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The effect of delta trap colors and heights on efficiency of trapping of *Lobesia botrana* (Lepidoptera: Tortricidae) in Iran

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Abstract
Grape is one of the major horticultural industries and ranks second in the area devoted to cultivation of fruit trees in Iran. There are many grape cultivars in the west of Iran. Grape vine moth is a major pest of grapes in Iran and it causes huge losses in quantity and quality of grape products every year. There is not any information regarding concentrations, delta traps colors and heights and attractiveness of cultivars on *Lobesia botrana* in Iran. This experiment was thus conducted to address this lack in information and based on the aforementioned parameters. Because of the importance of this pest, the concentration effects of pheromone, delta trap colors (white, yellow, green, brown and multi-color) and their heights (0.5, 1 and 1.5 m) on trapping of moth for optimal monitoring, research was performed in the west of Iran (Kurdistan). The effects of trap color (P = 0.114) and Trap height (P = 0.919) to attract pests were not significant. The results showed that ground slop did not have a significant effect on attraction of adult grape vine moths.

Keywords: *Lobesia botrana*, grape, Iran

1. Introduction
Grape is one of the major horticultural industries and ranks second in the area devoted to cultivation of fruit trees in Iran. There are 17 grape cultivars in the west of Iran which has the highest number of grape cultivars in this country. *Lobesia botrana* is one of the most destructive pests of grapes in the Palearctic region. Larvae nourishment causes direct damage to fruits and the fungus *Botrytis cinerea* Persoon (gray mold rot botrytis cluster) causes secondary infections [12]. Pest monitoring is one of the main parts of integrated pest management. Monitoring can determine appearance of the main activity of pests to see if it is accurate, and provide valuable information for the prognosis of the pests [8].
Many technical issues must be considered in application of pheromone traps including trap type, attractant combination, trap resistance to environmental factors, trap location, and the costs of the traps [28]. Appropriate concentration of pheromone used in pheromone traps is really effective in catching target insects [24]. Basically, a lower limit pheromone concentration is used to stimulate response of male butterflies to females, and there is an upper limit above which decreases the attraction of those insects. There is not always a linear relationship between an increase in pheromone concentration and an increase in the number of catches. The response to the pheromone of the species is different and there is a significant relationship between concentration and ability to attract butterflies by catching traps [25].
Many reports about response of *L. botrana* to different concentrations of formulated pheromone are available [24]. According to the results of previous experiments, the trap parameters such as color, height and pheromone concentration is effective in the optimized performance of traps. In addition, other features such as the concentration of pheromone and the distance of traps distance from one another in attracting the pests are significant [1]. How to install pheromone traps is one of the important factors affecting their performance. Appropriate time setting of traps, time of their replacement, distance of traps, and the height of traps can affect the efficiency of the traps (Houseweart *et al*., 1981). The effect of color as visual effect has been investigated as a factor influencing the preference of traps by pest butterflies [1, 18, 19, 29].
Moths that have been studied on these parameters include fall armyworm, *Spodoptera frugiperda* (J.E. Smith) [18], velvetbean caterpillar, *Anticarsia gemmatalis* (Hubner) [19], jasmine moth, *Palpita unionalis* (Hubner) [1], lightbrown apple moth, *Epiphyas postvittana*, codling

moth, *Cydia pomonella* (L.) [7], and currant clearwing, *Synanthedon tipuliformis* (Clerck) [29]. Most research shows that the color of traps has a significant impact on the number of caught pests [26]. Some researchers have evaluated appropriate concentrations of pheromone, the colors and the heights of delta traps on *Cydia pomonella*, *Tortrix viridana* and *Grapholita funebrana* in Iran [9, 11, 27]. However, there is not any information about concentrations, delta traps colors and heights and attractiveness of cultivars on *L. botrana* in Iran. Thus, to fill this gap in information evaluations of *L. botrana* was conducted.

2. Materials and Methods

Most experiments on delta trap colors and heights experiments were carried out on the Rashe cultivar because the impact of grape cultivars on attraction of pests was eliminated. The experiment (prepared from Chemical Ecology Group, Swedish Agricultural University (SLU)) was conducted a few days before the start of the second generation of the pest (throughout the 'cluster closure' to the beginning of ripening) in western Iran (Kurdistan) on 8th June 2012and a control (no pheromone capsules) with five replications. A total of 20 white delta traps were installed in the vineyard at a height of 1 meter above the ground on wooden legs with distances of 30 meters for the second generation of the pest. After 50 days of trapping, insects were counted and recorded. Traps were collected on 30th July 2012.

The experiment was performed with three heights of 0.5, 1 and 1.5 meters on wooden legs and five colors of white, yellow, green, brown and multi-color (mix of yellow, green and brown). The concentration of pheromone used for delta traps was 0.1 mg. The experiment was conducted on two factors of 15 treatments (five colors × three heights) with four replications (the randomized complete block design) for the second generation of pests. After 50 days of trapping, insects were counted and recorded.

Four grape cultivars of Askari, Farkhi, Bidane Ghermez and Rashe (Figure 1) were selected for evaluation of their attractiveness to adult grape vine moths in four isolated (~1 ha each) gardens throughout a 'cluster closure' to the beginning of ripening in western Iran (Kurdistan). Four white delta traps (with 1mg pheromone lure in each trap) was set up in each garden with distances of 30 meters on 17th June 2011. Normality of all data was checked with the Kolmogorov-Smirnov method and data was analyzed by SAS software, version 12.

Fig 1: Grape cultivars in western Iran (Kurdistan). a- Askari, b- Farkhi, c- Bidane Ghermez, d- Rashe

3. Results

There is not a great deal of information about appropriate delta trap colors and heights for *L. botrana* in Iran and therefore this experiment was based on these parameters to address this lack. Evaluation of colors and heights was conducted on second generation pests. Interaction effect of the five colors and the three heights of delta traps (color× height) on trapping adult grape vine moths were evaluated by randomized complete block design. Blocks of treatments were designed on ground slopes and results showed that ground slope had no significant effect on adult attraction by different colors and heights (F=0.74, *P*>0.05). The results illustrated that there was not a significant interaction between colors and heights of delta traps (F=0.95, P=0.48). In addition, results demonstrated that the effects of delta trap colors ($F_{50, 4}$ = 1.74, p = 0.152) and heights alone ($F_{50, 2}$ = 0.01, P=0.997) on adult *L. botrana* attraction was not significant (table 1). The mean and SE values for attraction of adults in different trap colors (White, yellow, green, brown and multi-color) and heights (0.5, 1 and 1.5 m) are shown graphically in Figure 2. Delta traps set at a height of 1m had the highest mean attractiveness (23.83±3.2), but did not show a significant difference in mean attractiveness at heights of 0.5 (23.75±2.1) and 1.5 m (23.45±2.04).

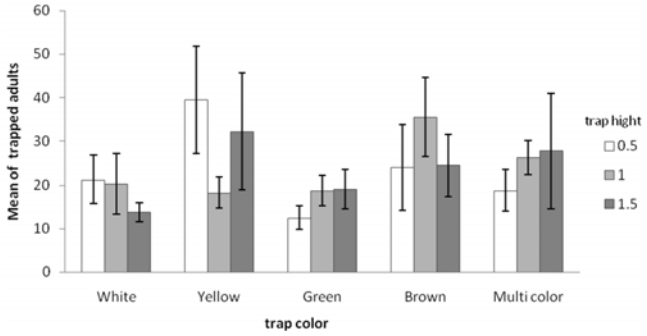

Fig 2: Means of trapped adults of the second generation of *Lobesia botrana* in different colors and at different heights of delta traps

Four cultivars of Askari, Farhki, Bidane Germez and Rashe were compared in their attraction of grape vine moth throughout the 'cluster closure' to the beginning of ripening (the second generation) because the most damage is caused by second generation pests in Iran. A comparison of trapped adult *L. botrana* on grape cultivars showed that there were significant differences between cultivars ($F_{12, 3}$=2.45, *P*<0.05). Askari cultivar had the highest number of trapped adults (47±11.07). However, there was not a significant difference between trapped adults on Askari, Farkhi (29.5±2.9) and Rashe (27.5±8.19) cultivars. The number of trapped adult grape vine moths on Bidane Ghermez was the lowest (14±3.87) and had significant difference with Askari cultivar.

Table 1: Variance analysis of trapped adults of the second generation of *Lobesia botrana* in different colors and heights of delta traps.

Source	DF	SS	MS	F
block	3	564	188	0.74 ns
height	2	1.43	0.71	0.01 ns
color	4	1765	441.25	1.74 ns
color× height	8	1926.4	240.8	0.95 ns
error	42	1.620.5	252.86	
total	59	14877.3		

4. Discussion

Host selection by insects is a complex process in which all five steps of host-habitat finding, host finding, host recognition, host acceptance, and host suitability must be completed in ordered sequence for a host to be successfully used. Behaviors during host finding are typically dominated by responses to visual and olfactory cues [14]. Our results showed that there was not a significant difference between colors. In those species which pheromones have been identified, research on host finding and its disruption for management usually concentrates on semi chemicals and related olfactory behaviors and physiology [4]. Vision, however, often impacts host finding by insects [14] and, especially when combined with olfaction, may produce effects that determine whether or not host finding is completed successfully. Each color has a unique range reflection that is distinguished by its impact in the dominant wavelength. Another experiment was performed to determine the effect of the color of traps (white, brown, yellow and white) in trapping of oak bud borer. The results illustrated that there was not a significant difference between colors of traps [35]. Moreover, it is important to pay attention to whether insects such as *L. botrana* can distinguish between two or more colors.

The results showed that the mean average of attracted adults at a height of 1m was higher than heights of 0.5 and 1.5 m, but there was not a significant difference among the trap heights. This might be because the height of delta traps were not designed to be more than 1.5 meter since in Iran a scaffold for holding of stems of grape trees is not used and stems lie near of the ground surface. In other pests, the effect of the heights of 2, 4 and 6 meters for pheromone traps of *Zeuzera pyrina* was evaluated, the results showed that height had significant effect in rates of trap attraction and traps were most attractive at heights of 6 meters [22]. It was proposed that Installation of pheromone traps for trapping of *Cydia pomonella* were effective in the middle and upper canopy [34]. In another research study, experiments were carried out on different heights of Pheromone traps in *C. pomonella*, and results suggested that the traps should be installed in the upper canopy [3]. Our results showed that there was no significant difference between experimental blocks of treatments. Because the experimental design was the randomized complete block design, experimental blocks were laid against direction of ground slope (because of mountain conditions). Therefore, ground slope had no significant effect on trapped adults of grape vine moth.

The results showed that there was a significant difference in the number of trapped adults between the four aforementioned cultivars in the second generation of pest. Therefore, cultivars of vineyards could affect the distribution pattern of the pest. Studies on the perception and the processing of plant volatiles in *L. botrana* at the level of both the central and peripheral nervous system led to the identification of a number of physiologically active compounds, and wind tunnel bioassay enabled the determination of the behavioral relevance of these compounds [16, 17]. In addition, female attraction to plant volatiles has been found in the North American grape berry moth, *Paralobesia viteana* (Clemens) [5]. Based on the analysis of the shoots of *Vitis riparia* Michx, a synthetic blend was formulated that, when used as bait in traps, caught females of *P. viteana* in a vineyard [6]. In addition, female antennal lobe

interneurons exhibited distinct response patterns when exposed to different volatile compounds [16]. These findings are consistent with previous reports that female European vine moths preferred certain host plants to others [10, 32], that they could distinguish between cultivars [20, 21], and that they were more attracted to specific blends of grape volatiles [30, 31]. In addition, female antennal lobe interneurons exhibited distinct response patterns when exposed to different volatile compounds [16]. Female European grape vine moths, although they are highly polyphagous [33] distinguish, for oviposition, between host plants in different phonological stages [32] and between varieties [15]. Rakefet [23] evaluated four grape cultivars of Carignan, Emerald Riesling, French Colombard and Cabernet Sauvignon. Their results illustrated that Carignan and French Colombard attracted the most and Cabernet Sauvignon the fewest specimens.

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