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Study of insect pests and natural enemies on sticky traps in organic lettuce fields

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Abstract The results of sticky insect traps showed that chili thrips (*Scirtothrips dorsalis*) was the most abundance and followed by cowpea aphids (*Aphis craccivora*). These thrips and aphids were most found on blue and yellow sticky traps, respectively. Whereas the survey of insect natural enemies on sticky traps presented that wasp in the family Pteromalidae as well as Mymaridae and Figitidae and short-winged beetles in the family Staphylinidae were found. Those insects were mostly found on yellow sticky traps, followed by red and black sticky traps, respectively.

Keywords: Sticky traps, IPM, Vegetable, Thrips, Aphids

Introduction

The lettuce (*Lactuca sativa* L. var. longifolia) is a vegetable that can be grown throughout the year. It is classified as a plant in the family Asteraceae because of a leafy vegetable, and generally consumed as a salad (Rajna, 2022). The lettuce is rich in essential nutrients such as nutrients, minerals and vitamins (A, C, Iron, K, and folate). It was also found to contain antioxidants such as quercetin, caffeic acid and lactupicrin, which are anti-cancer agents in humans (Khodijah *et al*., 2021; Mulabagal *et al*., 2010; Kim *et al*., 2016; Chiesa *et al.*, 2009). The cultivated vegetables in soil are still outstanding in Thailand. The farmers encounter many risky situations such as drought, inundation, insect pests, diseases, low quality produce and pervert of pesticides affect hazards to income obtaining (Sukprasert and Wattanapreechanon, 2015). Although the pest is not a specific attacker, it can cause more damage depending on the season (Barrière *et al.*, 2014). It is estimated that the global dietary supplement supply will decline by an average of 40% annually due to plant diseases and insect pests (Thangaraj *et al.*, 2021). Invasive insects cost the global economy an estimated US$70 billion each year (Deutsch *et al.*, 2018). Integrated pest management (IPM) principles are currently in use, a strategy that promotes the reduction of

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pesticide use through the use of a variety of pest control methods and eco-friendly, for example cultivation of resistant crops, cultural control, biological control, physical control and mechanical control, etc., to localize or manage pests below economically damaging levels (Ehler, 2006; Mashwani *et al.*, 2015).

Among the monitoring methods, the use of sticky traps is one of the effective tools for monitoring the number of insect pests in farmland (Gencsoylu, 2018). For example, Rajput *et al.* (2021) studied the use of colors in sticky glue traps in maize fields. Yellow sticky traps were found to be the most effective at attracting insects compared to other colors. The most common insect pests were *Rhospalosipum Maidis*, *Frankliniella occidentali*, *Adelphocoris suturalis* and natural enemies *Cheilomenes sexmaculata* were found. If the type of insect that is infested in the planting area is known can choose to use methods to prevent and eliminate more properly. Moreover, the choice of colors in sticky traps also plays a role in attracting different types of insects.

Therefore, surveillance and monitoring of insect pest populations infestation is decisive in the principles of IPM. For this reason, the objective was to know the influence of the attraction of different colors of sticky traps on insect pests and insect natural enemies.

Materiel and methods

Preparation of seedlings and planting of lettuce

The lettuce seedlings were prepared where cos lettuce using peat moss as planting material, on 104-well trays, they were seeded under house conditions for 14 days and then transplanted into the prepared blocks in which the block was put planting material (coconut coir: coconut husks: rain tree leaf soil: cow dung, ratio 1:1:1:0.5). It consisted of 8 blocks of width 1 m and length 5 m (Figure 1). Each block plant could with 3 rows of lettuce, 7 plants per row (total 21 plants/block). And plants were provided 2 types of fertilizer, including vermicompost and cow manure. The plant was grown as organic cultivation.

Preparation and installation of sticky traps in lettuce plots

When the plant was 15 days after transplanting, the sticky trap was installed with the spacing of each trap of 1.5 m. The traps were placed 30 cm above the ground. Those together three colors of sticky traps were randomized and placed in each block, three replicates of the experiment were performed per treatment. A total of 8 colored sticky traps were used: white, red, blue, green, yellow, orange, purple and black, made from corrugated plastic sheets sized 15 × 15 cm. The pole made from bamboo with a diameter

of 2 cm and a length of 45 cm was used as a pole to set up the sticky traps. The sticky glue was spreaded all over a transparent plastic bag and then covered them on different colored corrugated plastic sheets, place the sticky insect traps on the lettuce plot, using randomized complete block design planning (Figure 1).

Figure 1. The lettuce plantation design and the placement of sticky traps

Insect observation

The species and quantities of insect pests and insect natural enemies on transparent plastic bags on different colored corrugated plastic sheet were classified in the laboratory. The plastic bags covered with sticky glue were immediately change to trap insects in the next stage. They were repeated every 7 days for a total of 4 times. In the fourth time, insect samples were collected for examination when the lettuce were 43 days old, and the species and quantity of insect pests and insect natural enemies found on sticky glue traps were examined. Counting was made by taking white paper, size 15 × 21

cm, with insect counting tables size 1 × 1 inch (72 squares, both front and back) random 20 squares used as a table for quantifying. The species of insects and insect natural enemies was done under a stereo microscope and relationships among vegetable pests with sticky traps of various colors were also determined.

Analysis of statistical data

The randomized complete block design (RCBD) experiment was planned and the results were statistically analyzed by finding the statistical difference of the means. Then all the data obtained were analyzed to find statistical variance.

Results

The obtained result of the species and populations survey of insect pests and insect natural enemies on the cos lettuce fields found on various colored sticky traps implied that the chili thrips (*Scirtothrips dorsalis* Hood) had more numerous than other insect pests in weeks 2, 3, and 4 that was found in blue sticky traps with 57.7, 123.7, and 85.3 insects/trap, respectively. Followed by bean aphid (*Aphis craccivora* Koch) was found in yellow sticky traps in weeks 1, 2, 3, and 4 of 20.0, 10.7, 13.3 and 11.3 insects/trap. In addition, leafhopper (*Amrasca splendens* Ghauri) and cotton leafhopper (*Amrasca biguttula* Ishida) were found in yellow, orange and white sticky traps of < 10 insects/trap. In the overall of this survey demonstrated the insect pests in organic lettuce fields presented the most on blue sticky traps, followed by yellow and orange sticky traps, respectively (Table 1).

In the insect natural enemies observed on various colored sticky traps placed in the organic lettuce fields presented that in weeks 1, 3, and 4, the short-winged beetles of the family Staphylinidae exhibited the most in black sticky traps of 24.67, 21.33, and 20.00 insects/trap, respectively. Followed by in red sticky traps of 20.00, 20.00, and 16.00 insects/trap in weeks 1, 2, and 4, respectively. While family Pteromalidae were found in yellow sticky traps of 20.67 and 20.33 insects/trap in weeks 1 and 4, respectively. In addition, family Figitidae and family Mymaridae found in sticky traps of < 13 insects/trap. In the overall of this survey revealed that the insect natural enemies in organic lettuce fields presented the most on yellow sticky traps, followed by red and black sticky traps, respectively (Table 2).

Table 1. Species and average numbers of insect pests trapped in different colored sticky traps in the organic lettuce fields

Order	Family	Scientific name	Number of insects ($\bar{x}$) (insects/traps)								
			White	Black	Red	Orange	Yellow	Green	Blue	Purple	total
Week 1											
Hemiptera	cicadellidae	*Amrasca splendens*	1.0	1.3	1.3	4.0	6.7	0.7	0.3	0.3	**15.6**
		Amrasca biguttula	0.0	0.3	0.7	0.7	0.0	1.0	0.0	0.3	**3.0**
Homoptera	Aphididae	*Aphis craccivora*	3.3	1.3	3.0	8.0	20.0	2.7	2.0	3.0	**43.3**
Thysanoptera	Thripidae	*Scirtothrips dorsalis*	30.3	28.3	38.7	75.7	85.0	47.0	60.0	67.0	**432.0**
Week 2											
Hemiptera	cicadellidae	*Amrasca splendens*	0.0	0.0	0.0	0.3	2.3	1.0	0.0	0.3	**3.9**
		Amrasca biguttula	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	**2.0**
Homoptera	Aphididae	*Aphis craccivora*	3.7	1.7	2.7	3.7	10.7	1.0	4.0	2.7	**30.2**
Thysanoptera	Thripidae	*Scirtothrips dorsalis*	46.0	15.0	33.0	35.3	40.0	34.0	57.7	44.0	**305.0**
Week 3											
Hemiptera	cicadellidae	*Amrasca splendens*	1.7	0.3	1.0	1.7	1.3	1.0	0.7	0.0	**7.7**
		Amrasca biguttula	1.0	0.0	0.0	0.7	0.3	0.0	0.0	0.0	**2.0**
Homoptera	Aphididae	*Aphis craccivora*	6.3	5.3	4.3	12.7	13.3	3.7	4.3	3.7	**53.6**
Thysanoptera	Thripidae	*Scirtothrips dorsalis*	43.3	32.0	54.0	76.7	63.7	79.7	123.7	76.3	**549.4.0**
Week 4											
Hemiptera	cicadellidae	*Amrasca splendens*	3.3	2.3	1.3	4.0	3.3	2.3	0.0	0.0	**16.5**
		Amrasca biguttula	3.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	**3.7**
Homoptera	Aphididae	*Aphis craccivora*	4.3	3.3	2.7	4.0	11.3	4.0	3.3	1.7	**34.6**
Thysanoptera	Thripidae	*Scirtothrips dorsalis*	35.0	29.3	25.7	59.3	45.0	41.0	85.3	49.0	**369.6.0**
Total											
Hemiptera	cicadellidae	*Amrasca splendens*	6.0	3.9	3.6	10	13.6	5	1.0	0.6	**43.7**
		Amrasca biguttula	4.0	0.3	0.7	1.4	3.0	1.0	0.0	0.3	**10.7**
Homoptera	Aphididae	*Aphis craccivora*	17.6	11.6	12.7	28.4	55.3	11.4	13.6	11.1	**161.7**
Thysanoptera	Thripidae	*Scirtothrips dorsalis*	154.6	104.6	151.4	247	233.7	201.7	326.7	236.3	**1656.0**
Sum of total			**182.2**	**120.4**	**168.4**	**286.8**	**305.6**	**219.1**	**341.3**	**248.3**	**1872.1**

Table 2. Species and average number of insect natural enemies trapped in sticky traps of different colored in the organic lettuce fields

Order	Family	Number of insects ($\bar{x}$) (insects/traps)								
		White	Black	Red	Orange	Yellow	Green	Blue	Purple	total
Week 1										
Hymenoptera	Figitidae	2.3	1.3	0.0	2.3	2.3	0.7	2.3	1.3	**12.5**
	Mymaridae	0.3	0.0	0.0	0.0	0.7	0.0	0.3	5.7	**7.0**
	Pteromalidae	7.3	5.0	8.0	11.0	20.7	9.7	6.0	7.0	**74.7**
Coleoptera	Staphylinidae	6.7	24.7	20.0	16.2	9.0	13.3	13.7	15.3	**118.9**
Week 2										
Hymenoptera	Figitidae	1.0	0.0	1.3	2.0	1.3	1.3	0.3	0.7	**7.9**
	Mymaridae	0.0	0.7	0.0	0.7	0.0	0.0	0.0	1.0	**2.4**
	Pteromalidae	6.3	0.7	5.7	8.3	14.3	12.3	9.0	2.3	**58.9**
Coleoptera	Staphylinidae	3.0	18.3	20.0	12.0	5.0	8.0	5.7	8.0	**80.0**
Week 3										
Hymenoptera	Figitidae	5.7	7.3	10.3	9.3	10.7	8.3	5.7	2.7	**60.0**
	Mymaridae	2.0	0.7	1.0	1.3	5.0	0.7	0.0	0.0	**10.7**
	Pteromalidae	7.0	6.3	6.7	14.0	13.3	12.7	1.0	3.3	**64.3**
Coleoptera	Staphylinidae	5.7	21.3	13.3	8.3	1.7	2.7	2.3	6.0	**61.3**
Week 4										
Hymenoptera	Figitidae	5.0	3.3	4.0	3.3	7.3	7.0	12.3	1.7	**43.9**
	Mymaridae	4.3	3.0	5.7	3.3	10.7	5.3	7.7	1.3	**41.3**
	Pteromalidae	10.3	7.7	8.7	11.3	20.3	9.7	6.7	7.3	**82.0**
Coleoptera	Staphylinidae	5.7	20.0	16.0	10.3	10.0	6.7	7.3	12.0	**88.0**
Total										
Hymenoptera	Figitidae	13.9	12.0	15.7	17.0	21.7	17.3	20.7	6.3	**124.6**
	Mymaridae	6.7	4.3	6.7	5.3	16.3	6.0	8.0	8.0	**61.3**
	Pteromalidae	31.0	19.7	29.0	44.7	68.7	44.3	22.7	20.0	**280.1**
Coleoptera	Staphylinidae	21.0	84.3	69.3	46.9	25.7	30.7	29.0	41.3	**348.2**
Sum of total		**72.6**	**120.3**	**120.7**	**113.9**	**132.3**	**98.3**	**80.3**	**75.7**	**814.1**

Overall, this survey informed that the higher insect pests in organic lettuce fields were found on the various of sticky traps in 4 weeks throughout the cultivation period than insect natural enemies. It was found that the blue sticky traps were able to attract the most insect pests, with a total of 341.3 insects/trap, while attracted the less insect natural enemies (80.3 insects/trap), with difference of insect pests and insect natural enemies of 261.0 insects/trap. In addition, the orange, purple and yellow sticky traps presented the same different amount of insect pests and insect natural enemies (172.3-172.9 insects/trap). Besides, black sticky trap was nondifference of insect pests and insect natural enemies (Figure 1).

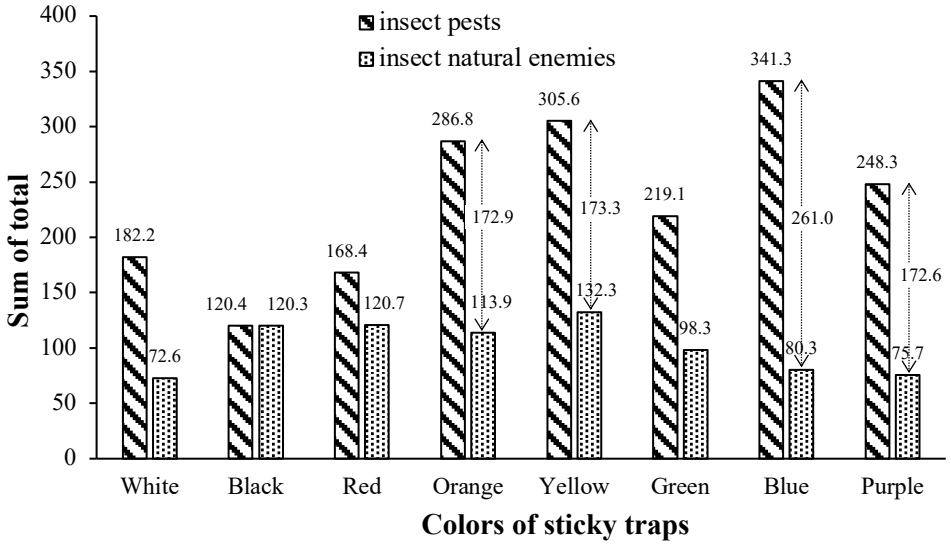

Figure 1. The total of the insect pests and insect natural enemies in sticky traps of different colored in the organic lettuce fields

Discussion

In this survey, the species and populations of insect pests caught in different colored sticky traps placed in organic lettuce fields exhibited that the blue sticky trap attracted the more insect pests than the other colors. The insect pest was found mostly chili thrips (*S. dorsalis*) in blue sticky trap as 326.7 insects/trap, follows by orange, purple, and yellow sticky traps, respectively. In addition, bean aphid (*A. craccivora*) was found in yellow sticky trap as 55.3 insects/trap. Interestingly, the blue sticky trap could be the most attractive color to the thrips, while yellow sticky trap could be the best attractive color to the aphid. Consistent with the study of Natwick *et al.* (2007) a study on finding and detecting thrips in vegetables, which found that blue sticky traps were most effective in attracting western flower thrips (*Frankliniella occidentalis* Pergande) and onion thrips (*Thrips tabaci* Lindeman). Similarly, Liu and Chu (2004) studied the use of sticky traps to count insect populations in the field in onion growing fields in South Texas. It was found that blue sticky traps were the most effective in attracting onion thrips (*T. tabaci*). In addition, Prema *et al.* (2018) reported that insect pests in order Thysanoptera were attracted by blue sticky traps more than any other color. This survey, the bean aphid (*A. craccivora*) most frequently found on the yellow sticky traps as 55.3 insects/trap in the organic lettuce fields, which the aphid prevalence following from the thrips. Consistent with Demirel and Yildirim (2008) who reported that yellow sticky traps were the most effective at attracting insect pests in order Homoptera, this survey was made on cotton crops in Turkey. The yellow traps proved highly effective to capture predominantly more than half of total insects captured in all traps, survey on

mustard field in Pakistan (Khanzada *et al.*, 2016). From this study and the previous research would confirm that blue sticky traps could be the most attractive color to the thrips, yellow sticky traps could be the most attractive color to the aphids.

For insect natural enemies survey, it was found that black sticky traps played high attractive color to the insects in family Staphylinidae (order Coleoptera), followed by red and purple sticky traps, respectively. In addition, the insect natural enemies in order Hymenoptera were higher found on yellow sticky traps than the other traps. Consistent with the research of Lima *et al.* (2015) who investigated the distribution of vesicating beetles in the genus *Paederus* (Coleoptera: Staphylinidae) attraction from fluorescent, incandescent, and black light in the Brazilian Savanna, black light was found to be most attractive to insects. In addition, Maryam *et al.* (2017) reported that black light was used to attract *Paederus fuscipes* (Coleoptera: Staphylinidae) in rice fields, while yellow sticky traps were able to attract insects in the order Hymenoptera. And also, many reports describing the effectiveness of yellow sticky traps, for example, high densities of parasitoids in order Hymenoptera have been found in yellow sticky traps (Böckmann, 2015; Beers, 2012; Larsen *et al.*, 2014).

Importantly for application the sticky traps with the IPM program in the field crops is the most attract ability for insect pest, lowest for insect natural enemies. In this study presented that blue sticky trap could be use in lettuce or vegetable organic fields, prevalence thrips case. While, yellow or orange sticky traps could be use when prevalence homopteran insect case. The result in this survey lead to important improvements for selection sticky traps increase the efficacy of IPM programs.

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