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Short paper

Effect of pheromone trap sizes and colors on capture of Leopard moth, *Zeuzera pyrina* (Lepidoptera: Cossidae)

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Abstract: The Leopard moth, *Zeuzera pyrina* (L.) (Lepidoptera: Cossidae) is a serious pest of walnut and apple trees in Iran. One of the control methods for this pest is the mass trapping of males using pheromone traps. To determine the best size and color of traps, four different colors (green, yellow, white, gray) and two different sizes (delta shape with standard adhesive surface, 19 × 22 cm and trapezoidal shape with twofold adhesive surface, 36 × 22cm) were compared in a walnut orchard in Alborz province. The results showed that color did not have any significant effect on the number of males captured by traps, whereas the newly made, trapezoidal trap could capture more than twice as many as a delta trap. This means that with the same number of pheromone dispensers, more than twice as many moths could be captured by trapezoidal traps than by delta traps, which could increase the efficiency of pheromone traps in an Integrated Pest Management (IPM) program.

Keywords: Leopard moth, *Zeuzera pyrina*, walnut pest, pest control, pheromone trap

Introduction

The Leopard moth, *Zeuzera pyrina* (L.), is a xylophagous and a key pest of walnut and apple trees in Iran (Radjabi, 1986). Larvae penetrate into young branches, gradually spreading throughout the entire plant and in high density, which can result in tree death (Bonnemaison, 1976).

Mass trapping of males using pheromone traps is one of the control methods for this pest. For example mass trapping of *Z. pyrina* with pheromones was a successful method for controlling this pest on hazel nuts in north east Spain (Isart *et al.*, 1997). Using pheromone traps in France, Italy, Portugal, Spain and Greece has given the impression that continuous use of this method has successfully reduced the number of males caught per trap and decreased the number of larvae (Pasqualini *et al*., 1996, Pasqualini *et al*., 1997, Audemard *et al*., 1997). These literatures might show some differences, regarding the capturing rate of *Z. pyrina* with pheromone traps, which might be due to different maintenance styles of traps in the orchards.

Delta traps are mainly used for trapping and monitoring of Lepidopterans. Nevertheless, the effectiveness of an adhesive trap depends on trap design and color, the quality of the adhesive surface of trap over the season, good accessibility to attracted moths and a proper entrance space for moths (Trematerra *et al.*, 1994; Wright and Cogan, 1995).

Color seems to be an important factor affecting the performance of traps. For example, all-green and all-white unitraps baited with Tre´ce´ lures were significantly less effective than a multicolored one (a

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green cover, yellow top, and white bottom) in capturing *Spodoptera exigua* (Hübner) (Lepidoptera: Noctuidae) (Lopez, 1998). On the contrary, clear traps caught significantly more codling moths than white, red, and orange traps and more females than males (Knight and Fisher 2006, Knight 2010).

Trap color has been shown to improve trapping efficiency in the case of other economically important Lepidopterans. For example, Meagher (2001) showed that traps that had contrasting colors captured more fall armyworm, *Spodoptera frugiperda* (Smith) males than unicolor traps. Knight and Miliczky (2003) found that painted delta traps (green and orange) captured significantly more male codling moths than white traps. Where, green delta traps appeared to be the most selective and attractive color for monitoring of codling moths (Knight and Miliczky, 2003).

Trap design also affects the number of moths captured by traps. For instance, there was no significant difference between captures of *S. exigua* in the wire cone and Scentry traps (Lopez, 1998). Comparison among the wing trap, funnel trap and cone trap showed that 75-cm-diameter cone trap captured more *Ostrinia nubilalis* (Hübner) (Lepidoptera: Noctuidae) moths than the smaller diameter cone traps (Reardon *et. al.*, 2006).

Since the Leopard moth is a serious pest in walnut orchards, the above-mentioned factors should be considered in designing a good trap to capture the males. Therefore, the objectives of this study were to examine the effect of adhesive surface size, the shape of trap entrance and trap color on the number of captured males of leopard moth.

Materials and Methods

Field trials were conducted on walnut trees at a fruit trees collection of Seed and Plant Improvement Institute located in Alborz province (35°51' N, 55°55' E). Traps were set up in mid-April, while male moths started emerging. The experiment was conducted in a randomized complete block design with four replications and eight treatments. The distance between two adjacent blocks was 100 m, whereas the distance between two adjacent traps within the same block was about 50 m. All traps were hanged at about 3 m height at the external part of the canopy of a walnut tree. Leaves and branches were excised around the trap entrances.

Treatments included trapezoid and delta traps in four different colors (green, yellow, white and gray). The traps were made of cartonplast (Nafis Cartonplast Ind., Iran) (2 mm diameter). The trapezoide traps had a (36 × 22 cm) base and a (36 × 16 cm) top, with a height of 8.5 cm, whereas the delta traps had the same size as standard (21 × 18 cm in base and 11 cm in height). An adhesive sheet was put on the base of each trap. The total area of the adhesive surface for trapezoidal trap was 792 cm^2 and for delta trap was 378 cm^2 (Fig. 1). One pheromone dispenser of *Synanthedon tipuliformis* (Clerck) (ST058A.133® Agrisenes BCS Ltd), that are used for capturing leopard moths, was hung under the trap roof just above the center of the adhesive surface.

The numbers of captured leopard moths were recorded and were removed, along with other insects and Debris, from the adhesive surface each week from mid April for eight weeks. The adhesive surfaces were replaced every two weeks and the pheromone dispensers were replaced monthly. The data were transformed by square root and analyzed by proc. GLM (General linear model). The means were compared using Duncan test**,** by SAS program (SAS 9.1 Institute Inc).

Results

All traps captured males of Leopard moth during the whole time, the highest number of capture occurred in the first week for green trapezoidal traps, and the lowest capture was recorded in the fifth week in white delta trap. However, after week fifteen, the numbers of capture were very low and sporadic. Therefore the data of the five weeks were analyzed. Results showed no significant differences among the mean number of the captured males by each type of traps during the five weeks (Table 1, Fig. 2).

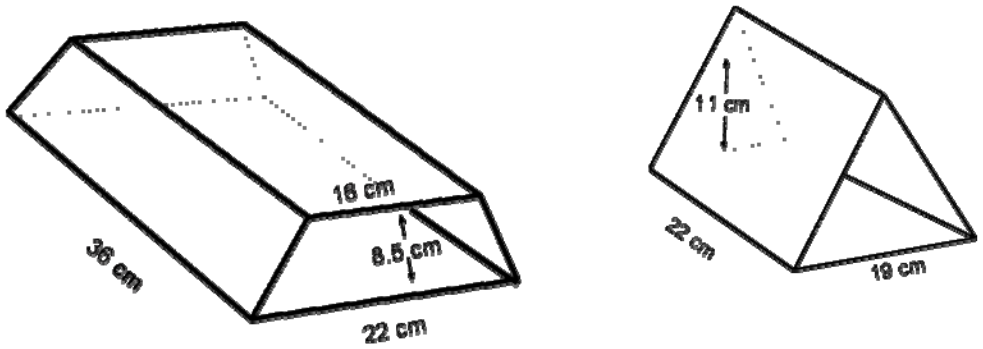

Figure 1 Shapes of the two traps used in the experiments.

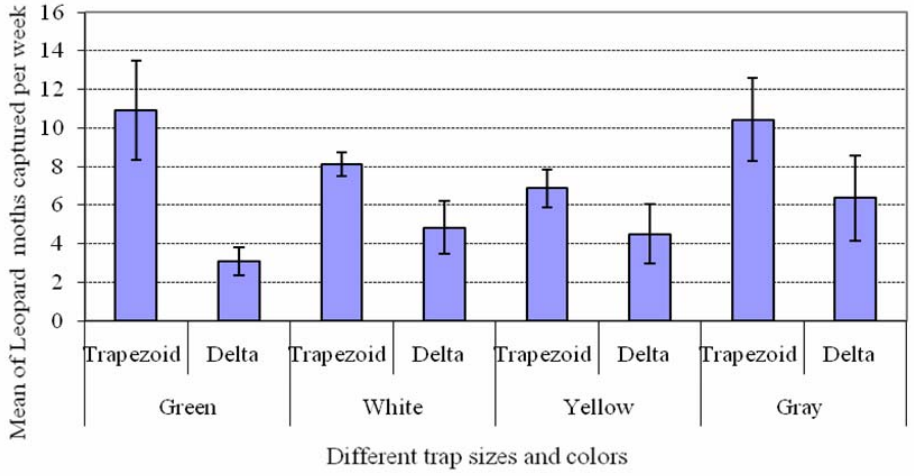

Figure 2 The means number of Leopard moth seized in traps during five weeks.

Table 1 Data analysis of four colors and two pheromone shapes of traps for Seized Leopard moth.

Source	df	Mean Square	P
Color trap (C)	3	0.41	0.80
Traps shape (T)	1	3.34	0.01
C × T	3	0.44	0.78
Block	3	5.77	0.01
Error	21	8.67	

CV = 29.69

The colors of traps did not significantly affect capture of the Leopard moth males in each group of traps (trapezoidal or delta traps) (Table 2).

Table 2 Number of seized Leopard moths in different colors of traps.

Treatment	No. of captured moth (trap/week) (Means ± SE)
Green	5.1 ± 0.89
Yellow	4.6 ± 0.95
Gray	3.8 ± 1.54
White	3.6 ± 1.30
Trapezoid	6.1 ± 1.23
Delta	2.5 ± 0.34

Discussion

Although sex pheromone is fundamental for attracting lepidopteran males toward a pheromone trap, the color and design of trap may also be effective in capturing them. In some cases, trap color has been reported to have influence on the capture of several noctuids, including *S. frugiperda* (Malo *et al.,* 2001). For example, plastic bucket traps with green canopies, yellow funnels, and white bucket traps collected more *Spodoptera* spp. males than all-green traps in several studies (Mitchell *et al.*, 1989; Pair *et al.*, 1989; Lopez, 1998). On the contrary, the trap color did not reveal significant differences for capturing *Cactoblastis cactorum* (Berg) (Bloem *et al.*, 2005). In our study the four different colors did not show any difference in the number of trapped Leopard moths males. It could be stated that the females of Leopard moth emerge from the trunks or big stems of walnut trees and fly up to the green part of the trees, therefore, Leopard moths males could find females in different parts of trees with different colors in background.

The trap type is the other important factor for the trap capturing efficiency. Therefore, different trap types with the same pheromone show different capture rates of pests (Hillier, *et al.*, 2003**,** Roubos and Liburd, 2009). Meanwhile, the size and the shape of the entrance to traps seem to be more important, where a good trap should allow moths to fly in easily while capturing them at high rate.

Since, *Z. pyrina* is a big moth, the males might not go in from all part of the entrance of a delta trap, especially from the acute angle at the top, that would not allow the males to fly in easily. Whereas, this problem does not exist in our new design trap "trapezoid shape". The trapezoidal entrance hole (187 cm^2) is bigger than the delta entrance hole (105 cm^2) that lets the Leopard Moth fly in easily and be trapped.

Another point is that the size of the adhesive in trapezoidal shape was twofold that of delta trap, which in assumption it could hunt two times more males than a delta trap. However, when catches were adjusted for adhesive surface area, the Delta traps still caught fewer moths than trapezoidal traps. This means that with the same number of pheromone dispensers, more than twice moth could be captured by trapezoidal trap, which could reduce the cost of using pheromone traps in an IPM program. Moreover, this new trap could potentially be used for other big size moths (e.g. noctuid moths) to improve the monitoring of pest populations and provide information on pest presence/absence and timing of adult flight.

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تأثیر اندازه و رنگ تله فرمونی در شکار شب‌پره کرم خراط *Zeuzera pyrina* (Lepidoptera: Cossidae)

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چکیده: شب‌پره کرم خراط *Zeuzera pyrina* L. (Lepidoptera: Cossidae) یکی از آفات مهم درختان گردو و سیب در ایران است. یکی از روش‌های کنترل این آفت شکار انبوه حشرات کامل نر توسط تله‌های فرومونی می‌باشد. برای ارزیابی بهترین رنگ و اندازه تله، چهار رنگ (سبز، زرد، سفید و خاکستری) و دو اندازه متفاوت (تله دلتاشکل با اندازه استاندارد ۱۹ × ۲۲ سانتی‌متر و تله ذوزنقه‌ای شکل با سطح چسبنده دو برابر، ۲۲ × ۳۶ سانتی‌متر) در باغ گردو در استان البرز مورد مقایسه قرار گرفت. نتایج نشان داد که رنگ تأثیر معنی‌داری بر تعداد شکار حشرات نر توسط تله‌ها فرمونی ندارد، در مقابل شکار حشرات نر به‌وسیله تله‌های ذوزنقه‌ای شکل بیش از دو برابر تله‌های دلتا بود. این بدین‌معنی است که با تعداد یکسان پخش‌کننده فرمون، بیش از دو برابر حشره نر به‌وسیله تله ذوزنقه‌ای شکار می‌شود و در نتیجه تله‌های فرمونی ذوزنقه‌ای کارآیی برنامه‌های مدیریت تلفیقی آفت (IPM) را افزایش می‌دهد.

واژگان کلیدی: کرم خراط، *Zeuzera pyrina*، آفت گردو، کنترل آفت، تله فرمونی