colonus	2																	X	X								
	6										0												0				
Typocerus zebra	1																	X									

Table 2. Coleopterans captured pyramid traps in an ornamental plant nursery during 1995. Trap color and bait type were compared

	Mean ± S.E. Beetles collected per trap					
	Trap color			Bait type		
Taxon	Yellow	Gray	No bait	ETOH/TURP	TURP	ETOH
Buprestidae						
B lineata	0.58 ± 0.4a*	0.75 ± 0.4a	0.33 ± 0.3a	0.33 ± 0.2a	1.50 ± 0.9a	0.50 ± 0.3a
Cerambycidae						
Total	2.75 ± 1.0a	2.08 ± 0.5a	0 ± 0a	3.0 ± 0.6a	2.33 ± 1.2a	4.33 ± 1.5a
Curculionidae						
Hylobius/Pachylobius	12.0 ± 4.2a	16.67 ± 5.0a	2.67 ± 1.66	31.50 ± 5.3a	19.83 ± 6.7a	3.33 ± 1.4b

* Means followed by the same letter within a row and trap color or bait type are not significantly different $P \geq 0.05$.

Table 3. Coleopterans captured pyramid traps in an ornamental plant nursery during 1995. Trap color and bait type were compared

	Mean ± S.E. Beetles collected per trap					
	Trap color			Bait type		
Taxon	Yellow	Gray	No bait	ETOH TURP	TURP	ETOH
Buprestidae						
B. lineata	0.33 ± 0.1a*	1.09 ± 0.1a	0.16 ± 0.1b	1.51 ± 0.2a	1.16 ± 0.1ab	0 ± 0b
Cerambycidae Chrysobothris spp.	0.08 ± 0.4b	1.82 ± 0.4a	0.50 ± 0.1a	0.83 ± 0.1a	1.17 ± 0.1a	1.85 ± 0.1a
Total	3.17 ± 0.8a	3.83 ± 0.9a	2.67 ± 1.4a	3.33 ± 0.9a	3.17 ± 0.9a	4.83 ± 1.5a
K. cincta	0.42 ± 0.1b	1.92 ± 0.1a	2.50 ± 0.2a	1.17 ± 0.1a	0 ± 0a	0.99 ± 0.1a
Curculionidae *O. calceatus*	11.08 ± 0.7a	2.16 ± 0.2b	12.3 ± 1.1a	1.48 ± 0.1a	6.5 ± 0.7a	6.16 ± 0.5a
Hylobius/Pachylobius	22.57 ± 0.7a	23.17 ± 0.8a	8.84 ± 0.6b	40.82 ± 1.4a	30.94 ± 1.1a	10.84 ± 0.5b
Coccinellidae	9.65 ± 0.3a	1.2 ± 0.1b	5.48 ± 0.3a	1.48 ± 0.1a	1.16 ± 0.7a	0 ± 0a
Carabidae	0.67 ± 0.2a	1.08 ± 0.7a	0.66 ± 0.1a	0.49 ± 0.1a	1.50 ± 0.1a	4.16 ± 0.3a

* Means followed by the same letter within a row and trap color or bait type are not significantly different $P \geq 0.05$.

yellow traps in collecting pine root weevils, in our study, both yellow and gray traps were similar in their capture of weevils.

The cerambycid and buprestid beetles captured in our study are known to feed on both coniferous plants and deciduous hardwoods (Franklin and Lund 1956, Linsdley 1961-1964, Linsdley and Chemsak 1972-1984). The buprestids captured included *C. dentipes* (*Pinus*), *B. rufipes* (*Ulmus, Nyssa*, dead *Fagas, Quercus, Acer, Castanea, Liriodendron*), *B. lineata* (*uPinus*) *C.* prob. *femorata* (*Acer, Quercus, Carya, Platanus, Liriodendron, Salix, Rosa* and *Cotoneaster*). Host records for the cerambycids collected include: *C. ruricola*: (*Acer, Alnus, Carya, Betula, Fagus, Ostrya, Quercus, Sorbus*, and *Tilia*), *T. zebra* and *L. albescens* (*Pinus*, dead pine stumps), *A. modestus* (most hardwoods not *Pinus*), *A. variegatus* (most hardwoods but not *Quercus* or *Pinus*), *M. carolinensis* (*Pinus*), *A. bicolor* (*Carya, Quercus, Acacia, Baccharis*), *A. striatum* (*Abies, Larix, Picea, Pinus, Pseudotsuga*), *A. parallelus* (*Carya, Juglans, Malus, Quercus, Prunus, Vitis*, etc.), *A. crypta* (*Acer, Acacia, Castanea, Celtis, Ficus, Prunus, Pyrus, Quercus, Salix*), *R. inquisitor* (*Abies, Larix, Picea, Pinus, Pseudotsuga, Tsuga*). *P. amoenus* (*Vitis*), and *E. dasycerus* (*Acer, Ampelopsis, Carya, Castanea, Celtis, Gleditsia, Magnolia, Paulownia, Prunus, Quercus, Robinia, Tilia, Morus, Ulmus*).

Although many of the captured buprestids and cerambycids have coniferous hosts, there was no clear benefit to adding an attractant bait to the trap for the beetles in these families, although *B. lineata* demonstrated a weak preference for baited traps during one of two years. Neither did there appear to be any repellent effect of the baited traps for these taxa. The pine weevils were much more effectively sampled with turpentine-baited traps, suggesting that for locations where wood borers and root weevils are both problematic, gray traps baited with turpentine would be the most effective at capturing a wide range of potential pests.

During certain years, the yellow poplar weevil, *O. calceatus*, can severely damage tuliptree and magnolia. Adults spend the winter in leaf litter beneath trees and feed on buds and new leaves in the spring. Eggs deposited in the midrib on the undersides of leaves hatch and the larvae mine the leaves and cause large, blotch-type mines. Yellow pyramid traps were most effective in capturing this early-season weevil, but, unfortunately also readily captured coccinellids. Traps of the type used in this study can be easily constructed or may be purchased commercially and offer the nursery grower a practical monitoring tool for a wide variety of Coleoptera that attack woody plants.

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