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Orijinal araştırma (Original article)

Effect of various hues of yellow as sticky trap color on leafminers in cucumber growing greenhouses[1]

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Summary

Yellow sticky traps are widely used in the management of several insect pests. Many studies were carried out on the effects of some factors such as trap size, vertical and horizontal positioning, and trap location on capturing capacity of traps. However, there is not much information on color characteristics; brightness, hues of the color, and wave length of the reflected light. In this study, it is aimed to find out optimum trap color by determining the most attractive hues of yellow for leafminers. Different hues were chosen from RAL catalogue and produced in DYO Paint Factory in Bornova (İzmir-Turkey). The traps were hanged in three organically grown cucumber greenhouses in Menderes (İzmir) in 2008. The trials were set up according to randomized block design with eight replicates. Leafminer adults on both sides of the traps were counted two week after the traps were hanged. The data were subjected to one way ANNOVA. Although there was significant variation amongst the replicates, it was found statistically insignificant in terms of mean individual numbers of leafminers on traps colored with different hues of yellow.

Key words: Leafminer, *Liriomyza huidobrensis*, visual yellow sticky trap, cucumber, greenhouse

Anahtar sözcükler: Yaprak galeri sineği, *Liriomyza huidobrensis*, görsel sarı yapışkan tuzak, hıyar, örtüaltı

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Introduction

Protected agricultural production area is estimated to be about 50 000 ha in Turkey in 2007 (Anonymous, 2008a). More than 90 % of the production is for vegetable crops. Tomato is ranked in the first place with the share of about 51 %, which is followed by cucumber (19 %), pepper (7 %) and eggplant (5 %). Cucumber (*Cucumis sativus* L.) is grown throughout the year, in open field in summer, and in greenhouses during winter due to better income. Undercover cucumber production is about 924 000 tones yearly in Turkey (Anonymous, 2008a).

Izmir, where cucumber is grown widely, has very good climate and environmental conditions for undercover agricultural production. Besides, Izmir is in the center of agricultural marketing and source for geothermal facilities.

Leafminers, *Liriomyza* spp. (Diptera: Agromyzidae), are one of the important threats to undercover cucumber production. Leafminers could cause an important damage due to their ability to stay active the whole year under greenhouse conditions. They have a wider range of host plants and an impact on many field and flower crops in Turkey (Anonymous, 2008b).

Both larvae and adults cause damage: larvae primarily mine the spongy mesophyll where chloroplasts are located (Parrella et al., 1984) and adult females puncture both upper and lower leaf surfaces to feed and lay eggs (Weintraub & Horowitz, 1995). Replanting could be required especially in the case of heavy infestations during the seedling period. Also it is known that due to the damage caused by larvae on the leaves, 80 % of the leaf blade looses its function (Schuster & Beck, 1992). In addition to this, it is determined that a larva causes 2 % loss of leaf epidermal area and this loss produces 60 % reduction in total photosynthesis by the leaf (Erb et al., 1993). It is also known that adults transfer viral and fungal diseases from one plant to another during their activities (Costa et al., 1988; Civelek & Önder, 1997).

For management of leafminers, environmentally friendly alternatives to chemical pesticides have been popular not only in organic farming but also in integrated crop management technique. Among these alternative approaches, yellow sticky traps attracted more attention as it is practically and economically sound.

The sticky traps can be used directly to control the pests and to monitor the population density of the pests (Öncüer & Durmuşoğlu, 2008). Therefore, a number of studies have been carried out on sticky traps; investigating the importance of color in various types of pests (Tryon et al., 1980; Parrella & Jones, 1985; Webb et al., 1994; Hoback et al., 1999; Tezcan, 2000; Harman et al., 2007); effect of dimension on catching capacity of traps (Parrella & Jones, 1985); effect of trap shape on catching capacity (Katsoyannos et al., 2000;

Liburd et al., 2000); effects of vertical or horizontal positioning or location of traps (over or near plants etc.) on catching capacity (Hoback et al., 1999; Esker et al., 2004; Blackmer et al., 2007).

Although much research has been carried out about the visual color traps and it is found that yellow sticky traps can be used successfully against many insect pests, there has not been a particular choice on the tone of yellow. Therefore, in this study, it is aimed to determine which hue of yellow color on sticky traps attracts leafminers better and thus to determine the optimum trap color.

Material and Methods

Different hues of yellow were chosen from RAL (Deutsches Institut für Gütesicherung und Kennzeichnung e. V.) catalogue and produced in DYO Factory in Bornova (İzmir-Turkey). Each color was applied on metal sheets with the dimensions of 5 x 7.5 cm and then the sheets were dried in a drying-oven at 80ºC. Corresponding RAL color catalogue entries for different tones of yellow are shown in Table 1 (Anonymous, 2008c). In order to recognize the colors used in the traps, the tones were listed in an increasing order with respect to their corresponding RAL catalogue number and enumerated from 1 to 8.

Table 1. Hues of yellow color with the corresponding RAL entries

Color No	RAL No	RAL Color Name	Trinitron RGB*
1	1003	Signal yellow	252, 163, 41
2	1006	Maize yellow	224, 130, 31
3	1012	Lemon yellow	227, 184, 56
4	1016	Sulphur yellow	255, 245, 66
5	1018	Zinc yellow	255, 214, 77
6	1021	Rape yellow	252, 189, 31
7	1023	Traffic yellow	252, 184, 33
8	1033	Dahlia yellow	255, 148, 54

* RGB = Red, Green, Blue

The colored sheets were then adhered side by side to a larger sheet with the dimensions of 20 x 25 cm according to randomized block design with eight replicates. This produced larger sheets bearing each hue of yellow on one part of each trap. In order to make it easier to handle and transport, uncolored space was left around the edges of the traps (3 cm from above and below, 2 cm from sides). A sticker named “Ekotrap® (Koruma Tarım A. Ş, Kocaeli-Turkey)” was diluted with the addition of thinner and applied on top of the traps using a brush. The traps were transported in special wooden cases to avoid adherence to each other or other surfaces.

The traps were placed on 3 May 2008 according to population density and plant heights. Eight traps were hung in each greenhouse by a rope 10 cm above the plants when the plants were about 40-50 cm tall.

To determine the effectiveness of traps with different hues of yellow color, the observations were made on the 3rd, 7th and 14th days after they were hung, however, the data obtained from counting on the 14th day was evaluated since there were enough adults on the traps.

The leafminer adults on the traps were identified by Dr. Civelek (Muğla University, Faculty of Arts and Sciences, Department of Biology, 48100, Kötekli, Muğla) and all of them were *Liriomyza huidobrensis* (Blanchard) (Diptera: Agromyzidae).

Both sides of each trap were counted and the results were evaluated by using one way ANOVA.

Results and Discussion

The number of adults trapped on the sticky traps colored with different hues of yellow, the mean values and standard deviation values are given in Table 2-4.

Table 2. The number of leafminer adults counted in the first greenhouse on the sticky traps (n=8) with different hues of yellow color

	Traps							
Replicates	1003	1006	1012	1016	1018	1021	1023	1033
1	13	51	27	23	17	54	26	41
2	34	22	72	14	14	52	49	50
3	18	37	16	33	15	48	37	28
4	41	30	40	21	19	37	25	35
5	56	24	21	47	40	18	40	20
6	28	21	18	45	26	19	30	29
7	67	19	32	21	58	26	30	53
8	27	24	21	23	53	43	43	61
Average	35,5	28,5	30,9	28,4	30,3	37,1	35,0	39,6
Standard Deviation	6,5	3,8	6,5	4,3	6,3	5,1	3,0	5,0

Table 3. The number of leafminer adults counted in the second greenhouse on the sticky traps (n=8) with different hues of yellow color

	Traps							
Replicates	1003	1006	1012	1016	1018	1021	1023	1033
1	58	21	57	13	33	20	17	31
2	9	37	26	13	18	55	34	43
3	27	26	38	44	33	49	65	32
4	37	49	21	32	56	24	43	19
5	24	28	24	32	10	42	33	29
6	57	39	50	47	44	36	29	22
7	53	55	32	23	32	51	41	24
8	43	33	31	37	35	43	39	38
Average	38,5	36,0	34,9	30,1	32,6	40,0	37,6	29,8
Standard Deviation	6,2	4,1	4,5	4,6	4,1	4,5	4,9	2,9

Table 4. The number of leafminer adults counted in the third greenhouse on the sticky traps (n=8) with different hues of yellow color

	Traps							
Replicates	1003	1006	1012	1016	1018	1021	1023	1033
1	43	36	27	23	35	46	33	32
2	77	48	27	41	30	72	63	32
3	23	31	16	20	18	50	43	29
4	58	47	33	18	20	66	51	54
5	25	22	28	36	12	25	53	23
6	67	28	55	21	53	59	43	68
7	71	15	23	13	51	38	27	18
8	31	23	34	53	22	49	47	32
Average	49,4	31,3	30,4	28,1	30,1	50,6	45,0	36,0
Standard Deviation	7,7	4,2	4,0	4,9	5,4	5,4	4,0	5,9

As can be seen from the tables, in all three greenhouses, the numbers of leafminer adults on traps had important variations amongst the replicates. For instance, in the first greenhouse, the number of adult individuals trapped on the RAL 1003 namely “Signal yellow” colored trap varied from 13 and 67, but the average was 35.5 individuals per trap. In the same greenhouse, they were between 19 and 51 adults on the RAL 1006 namely “Maize yellow” colored trap with average of 28.5 adults per trap (Table 2). In the second greenhouse, the adult numbers changed from 13 to 47 on the 1016 RAL namely “Sulphur yellow” colored traps with average of 30.1 adults per trap (Table 3). They were found between 17 and 65 on the 1023 RAL namely “Traffic yellow” colored trap with average of 37.6 individuals per trap (Table 3). In the third greenhouse the number of adult individuals trapped on the RAL 1021 namely “Rape yellow” colored trap varied between 25 and 72, with an average of 50.6 individuals per trap (Table 4).

In the light of these findings in all three greenhouses, Maize yellow with 1021 RAL and Traffic yellow with 1023 RAL catalogue numbers had the higher number of adults compare to the others (Figure 1). However, due to big variation in the number of adults amongst the replicates for the same colored traps the differences between differently colored traps were found statistically insignificant for all greenhouses ($P > 0.01$).

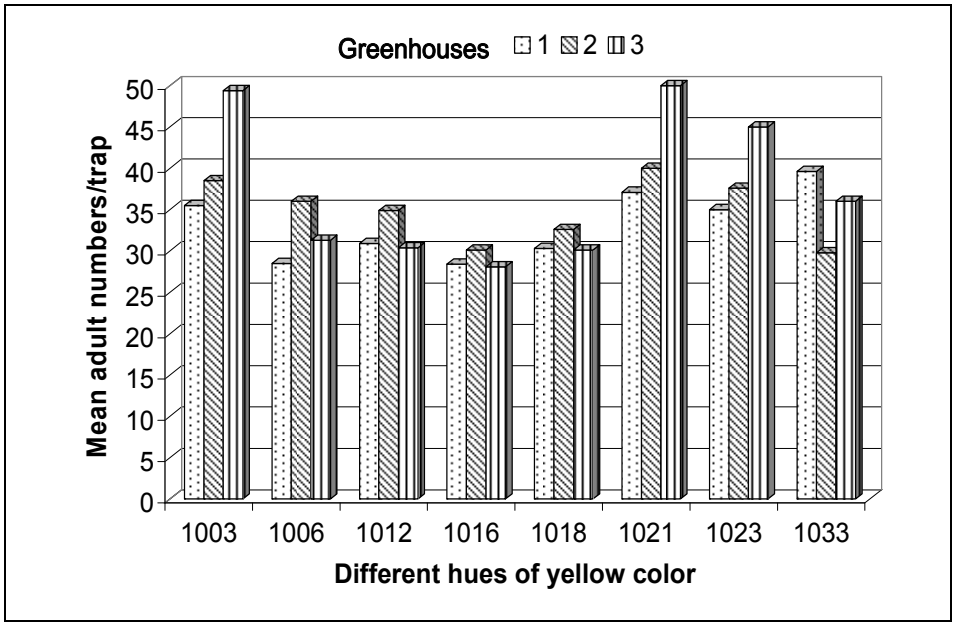

Figure 1. The average number of leafminer adults counted on sticky traps with different hues of yellow in three cucumber greenhouses.

As a result, it is concluded that using different hues of yellow color do not make any difference on the attraction of the adults for the control of leafminers. So, a normal hue of yellow color for the yellow sticky traps is sufficient in practice.

Özet

Örtüaltı hıyar yetiştiriciliğinde Yaprak galeri sineğine karşı farklı tonlardaki sarı renkli yapışkan tuzakların çekiciliği

Sarı yapışkan tuzaklar pek çok zararlıyla savaşta yaygın olarak kullanılmaktadır. Günümüze kadar; tuzak boyutu, vertikal veya horizontal konumlandırma veya tuzak yeri gibi faktörlerin tuzak yakalama kapasitesine etkisi gibi çeşitli konuları aydınlatacak pek çok çalışma gerçekleştirilmesine karşın, sarı rengin tonu, parlaklığı ve dalga boyunun ne olması gerektiğine yönelik bilgilere rastlanılmamaktadır. Bu çalışma ile Yaprak galeri sineklerini en çok cezbeden sarı renk tonu belirlenerek en uygun tuzak renginin ortaya konulması amaçlanmıştır. Farklı tonlardaki sarı renkler RAL kataloğundan seçilmiş ve DYO Boya Fabrikası (Bornova, İzmir-Türkiye)'nda üretilmiştir. Tuzaklar 2008 yılında Menderes (İzmir) ilçesindeki organik hıyar yetiştiriciliği yapılan üç farklı seraya asılmıştır. Denemeler tesadüf blokları deneme deseninde ve 8 tekerrürlü olarak kurulmuştur. Tuzaklar asıldıktan iki hafta sonra yapılan sayımlar sırasında, tuzakların her iki yüzeyinde yakalanmış Yaprak galeri sinekleri erginleri dikkate alınmıştır. Sayım sonuçları tek yönlü varyans analizi (ANOVA) yapılarak değerlendirildiğinde, tekerrürler arasında ciddi varyasyon görülmesine karşın, farklı sarı renk tonlarına sahip tuzaklardaki ergin Yaprak galeri sinekleri ortalama sayıları açısından istatistiki olarak önemli bir fark tespit edilememiştir.

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