Effect of Trap Size, Placement, and Age on Captures of Blueberry Maggot Flies (Diptera: Tephritidae)

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ABSTRACT Ammonium acetate and protein hydrolysate baited and unbaited green spheres (3.6, 9.0, and 15.6 cm diameter) were evaluated for effectiveness in capturing blueberry maggot flies, *Rhagoletis mendax* Curran. Early in the season, baited spheres (9.0 cm diameter) captured significantly more *R. mendax* flies than spheres of 3.6 and 15.6 cm diameter. As the season progressed, the differences in trap captures became less pronounced among the 3.6-, 9.0-, and 15.6-cm-diameter spheres. In other experiments, the effects of trap positions and age on captures of blueberry maggot flies were assessed. Traps were positioned 15 cm above the bush canopy, 15 cm inside the canopy (from top of the bush), and 45 cm from the ground. Traps placed within the canopy captured 2.5 and 1.5 times as many flies compared with traps placed above the canopy and 45 cm from the ground, respectively. When sticky yellow Pherocon AM boards and green sphere traps were allowed to age in field cages, freshly baited (0 d) yellow sticky boards captured significantly more blueberry maggot flies than boards aged for 11, 28, and 40 d, respectively. No significant differences were observed among boards aged for 11, 28, and 40 d. However, when baited 9-cm sticky spheres were aged in field cages, there were no significant differences between freshly baited spheres and spheres aged for 11 and 28 d, respectively. Spheres aged for 40 d differed significantly from freshly baited ones. The study demonstrated that the baited 9-cm-diameter sphere was more effective in capturing blueberry maggot flies than spheres of 3.6 and 15.6 cm diameter. When this trap is deployed in the center of the bush canopy ≈15 cm from the top of the bush, it is attractive and accessible to *R. mendax* flies. The data also indicated that a baited 9-cm sphere has a longer effective life span than Pherocon AM boards when deployed under the same field conditions.

KEY WORDS highbush blueberries, blueberry maggot, sphere size, trap position

THE BLUEBERRY MAGGOT fly, *Rhagoletis mendax* Curran, is the key pest infesting commercially grown blueberries *Vaccinium* L. spp. in eastern United States (Liburd et al. 1999). Adult eclosion is synchronized with host fruit maturation. Flies detect fruits on the basis of physical characteristics, such as fruit shape, color, and size (Prokopy and Bush 1973, Diehl and Prokopy 1986). Gravid females oviposit into susceptible fruits (Liburd et al. 1998a) and lay down deterring pheromones, which discourage other females from ovipositing into infested berries (Prokopy et al. 1976).

To date, the most effective tactics developed for detecting the presence of the adults include baited Pherocon AM yellow sticky boards (Prokopy and Coli 1978) and green and red spheres (Liburd et al. 1998b). Yellow boards have been used most extensively for monitoring, but recent evidence suggests that spheres may be more useful later in the season when flies are mature and berries are in a susceptible state (Liburd et al. 1998a, Liburd and Stelinski 1999).

In an experiment to determine the most effective trap for monitoring blueberry maggot flies, Prokopy and Coli (1978) compared sticky 3.5- and 7.5-cm-diameter red spheres and found that significantly more *R. mendax* flies were attracted to spheres of 7.5 cm diameter. They accounted for this by suggesting that the 7.5-cm-diameter sphere exemplified a supernormal fruit-type stimulus for the blueberry maggot fly. Earlier, Prokopy (1977) reported that this size was significantly more attractive to the apple maggot fly, *R. pomonella* (Walsh), than smaller spheres of 1.5 or 3.4 cm diameter. However, early in the season large spheres measuring 23 cm in diameter caught as many *R. pomonella* flies as spheres of 7.5 cm in diameter.

Over the last two decades, there have been several studies on optimal positioning of spheres for maximum capture of *R. pomonella* flies (Reissig 1975, Drummond et al. 1984). Reissig (1975) found that trap height above the ground and trap distance from the outside edge of the canopy significantly affected captures of *R. pomonella* flies, whereas compass direction within the canopy did not impact total trap catch. In another study, Drummond et al. (1984) found that traps positioned within the vicinity of apple fruits at a distance of 0.25–0.5 m caught significantly more apple maggot flies than other trap positions.

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In lowbush *V. angustifolium* Aiton blueberry plantings, Neilson et al. (1984) found that 8.5-cm-diameter dark red sticky spheres placed within the canopy captured significantly more *R. mendax* flies than Pherocon AM boards deployed vertically or at a 45° angle. However, when spheres were placed above the canopy there were no significant differences in trap captures between Pherocon AM boards and the 8.5-cm-diameter red spheres.

Chemical cues also affect total trap captures among several species of tephritids. Gow (1954) evaluated various baits containing ammonia and protein hydrolysates and found that when protein hydrolysates were protected from bacterial decomposition, their attractiveness to the oriental fruit fly, *Dacus dorsalis* Hendel, increased. Later, Bateman and Morton (1981) studied the role of proteinaceous baits including ammonia on the fruit fly *Dacus tryoni* (Froggatt) and concluded that olfactory stimulation was directly responsible for the attraction of these flies to the baits. More recently, Jones (1988) placed ammonium baited Pherocon AM traps in a weather shelter for different periods (before field deployment) and caught significantly fewer *R. pomonella* flies on traps aged for 9 d compared with freshly baited traps. He identified the loss of ammonia as a principal factor responsible for the significant drop in fly captures. In a more contemporary study, Liburd et al. (1998b) showed that ammonia and protein hydrolysate were more important than trap shape and color in attracting blueberry maggot flies.

In blueberries, there is zero tolerance for maggot-infested fruits. Therefore, traps need to be sensitive early in the season to detect *R. mendax* flies. The objectives of this study were to evaluate three sizes and positions of green sphere traps to determine their effects on captures of blueberry maggot flies. In addition, we evaluated aged traps versus freshly baited traps to determine longevity of lures for captures of blueberry maggot flies under field conditions.

Materials and Methods

Effect of Sphere Size on Trap Captures. Research in 1997 was designed to evaluate the effect of sphere size on captures of blueberry maggot flies. Three experiments were conducted at two sites. Research plots were located at a 2-ha highbush blueberry *V. corymbosum* planting of 'Berkley' and 'Collins' located in West Kingston, RI, and at a 3-ha planting of 'Bluecrop' located in Brownsmill, NJ.

The experimental design was a randomized complete block (blocked by variety) with four or five replicates. In all three experiments, three different sphere sizes were evaluated. These included a 3.6-cm-diameter table tennis ball (Franklin Sports, Stoughton, MA), 9.0-cm-diameter sphere trap (Great Lakes integrated pest management (IPM), Vestaburg, MI), and 15.6-cm-diameter volley ball (Reagent Sports, Hauppauge, NY). All of the spheres used in the experiments were first spray-painted with premium Rust-Oleum Green no. 7435 (Rust-Oleum, Vernon Hills, IL), then with 197A111 Shamrock green (ACE Hardware, Kensington, IL). The 3.6-, 9.0-, and 15.6-cm-diameter spheres were coated with 2, 13, and 38.5 g of Tangle-Trap (The Tanglefoot Company, Grand Rapids, MI), respectively. All baited spheres used in our experiments received 1 g of ammonium acetate (Aldrich, Milwaukee, WI) and 0.5 g protein hydrolysate (Sigma, St. Louis, MO), regardless of sphere size. Thirteen grams of Tangle-Trap with 1 g ammonium acetate and 0.5 g protein hydrolysate was used as a standard for comparison because Liburd et al. (1998b) showed this to be an effective baiting mixture for monitoring the blueberry maggot fly. The ammonium acetate and protein hydrolysate were mixed into the Tangle-Trap before application to the spheres. Unbaited spheres received only Tangle-Trap (2, 13, and 38.5 g with respect to the sphere size).

In Rhode Island, the sphere size experiment was established on 7 July and finished 15 August. Six treatments consisting of three baited (3.6, 9.0, and 15.6 cm diameter) and three unbaited (3.6, 9.0, and 15.6 cm diameter) spheres were evaluated. Traps were spaced ≈15 m apart with 20 m between blocks. In New Jersey, the experiments were established on 19 July and concluded 12 August. One of the experiments was conducted using only baited spheres and the other experiment was conducted using unbaited spheres. Three treatments (3.6, 9.0, and 15.6 cm diameter) were evaluated in both experiments. Sphere traps were spaced 25 m apart with 20 m between blocks. In all three experiments, sphere positions were rotated on a weekly basis to avoid field position effects.

Sampling. In Rhode Island and New Jersey, traps were checked two times per week and adult flies were counted and removed. In addition, flies were sexed once per week in the Rhode Island experiment.

Based on the results of our 1997 field studies, experiments in 1998 were designed to evaluate sphere placements or positions in highbush blueberry *V. corymbosum* L. plantings.

Effect of Trap Position on Captures. Experiments aimed at evaluating sphere positions were located in Chatsworth, NJ, and Fennville, MI. The traps used in these experiments were 9-cm-diameter green spheres (Great Lakes IPM, Vestaburg, MI). Each sphere was coated with 13 g of Tangle-Trap and baited with 1.0 g of ammonium acetate and 0.5 g of protein hydrolysate (Liburd et al. 1998b). In New Jersey the experiment was established on 7 July and concluded 28 July. In Michigan the experiment was established on 14 July and finished 13 August.

The experimental design was a completely randomized block with five replicates. In New Jersey, sphere traps were hung within the cultivar Bluecrop and spaced 25 m apart with 20 m between blocks. In Michigan, traps were spaced 30 m apart with 45 m between blocks in 'Jersey' blueberries. In both locations, three different trap positions were evaluated. The positions consisted of placing traps (1) 15 cm above the bush canopy, (2) 15 cm inside the canopy (from the top of the bush), and (3) 45 cm from the ground. At both sites, bushes were ≈1.5–1.8 m in height. Trap positions were rotated weekly, checked two times per week and adult flies were counted and removed.

Effect of Trap Age on Captures. Two different locations were used to evaluate the performance of traps with respect to age. Research plots were located at (1) the University of Rhode Island East Farm Experimental Station located in Kingston, RI, (2) at a commercial blueberry farm located in Douglas, MI.

In Rhode Island, unbaited Pherocon AM yellow boards obtained from Trece (Palo Alto, CA) were used for evaluation studies. Unbaited Pherocon AM yellow boards were coated with 13 g of Tangle Trap, 1 g ammonia acetate, and 0.5 g protein hydrolysate on the same day they were deployed in field cages. In Michigan, green spheres (9 cm diameter) were used for the evaluation studies. Spheres were coated with the same baiting mixture (13 g of Tangle Trap, 1 g ammonia acetate, and 0.5 g protein hydrolysate) as Pherocon AM yellow boards. Immediately after spheres were coated, they were placed into field cages (60 by 45 by 60 cm) for weathering.

The experimental design was completely randomized block (blocked by variety in Rhode Island) with five replicates. Both yellow boards (Rhode Island) and green spheres (Michigan) were hung 15 cm above the canopies of blueberry bushes. In Rhode Island, traps were spaced 10 m apart with 15 m between blocks of Bluecrop, 'Bluetta', 'Earliblue', and 'Lateblue'. In Michigan, traps were hung within the cultivar Jersey and spaced 15 m apart with 20 m between blocks.

Four treatments (based on duration of exposure in field cages) were evaluated for effectiveness in trapping blueberry maggot flies. The treatments included boards (RI) and spheres (MI) that were exposed in field cages for 0, 11, 28, and 40 d.

Sampling. Trap positions were rotated weekly to prevent postional effects. All traps were checked two times per week and adult flies were counted and removed.

Statistical Analysis. Data from all experiments were square-root transformed ($x + 0.5$). Data from experiments were subjected to analysis of variance followed by mean separation using the least significant difference test (SAS Institute 1989). The results were considered statistically significant when $P < 0.05$. The untransformed means and standard errors are presented in the tables.

Results

Effect of Sphere Size on Captures. In Rhode Island during the first trapping period (7–23 July), baited 9-cm-diameter spheres captured significantly ($F = 3.2$; df = 5, 20; $P = 0.03$) more blueberry maggot flies than any other baited or unbaited spheres evaluated in this experiment (Table 1). The 9-cm-diameter sphere captured an average of three times as many flies as the baited 3.6- and 15.6-cm spheres (Table 1). There were no significant differences among the other treatments evaluated in this experiment during this trapping period (Table 1).

Table 1. Capture of adult *R. mendax* flies on 3.6-, 9.0-, and 15.6-cm-diameter spheres West Kingston, Rhode Island (1997)

Sphere diameter, cm	Mean ± SEM no. flies per trap	
	7–23 July	28 July–15 Aug.
Baited spheres		
3.6	9.4 ± 2.3b	15.6 ± 4.9bc
9.0	28.6 ± 14.3a	26.4 ± 5.9ab
15.6	9.4 ± 3.9b	31.2 ± 7.6a
Unbaited spheres		
3.6	4.6 ± 1.9b	5.0 ± 1.4d
9.0	8.6 ± 4.7b	9.4 ± 3.9cd
15.6	6.2 ± 3.0b	5.8 ± 2.6cd

Means within columns followed by the same letter are not significantly different, (P = 0.05, LSD test). Baited spheres had 1 g ammonium acetate and 0.5 g protein hydrolysate.

During the second trapping period (28 July–15 August) there were no significant differences ($P > 0.05$) in trap captures between the baited 9.0- and the 15.6-cm-diameter spheres. Both traps caught significantly ($F = 7.2$; df = 5, 20; $P < 0.01$) more flies than unbaited spheres (Table 1). The baited 15.6-cm-diameter spheres captured significantly ($P < 0.01$) more flies than the baited 3.6-cm-diameter spheres (Table 1). There was no significant ($P > 0.05$) difference between the baited 9.0- and 3.6-cm-diameter sphere traps (Table 1). Also, there was no significant ($P >$ 0.05) difference among unbaited spheres (Table 1).

Ammonia baited spheres captured significantly ($P < 0.05$) more flies than unbaited (Fig. 1). Peak captures of *R. mendax* flies on baited spheres occurred around 28 July 1997 (Fig. 1). Captures of *R. mendax* females on baited 15.6-cm green sphere were significantly ($P < 0.05$) higher than male captures on 28 July 1997 (Fig. 1). We captured four times as many females as males (Fig. 1).

The results from New Jersey using baited spheres were very similar to those observed in Rhode Island. During the first trapping period (19–31 July), the 9-cm-diameter spheres captured significantly (F = 10.6; df = 2, 8; $P < 0.01$) more blueberry maggot flies than the 3.6- and 15.6-cm-diameter spheres (Table 2). On average, the 9-cm spheres captured 2.5 and 3 times as many flies as the 3.6- and 15.6-cm-diameter spheres, respectively (Table 2). During the second trapping period (1–12 August) there were no significant ($P >$ 0.05) differences among sphere sizes (Table 2).

For unbaited sphere traps, during the first trapping period the 9-cm-diameter sphere captured significantly ($F = 5.0$; df = 2, 8; $P = 0.03$) more blueberry maggot flies than the 3.6-cm-diameter sphere (Table 2). This trap captured three times as many flies as the 3.6-cm-diameter sphere (Table 2). There were no significant ($P > 0.05$) differences between the 9- and 15-cm-diameter sphere traps (Table 2). During the second trapping period (1–12 August), unbaited 15.6-cm-diameter spheres captured significantly ($F = 4.0$; df = 2, 6; $P = 0.05$) more blueberry maggot flies than 3.6-cm-diameter spheres (Table 2) but not significantly more than the 9-cm sphere.

Effect of Sphere Position on Captures. In New Jersey, traps hung within the bush canopy ≈15 cm from

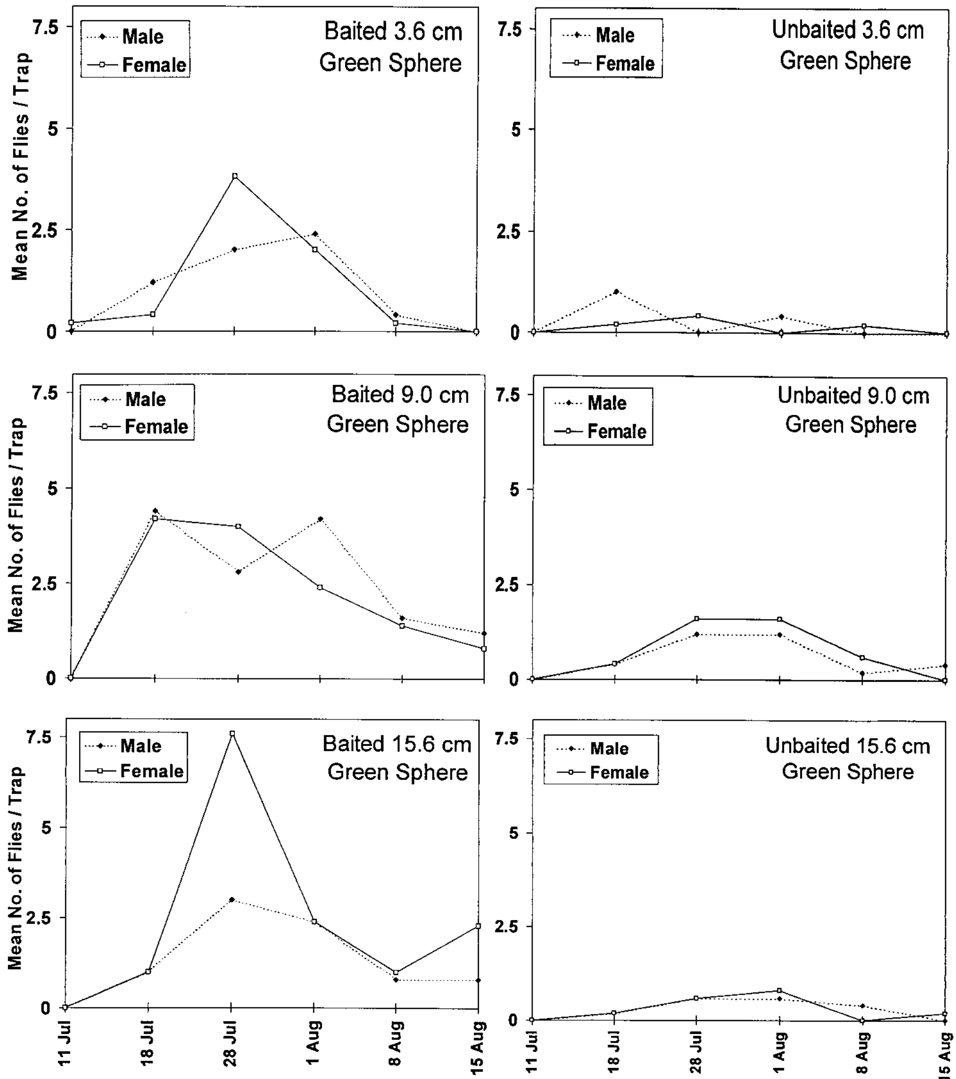

Fig. 1. Captures of *R. mendax* flies on spheres of different size, Kingston, RI (1997).

the top and 15 cm from surrounding foilage captured significantly ($F = 6.2$; df $= 2, 8$; $P = 0.02$) more *R. mendax* flies than traps placed above blueberry bush canopy (Table 3). Traps placed within the canopy captured on an average 2.5 and 1.5 times as many flies than those placed above or 45 cm above ground, respectively (Table 3). There was no significant ($P > 0.05$) difference between traps placed below and within the canopy (Table 3). Similarly, in Michigan, sphere traps placed within the canopy captured significantly ($F = 7.7$; df $= 2, 8$; $P = 0.01$) more flies than those placed either above or below the canopy (Table 3). These traps captured an average of 2.6 and 2.1 times as many flies as traps placed above and below the canopy, respectively (Table 3).

Table 2. Capture of adult *R. mendax* flies on 3.6-, 9.0-, and 15.6-cm diameter baited and unbaited spheres in Chatsworth, NJ (1997)

Sphere diameter, cm	Mean ± SEM no. flies per trap	
	19–31 July	1–12 Aug.
Baited spheres		
3.6	93.0 ± 20.1b	54.3 ± 21.3a
9.0	229.8 ± 43.3a	106.4 ± 37.8a
15.6	66.8 ± 12.7b	80.0 ± 14.3a
Unbaited spheres		
3.6	8.4 ± 1.6b	1.8 ± 0.6b
9.0	24.4 ± 5.9a	4.5 ± 2.1ab
15.6	22.8 ± 6.7ab	7.0 ± 1.1a

Means within columns followed by the same letter are not significantly different, ($P = 0.05$, LSD test). Baited spheres had 1 g ammonium acetate and 0.5 g protein hydrolysate.

Table 3. Captures of adult *R. mendax* flies on baited 9-cm-diameter spheres in Chatsworth, NJ, and Fennville, MI (1998)

Trap position	Mean ± SEM no. flies per trap	
	New Jersey 7–28 July	Michigan 14 July–13 Aug.
15 cm above canopy	3.8 ± 2.0b	7.4 ± 1.0b
Within bush canopy	9.6 ± 2.6a	19.6 ± 2.1a
45 cm above ground	6.4 ± 1.7ab	9.0 ± 2.6b

Means within columns followed by the same letter are not significantly different, ($P = 0.05$, LSD test).

Effect of Trap Age on Captures. Blueberry maggot fly pressure was higher in Rhode Island than in Michigan (Table 4). In Rhode Island, freshly baited (0-d) Pherocon AM yellow sticky boards captured significantly ($F = 9.2$; df = 3, 12; $P < 0.01$) more blueberry maggot flies than traps aged for 11, 28 and 40 d (Table 4). Blueberry maggot adult captures on new traps averaged 1.6 times as many flies as any other aged traps evaluated (Table 4). There were no significant ($P > 0.05$) differences between traps aged for 11, 28, and 40 d (Table 4). A newly baited yellow board captured 2.4 times as many flies as a similarly baited trap that was exposed for 40 d (Table 4).

The results in Michigan using spheres were different from those in Rhode Island where yellow boards were used. There were significant ($F = 4.1$; df = 3, 12; $P = 0.03$) differences among aged sphere traps. Sphere traps exposed in field cages from 0 to 28 d captured significantly ($P < 0.05$) more flies than baited sphere traps exposed for 40 d (Table 4). There were no significant ($P > 0.05$) differences among fly captures on sphere traps exposed from 0 to 28 d (Table 4). On average, sphere traps exposed for 0, 11, and 28 d captured 2.5 times as many flies as baited traps exposed for 40 d (Table 4).

Discussion

Sphere Size. Our results showed that early in the season, the 9-cm-diameter baited sphere caught considerably more blueberry maggot flies than the other traps evaluated. However, as the season progressed, *R. mendax* flies showed no preference between the 9.0- and the 15.6-cm-diameter baited spheres (during the second trapping period). One possible explanation for these results is that early in the season, ammonia surrounding a 9-cm-diameter sphere is more concentrated and hence more attractive to flies than ammonia emanating from a 15.6-cm-diameter sphere. The concentration of ammonia around a 3.6-cm-diameter sphere is also higher. However, the much smaller surface area (total surface area of 3.6 cm diameter is 40.7 cm^2 versus 254 cm^2 for the 9-cm-diameter sphere) limits the effectiveness of this sphere. The reduced surface area becomes even more important as nontarget insects become trapped on 3.6-cm spheres, reducing landing space for blueberry maggot flies. As the season progresses and flies become mature, ammonia becomes less important because mature flies are less prone to seek a protein meal. During this period, the gravid females orient to larger supernormal fruit-type stimuli. This may account for the greater response of *R. mendax* flies to the 15.6-cm-diameter spheres later in the season. Earlier work by Prokopy and Bush (1973) suggests that fruit size plays an important role in host selection. Data collected by Liburd et al. (1998a) also indicates that berry size is one factor, which influences the percentage of infested fruits. Other factors, such as availability of suitable fruit for oviposition, and the interaction of fly maturity and fruit color, may have affected *R. mendax* response to spheres (Liburd et al. 1998a).

Based on the number of flies caught per square centimeter, the 9-cm-diameter sphere was the most efficient trap evaluated in our sphere size experiments. The baited 15.6-cm-diameter sphere trap caught as many flies as the 9-cm-diameter spheres during the second trapping period. However, the total surface area of the 9-cm-diameter sphere is 254 cm^2, and when placed against a background it has a cross-sectional surface area of 64 cm^2. The total surface area of a 15.6-cm-diameter sphere is 764 cm^2, and against a background it displays a cross-sectional surface area of 191 cm^2. Although the 15.6-cm-diameter sphere had a surface area that was three times as large as the 9-cm-diameter sphere, its trap catch was not significantly different. Therefore, the 9-cm sphere is a more efficient trap.

The overall cost of using a 15.6-cm-diameter sphere may also limit its use in blueberry plantings. In our experiments, the time spent in coating (with Tangle-Trap), checking, and cleaning traps was proportional to sphere size. The average ±SEM time taken ($n = 5$) to coat a 3.6-, 9.0-, or 15.6-cm-diameter sphere with Tangle-Trap was 2.0 ± 0.3, 2.2 ± 0.2, and 4.7 ± 0.2 min, respectively. The time taken to count and remove flies in the field was also proportional to sphere size. During the peak trapping period (28 July), the average ±SEM time spent in the field to check each 3.6-, 9.0-, and 15.6-cm-diameter sphere was 2.0 ± 0.7, 3.5 ± 0.6, and 5.0 ± 0.4 min, respectively. This indicates that substantial labor costs may be involved if large scale trapping with a 15.6-cm-diameter were undertaken.

Trap Positions. Our results showed that sphere traps placed within the bush canopy were more effective in capturing blueberry maggot flies than traps placed above the canopy. This finding is significant because

Table 4. Effects of trap age on captures of blueberry maggot fly (1998)

Treatment (days)	Mean ± SEM no. flies per trap	
	Pherocon AM boards	Spheres
	Rhode Island	Michigan
0	106 ± 18.1a	23.0 ± 4.8a
11	67.4 ± 20.0b	23.0 ± 3.2a
28	46.4 ± 25.5b	23.0 ± 3.1a
40	43.8 ± 16.9b	9.8 ± 2.9b

Means within columns followed by the same letter are not significantly different, ($P = 0.05$, LSD test).

the standard sphere deployment tactic for monitoring blueberry maggot flies usually involves hanging a trap 15 cm above the bush canopy. One hypothesis that may explain these results is that more flies may be foraging in the interior of the bush canopy where adequate shading is available and berries are accessible for oviposition and mating. This is consistent with observations made by Reissig (1975) who reported that traps hung within the canopy and surrounded by foliage caught significantly more *R. pomonella* flies than traps hung in other positions. The higher captures of *R. pomonella* flies within the canopy may also be caused by shading effects. Prokopy (1972) reported (during a sunny afternoon) that flies under shady conditions were more active than those exposed to direct sun rays. Other findings by Drummond et al. (1984) indicated that traps surrounded by fruits and foliage in very close proximity could negatively affect fly captures because trap visibility may be obscured by foliage. Therefore, trimming away foliage (0.25–0.5 m) will increase visibility and ultimately increase trap captures.

Aged Traps. Our age experiment demonstrated that in Rhode Island, newly baited (0-d) Pherocon AM yellow sticky boards captured significantly more blueberry maggot flies than traps aged for >11 d. The decline in fly captures after 11 d was probably the result of a lower release rate of ammonia from Pherocon AM yellow boards as the boards aged. These results were consistent with Jones's (1988) study that also found that yellow Pherocon AM boards aged for 9 d caught significantly fewer flies than boards aged for <5 d. In his study, low release rates of ammonia from Pherocon AM boards were recorded after traps were aged for 5 d. He identified the loss of ammonia being the principal factor responsible for the diminished fly captures. Ammonia is a strong attractant for immature *R. mendax* flies. However, we noticed that when ammonium acetate is used as the principal bait for monitoring blueberry maggot flies, a large percentage of nontarget insects are also captured on the traps.

In Michigan, where sphere traps were used for evaluation studies, there were no differences in blueberry maggot fly captures from 0 to 28 d. However, when sphere traps were aged for 40 d, significantly fewer *R. mendax* flies were captured. The reason why there was no change in the frequency of fly captures to spheres for 4 wk is unknown. Two hypotheses may explain these results. First, 9-cm-diameter green spheres have less surface area (total surface area 254 cm^2) than the treated section of a Pherocon AM yellow board (394 cm^2) thereby allowing less volatilization of ammonia from the Tangle-Trap. Consequently, immature flies were still attracted to the ammonia even after spheres were deployed for 4 wk. Jones (1988) also implicated the large surface area of Pherocon AM boards for the short longevity of ammonium baits observed in his study. A second hypothesis is that the dark green silhouette of the spheres may have been visually attractive to mature blueberry maggot flies searching for mating and ovipositing sites. Therefore, *R. mendax* flies continued to visit sphere traps even after the ammonia was depleted. Unbaited green spheres (similar to the ones used in this study) have already been shown to be attractive to *R. mendax* flies (Liburd et al. 1998b).

Our findings have important implications with respect to monitoring *R. mendax* populations in blueberry plantings. The fact that significantly fewer flies are captured on Pherocon AM boards after 11 d implies that boards are operating at a lower efficiency. The standard practice in highbush blueberry plantings in New Jersey and Michigan is to use the same board for the entire season for monitoring adults (O.E.L. and S.P., unpublished data). Although our data indicate that a substantial amount of ammonia is lost after 1 wk, we recommend that growers who are using Pherocon AM yellow sticky boards change their traps every 3 wk. This would require approximately three changes during a 9-wk blueberry growing season. Growers that are using green spheres can change their traps after 4 wk requiring only two changes during the same 9-wk period.

Our study demonstrated that the baited 9-cm-diameter green sphere was a superior trap to 3.6- and 15.6-cm-diameter spheres. The study showed that when this sphere is deployed in the center of the bush canopy, it is very attractive to *R. mendax* flies. In addition, the results indicated that ammonium acetate baited spheres have a longer attractive life span for *R. mendax* flies than Pherocon AM boards. Flies appear to be visually attracted to this 9-cm-diameter sphere because it depicts a supernormal fruit in an optimum state of susceptibility.

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