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The Capturing of the Apple Blossom Beetle, *Tropinota hirta* (Poda) (Coleoptera: Scarabaeidae), by Different Traps in Afyonkarahisar

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Abstract: This study was conducted to determine the most effective traps for capturing *Tropinota hirta* (Poda) (Coleoptera: Scarabaeidae) being an economical pest on the flowers of apple trees in Sultandağı county of Afyonkarahisar province in 2010. Blue plastic traps of in the same color (Sticky plate trap, funnel plus water and large bowl plus water) and also an attractant containing cinnamyl alcohol and trans-anethol, as a commercial preparation were used in the present study. Four different selected sites were investigated to find the most attractive traps for the mentioned pest. The highest number of captives was achieved in the first (43.60% of total) and third (33.13% of total) location sites. They were found in the locations second and the fourth as 14.53% and 8.72%, respectively. Most of the adults were captured by the blue funnel plus water traps with the attractants. We assume that the number of apple blossom beetles captured in apple orchards depends upon the age of the trees and whether they are near uncultivated or grain growing areas. In conclusion, we propose that the use of a blue funnel in a cup containing water, and also with an attractant, is an effective biotechnical method for controlling pest existing on apple trees when chemicals cannot be applied during the blooming period.

Keywords: Apple, attractant, funnel, trap, *Tropinota hirta*

Afyonkarahisar İlinde Bakla Zınnığının, *Tropinota hirta* (Poda) (Coleoptera: Scarabaeidae), Değişik Tuzaklarla Yakalanması

Özet: Bu çalışma 2010 yılında Afyonkarahisar ili Sultandağı ilçesinde elma ağaçlarının çiçeklerinde ekonomik zarara neden olan bakla zınnığını, *Tropinota hirta* (Poda) (Coleoptera: Scarabaeidae) yakalamada en etkili tuzak çeşidini belirlemek amacıyla yürütülmüştür. Çalışmada aynı renkte mavi plastik (Huni, leğen ve kanatlı yapışkan) tuzaklar ile birlikte içeriğinde cinnamyl alkol ve trans-anethol içeren, çekici etkili ticari preparat kullanılmıştır. Çalışma dört farklı elma bahçesinde yürütülmüştür. En yüksek sayıda ergin, 1. (% 43.60) ve 3. (% 33.13) bahçelerde yakalanmıştır. 2. ve 4. bahçede ise % 14.53 ve % 8.72 olmuştur. Erginlerin çoğu altında su bidonu ve üzerinde çekici bulunan mavi renkli hunilerle yakalanmıştır. Sonuç olarak en fazla erginin, genç yaştaki ağaçların bulunduğu veya etrafında mera ve sürülmemiş arazi bulunan bahçelerdeki tuzaklarda yakalandığı düşünülmektedir. Sonuç olarak çalışmada elma bahçelerinde çekicilerle birlikte kullanılan altında su bulunan mavi renkli hunilerin, ilaçlamaların yapılamadığı ağaçların çiçeklenme döneminde zarar yapan bu türün erginlerini kontrol altında tutmada etkili bir biyoteknik yöntem olduğunu söylenebilir.

Anahtar Kelimeler: Elma, çekici, huni, tuzak, *Tropinota hirta*

1. Introduction

Tropinota hirta distributes in the Palaearctic region (Lodos, 1989). These species spend the winter period in soil during its larval and adult stages in Turkey (Anonymous, 2010a). However,

Endrödi (1956) reported that in Central Europe, these species spend only the winter in the soil as adult stage only. Also, its larvae live in the soil, feed on rotting plant materials, and cause no damage. The adult is polyfagous and harmful to various plants by feeding on the stamens and pistils of the flowers (Kara, 1992; Milenkovic and Stanisavljevic, 2003; Ertop and Özpınar, 2011; Perez and Traveset, 2011).

The adults emerging in spring throughout the blossoming period of trees and other plants mostly feed on flowers. They lay their eggs in humus-rich soils, and the larvae hatching 1-2 weeks after and feed on the roots of weeds. The adults are very dynamic in sunshine, and their population density is at its highest at the end of spring. The adults are seen flying until the middle of July in Turkey (Özbek et al., 1998; Anonymous, 2008: Özbek 2008).

T. hirta emerge in spring and feed on male and female organs of the flowers of some plants such as fruit trees, strawberries, roses and grains. Adults are known also to occasionally feed on young shoots, leaves and even fruits. Because of their high flying capabilities, they land on many different types of plants and continue harming. As a result, damaged flowers cannot produce fruits (Anonymous, 2008; Özbek, 2008). Özbek et al. (1998) reported that coping with these insects is very challenging because blossoms are damaged; however, pesticides may be employed if the population becomes excessive.

Despite such drawbacks, it is possible to use biotechnical control against them as some of the colors and odors lures that influence these insects have been determined (Toth et al., 2003a and 2009; Ortu et al., 2003). It was reported that it is possible to capture these pest if (*E*)-cinnamyl alcohol and (*E*)-anethol are used in combination along with blue and white traps (Schmera et al., 2004). Imrei et al. (2001) reported that modified funnel traps were used for the trapping of related scarab sand proved to be extremely effective. According to the study of Schmera et al. (2004), using of light blue traps combined with (*E*)-cinnamyl alcohol and (*E*)-anethol at a ratio of 1:1 lures these insects into captivity. Vuts et al. (2009) reported that the most effective mixture in arresting *T. hirta* consists of (*E*)-anethol and (*E*)-cinnamyl alcohol and 4-methoxyphenethyl alcohol at a ratio of 1:1:1. Also, Sivcev et al. (2006) reported that the most effective color for the capture of *T. hirta* was light blue. On the other hand, Ortu et al. (2001) reported that *Epicometis squalida* (Scopoli) was captured effectively by a white colored trap. Aydın (2011a) declared plant phenology related shifts in color preferences of *T. hirta* in *Prunus* spp. orchards. According to study results the largest numbers of *T. hirta* were sampled by floral white-colored traps in both the pre-bloom and post-bloom periods. However, during the bloom period significantly the largest numbers of *T. hirta* were sampled by the light sky-blue-colored traps.

Sultandağı is a county of Afyonkarahisar province in which the highest fruit production rate exists when compared to its other counties (Anonymous, 2010b). Cherries occupy top place according to the production amount compared to other fruits grown in Sultandağı at 41.88%, followed by apples at 23.77% and then black cherries at 22.58% as (Anonymous, 2010c).

The controlling of these insects in this region has not been possible for years, but some farmers have been known to use blue bowls and others-although very few- use blue funnels. The objective of this study is to discover which type of trap is more effective in capturing apple blossom beetles, and to determine the effect of the use of this attractant on pest.

2. Material and Methods

The materials for this study were apple orchards in Sultandağı, a blue sticky plate, bowl, funnel with water and lure. The sizes of the trap materials used in the study: Upper diameter of funnels 22 cm, lower hole diameter 5 cm, lower diameter of bowls 36 cm and their upper diameter, 48 cm. The size of the rectangular plates was 24 x 20 cm (Figure 1). Diligence was required in order to ensure that the blue colors used in this study matched the shade of blue known as Picasso blue #0276FD the Hex Hub (Named Hexadecimal Color Codes for HTML). This study began two weeks before the trees blossom in the apple orchards in 2010. All the traps were checked and counted at least three times weekly until no insects could be observed. The study was conducted in four separate locations with at least one kilometer distance between each location, which all included the apple varieties of Golden Delicious and Starking Delicious. The locations and some of their features are given in Table 1.

For this study a blue sticky plate, a bowl and a funnel with water and attractant were placed side by side with a distance of 1 m between them in each location and with being no pesticide having been applied during the blooming period. Similarly, those traps containing a attractant were placed in each location at least 50 m apart from the other traps to prevent any interaction.

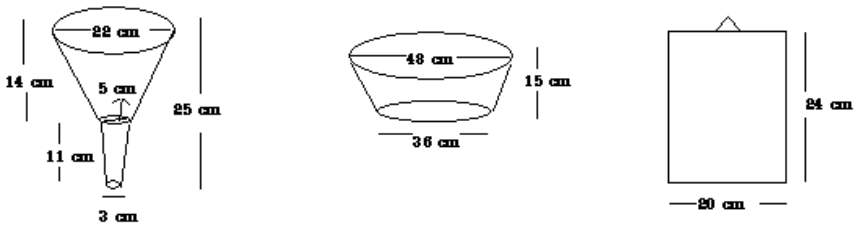

Figure 1. The sizes of the trap materials. a) Funnel b) Bowl c) Sticky trap

Table 1. General features of the locations also the results of the DUNCAN test for the differences in organic matter and pH

Locations	Apple Orchards	Coordinations	Ages	Organic matter (Soil)	pH (Soil)
1	The Sarıtaş area	38° 32′ 10″ N 31° 14′ 32″ E	15-18	2.24	7.70
2	The railway station	38° 33′ 08″ N 31° 16′ 07″ E	23-25	2.07	7.88
3	Yeşilçiftlik town	38° 33′ 52″ N 31° 16′ 12″ E	30-35	2.68	7.70
4	Yeşilçiftlik town	38° 33′ 37″ N 31° 13′ 35″ E	30-32	1.96	7.45

Each of four separate orchards was equipped with six traps in total (Three of them containing lure). That is, all studies was conducted with two replicates every orchards. A 5 L PET bottle containing water at a ratio of 1/3 was put under each funnel. Then, very small holes through which insects could not escape were drilled on the upper part of the bottle at a ratio of 1/3 so as to allow for excess water pouring out during rainy periods. Afterwards, traps with a funnel were attached to branches of the trees by binding them with wires. Next, bowls were filled with water at a ratio of 1/3 as was done in the case of the funnels and placed on the ground. Following this, sticky plates were hung among the branches of trees with the help of wires.

Lures, which were used in traps, were hung by a wire from the upper part of the traps up to middle part of them. Commercial lures used in the study contained (*E*)-anethol, (*E*)-cinnamyl alcohol, 2-propanol, 1,1-oxybis and dipropylene glycol.

Weeds in the orchards were removed before they began to inhibit the visibility of the traps and to prevent coverage. The locations were checked three times per week and the captive insects were counted. They were killed by using potassium cyanide in killing bottles and labeled according to their sex. Relevant locations, trap type and date were written on each label and the sexes were separated under a binocular microscope by removing their genitalia.

The obtained results were assessed through the analysis of variance (ANOVA) technique which is a collection of statistical models, and their associated procedures, in which the observed variance in a particular variable is partitioned into components attributable to different sources of variation. The data obtained by counting under different conditions with respect to the properties under study, were made subject to $\sqrt{(x + 3/8)}$ transformation and analyzed through unidirectional variance analysis technique. The DUNCAN test was used to find the difference between the means of the groups.

The temperature and humidity were obtained from the management of the Sultandağı County Agricultural Directorate in the early warning system in apple orchards.

3. Results and Discussion

The emergence of the first apple blossom beetle was observed on March 3rd, 2010 at an average temperature of 7 ^{0}C with a 56% relative humidity in the nature, the first batch of beetles was captured on 25st March 2010 while the last were captured on 13th May 2010 in all the apple orchards in Sultandağı, Turkey.

Adults of apple blossom beetle were sampled 43.60%, 33.13%, 14.53% and 8.72% in location 1, 3, 2, and 4, respectively (Figure 2).

The highest number of caught insects was obtained through the funnel + attractant traps in locations 1, 3 and 4 during the present study, respectively. The differing results in the other traps were found to be statistically significant ($P<0.05$) (Table 2). The highest number for the sampled insects was obtained through the funnel in location 1 during the study. However, the funnel + attractant traps were the most attractive traps for the adults. The difference between the funnel and funnel + attractant traps were found statistically significant for location 1, 3, and 4 according to the conducted statistical analysis ($P>0.05$) (Table 2).

The funnel + attractant traps captured the most adults of apple blossom beetles in locations 1 and 3. Therefore, the difference between them was found statistically significant ($P<0.05$) (Table 3).

However, the difference between these two locations and the others was found to be also statistically significant ($P<0.05$) (Table 3). Because of adults of *T. hirta* were captured the least in location 4 where it was found statistically different than the rest of the locations. For instance, in locations 1 and 3, the funnel + attractant traps generally captured more beetles when compared with the others in terms of the funnel + attractant traps. The captured beetles were found as 40%, 39%, 11% and 10% of in total during the study in locations 1, 3, 4 and 2, respectively. This study drew the same conclusions as the study by Toth et al (2003a) as regards the attractant that the use of (*E*)-cinnamyl alcohol and (*E*)-anethol at a ratio of 1:1 are effective in capturing *T. hirta.* Vuts et al. (2009) reported, according to their study, that the addition of (*E*)-anethol, (*E*)-cinnamyl alcohol and 4-methoxyphenethyl alcohol, the most common attractant for *T. hirta,* at a ratio of 1:1:1 increased the rate of capture significantly. The commercial preparation, which was provided for present study as ready-to-use, contains 2-propanol, 1,1-oxybis and dibutylene glycol in addition to (*E*)-anethol and (*E*)-cinnamyl alcohol.

To express in ratios, in location 1, 60% of the total of the captured beetles were captured by the funnel + attractant during the study, while 20% of them were captured by the funnel that did not contain a lure. The funnel traps with and without lures were found to be more effective than the other traps in this location.

To express in ratios, in location 2, during the entire study, 52% of the total beetles were captured by the funnel method, while 44% of them were captured by the funnel containing the attractant during the entire study. The funnel traps with and without lures were found to be more effective than the other traps in location 2.

To express in ratios, in location 3, during the entire study, 78% of the total captured beetles were done by the funnel + lure, while 20% of them were captured by the funnel without lures. The funnel traps with and without lures were found more effective than the other traps in location 3.

To express in ratios, in location 4, 80% of the total the beetles were captured by the funnel + lure, while the remaining 20% were captured by the bowls with and without lures during the entire study. The funnel + attractant trap captured the most beetles in location 4 and as a result, it was observed that the funnel trap is a more effective than the others. Vuts et al. (2010) expressed that *T. hirta* was generally captured by CA-baited traps in a ratio from 100% to 54%.

Due to the fact that most of the beetles were captured in location 1 during the study, the difference between this location with the others were found to be statistically significant ($P<0.05$) (Table 3). Adults of *T. hirta* were sampled 44%, 33%, 14% and 9% during the study in locations 1, 3, 2 and 4, respectively. Kutinkova and Andreev (2004) who reported that *T. hirta* may cause damage of up to 70% of the young cherry trees in Bulgaria. The reason of the highest number of beetles captured in location 1, may be the fact that the trees in this orchard are younger than other orchards. The other reason, for the locations 1 and 3, may be nearer to uncultivated areas than the rest of the locations. Schmera et al. (2004) in Hungary and also Aydın (2011b) in Isparta reported that the adults of *T. hirta* were caught much more in the plantations setting near non-agricultural areas such as the meadows than cultivated areas.

During the study, number of males was higher than females in the first five days after the emergence of the first batch of apple blossom beetle in the traps while thereafter the number of females exceeded that of the males. The sex ratio was found to be 0.44 in location 1, occurred as a result of the determining of their sex. This was followed by location 3 with 0.42. Schmera et al. (2004) reported in their study, that light blue traps with (*E*)-cinnamyl alcohol and (*E*)-anethol mixture at a ratio of 1:1 was the best method to observe the male and female *T. hirta* insect seasonally, there is no difference between male and female capturing rates while the decrease in this ratio in later periods indicates the local natural sexual ratio. However, the number of females was always

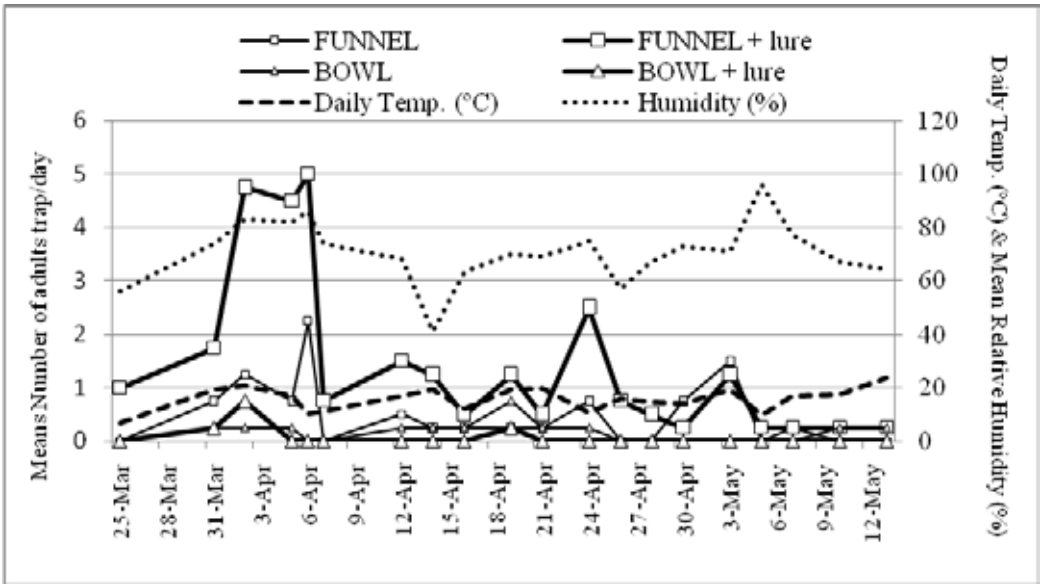

Figure 2. The mean numbers of apple blossom beetles captured by different traps in all locations

Table 2. Results of the DUNCAN test for adults of the apple blossom beetles daily captured by the different traps in each location

Traps	Number of adults (Means ± SE)			
	Location 1	Location 2	Location 3	Location 4
Funnel	0.63 ± 0.22 b*	0.54 ± 0.19 a	0.46 ± 0.13 b	0.00 ± 0.00 b
Sticky plate	0.00 ± 0.00 c	0.00 ± 0.00 b	0.00 ± 0.00 c	0.00 ± 0.00 b
Bowl	0.42 ± 0.15 bc	0.00 ± 0.00 b	0.08 ± 0.06 bc	0.04 ± 0.04 b
Funnel + lure	1.88 ± 0.47 a	0.46 ± 0.23 a	1.83 ± 0.60 a	0.50 ± 0.22 a
Sticky plate + lure	0.04 ± 0.04 c	0.00 ± 0.00 b	0.00 ± 0.00 c	0.00 ± 0.00 b
Bowl + lure	0.17 ± 0.13 bc	0.04 ± 0.04 b	0.00 ± 0.00 c	0.08 ± 0.06 b

*Means within a column followed by the same letter are not significant by DUNCAN test (P<0.05)

higher than that of the males in all locations in the present study.

As a result, it was clearly evident that the blue funnel captured the most individual when compared with the other traps used to capture the adults of apple blossom beetles in this study, which was conducted in four different apple orchards located in various places in Sultandağı. This result showed that blue bowls, which farmers usually use, are not very effective to capture to mentioned pest. However, it should be highlighted that water, which exists under funnels and in bowls, is another significant factor in attracting these species since the blue flapped sticky traps captured hardly any beetles at all. In addition, it was seen that the use of commercial lures, which are manufactured in Turkey, also increased the number of beetles captured 3-4 fold in the orchards.

Table 3. Results of the DUNCAN test for adults of the apple blossom beetles daily captured by the all traps in each location

Locations	n	Number of adults (Means ± SE)	
1	24	3.13 ± 0.75	a*
2	24	1.04 ± 0.38	bc
3	24	2.38 ± 0.68	ab
4	24	0.63 ± 0.24	c

*Means within a column followed by the same letter are not significant by DUNCAN test (P<0.05)

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