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Effects of different sticky trap color and height on insects in chili

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Abstract

Color traps are often used to monitor and control insects, but a systematic analysis has not been conducted to identify the most effective color and height of traps, especially in chili. This research was intended to find out the effects of sticky color and height of different traps on insects in chili. The method used in the research was a randomized block design with 2 factors of factorial split plot design. Types of colors used were yellow, red, blue, and green placed at heights of 0.5, 0.75, and 1.0 m. The interaction of four color types of the traps placed at different heights and the single factor of trap height in this study did not have significant effects on the number of insects trapped in four observation times. The only significant effect was seen in the treatment of trap colors in the observation time of 65 DAP. The observations showed very significant differences in the number of catches. Mean number the higher level of capturing was shown by the red color trap (41.5) followed by blue, green and yellow colors traps (30.5, 9.5 and 27,2) at all height level. The captured insects were mostly natural enemies, therefore, a careful consideration in setting up the color traps is required; when the trap placement aims at monitoring or controlling pests, the traps should be placed atthe locations that tend to be attacked by pests in order to minimize the effects on non-targeted insects.

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Introduction

The Integrated Pest Management (IPM) approach in the production of vegetable crops involves the monitoring of pest insects and the proper identification of the use of physical and biological controls during the plant growth and development. Color traps are often used to monitor insects (Chu *et al.*, 2000; Pundt, 2013; Atakan and Pehlivan, 2015; Sridhar and Onkara, 2015) and at the same time can be used tocontrol the insects. Abdel Megeed *et al.* (1998) states that yellow sticky traps can significantly reduce the density of *Bemisia tabaci* in some periods of plant growth.

The use of color traps can reduce the infestation of some pest insects in plants (Ranamukhaarachchi and Wickramarachchi, 2007; Lu *et al.*, 2012).

The commonly used colors are bright colors, such as yellow, red, blue, and green (Chu *et al.,* 2000; Ranamukhaarachchi and Wickramarachchi, 2007; Straw *et al.*, 2011; Lu *et al.*, 2012; Atakan and Pehlivan, 2015). That it is cheap, efficient and practical is the advantage of using the color traps.

The working principle of the color traps is not much different from the light traps where the insects that come to the plants divert their attention to the color traps. The insects attracted to the color will approach and even touch the colored object. When the colored object has been coated with glue, adhesive or sap, the insects will adhere to it and then die (Southwood, 1978).

The trap height also affects the catching efficiency (Straw *et al.*, 2011; Pundt, 2013) the farther the traps are from the plant canopy, the less number of pests are trapped.

The most efficient traps in capturing pests are those that are placed around the plant canopy. It indicates that the activity of flying insects only occurs around the height of the plant (Sinubulan, 2013).This research was intended to find out the effects of sticky color and height of different traps on insects in chili.

Material and methods

Study site

The research was conducted from April to July 2016 at the experimental garden of Agricultural Faculty, Lambung Mangkurat University, South Kalimantan, Indonesia.

Trap description

There were four color traps used in this research with the codes listed in Wikipedia, namely yellow with the code of FF FF 00, red FF 00 00, blue 1E 90 FF, and green 00 FF 00. A rectangular color trap in the size of 25 x 10 cm and with adhesive, placed at the field for 1 x 12 hours with the trap heights of 0.5, 0.75 and 1 m from the ground.

Experimental design and statistical analysis

The traps were set 2 times in each period of plant growth, namely vegetative period (at 35 and 50 days after planting/DAP) and generative period (at 65 and 80 DAP).

The method used in the research was a randomized block design with 2 factors of factorial split plot design with 2 replications, so there were 24 experimental units. The trap height was the main plot and the color type was the sub-plot.

The data were transformed using the square root transformation of X + 1 and the mean values were compared using the least significant difference (LSD) at the 5% level with SPSS 16.0.

Results and discussion

The interaction of four color types of the traps placed at different heights and the single factor of trap height in this study did not have significant effects on the number of insects trapped in four observation times.

The only significant effect was seen in the treatment of trap colors in the observation time of 65 DAP (Table 1).

Table 1. Mean number of insects trapped at different heights and trap colors in four observation times.

Height of trap (m)	Color of trap	Average number of insects trapped during observation			
		35 DAP	50 DAP	65 DAP	80 DAP
0.5	Yellow	4.5a*	14a	10bc	4.0a
	Red	5.0a	12a	18.5d	5.5a
	Blue	6.0a	3.5a	14cd	4.5a
	Green	7.5a	4.5a	9.0abc	6.0a
0.75	Yellow	5.0a	6.0a	4.5a	3.5a
	Red	5.5a	8.5a	18.5d	8.5a
	Blue	8.5a	5.5a	17cd	1.0a
	Green	7.0a	8.5a	10bc	7.0a
1.0	Yellow	6.5a	7.5a	5.5b	10.5a
	Red	7.5a	6.0a	20.5d	7.5a
	Blue	6.5a	6.0a	6.0ab	11a
	Green	5.0a	3.0a	4.5abc	6.5a

Data were counts, analyzed after transforming $\sqrt{X+1}$, but presented are means of actual data

*Mean within a column followed by the same letter are not significantly different (P=0.05) according to LSD.

The observations at 65 DAP showed very significant differences in the number of catches. The red colored trap had the most number of captured insects in all types of trap heights, followed by the blue, green and yellow colored traps (Table 2).

The red color had the longest color spectrum (620-750 nm) among other colors used, namely blue 450-495 nm, green 495-570 nm, and yellow 570-590 nm (Thomas and Paris, 2005), so the light reflection of the red color was more spread and more visible to the insects. Hasan and Mohammed (2004) suggest that more insects are trapped in color traps with higher light reflections than those with lower light reflections.

The level of reflection and wavelength of light also determines the number of catches (Dibiyantoro, 1994). Spectral qualities of plants (especially color & intensity) appear to be the major stimuli for the alignment of herbivorous insects in plant life (Prokopy and Owens, 1983).

The red color in the trap has a resemblance to the color of mature chili that makes the insects want to approach.

The attraction of the insects to the types of colors can be attributed to the effects of various cultivated plants (Gharekhani *et al.*, 2014) or vegetation of the ecosystem (Bashir *et al.*, 2014).

At the age of 65 DAP chili plants are at the maturation phase of the fruit so that the appeal of the red color may also be associated with the accumulation of red pigment (anthocyanin) in chili. Zapsalis and Francis (1965) state that anthocyanin content makes the chilibecome red (Rodriguez-Saona *et al.*, 2012).

The attraction of red color may be a physiological artifact associated with the presence of red filtration pigments in the multiple eyes of insects (Straw *et al.*, 2011).

The trap height also affects the capturing efficiency (Straw *et al.*, 2011;Pundt, 2013). Gillespie and Vernon (1990) state that the height and color of traps are the important factors affecting the thrip catches in cucumber plants in commercial greenhouses. In this study, the trap height did not show any different effect on the catches. All the trap heights used in this study were simultaneously installed at the beginning of the experiment so as to represent all the canopy heights of the chili plant from the vegetative phase to the generative phase.

Table 3. Insects trapped in color traps in chili.

No.	Order	Family	Species	Status
1	Hemiptera	Miridae	*Cyrtorhinus lividipennis*	Predator
		Piesmatidae		Pest
2	Coleoptera	Coccinellidae	*Menochilussex maculatus*	Predator
		Nitidulidae		Pest
		Desmestidae		Carpet beetle
		Erotylidae		Fungus beetle
		Anobiidae		Saprophyte
3	Hymenoptera	Bombyliidae		Pollinator
		Pteromalidae		Parasitoid
		Colletidae		Pollinator
		Elasmidae	*Elasmus* sp.	Parasitoid
		Braconidae	*Phanerotoma* sp.	Parasitoid
		Ichneumonidae		Parasitoid
		Mymaridae		Parasitoid
		Xyelidae		Pest
		Formicidae		Saprophyte
		Dryinidae	*Pseudogonatopusflavifemur*	Parasitoid
		Eupelmidae		Parasitoid
		Callaspidae		Predator
		Aulacidae		Parasitoid
4	Diptera	Drosophilidae		Pest
		Sciaridae	*Sciara* sp.	Fungus beetle
		Mycetophilidae		Parasitoid
		Acroceridae	*Ogcodes* sp.	Parasitoid
		Dolichopidae		Predator
5	Odonata	Coenagrionidae	*Agrionemisfemina femina*	Predator

In the35 and 50 DAP observations, the height of plants was ± 50 cm and the insects flying around the plant canopy focused on the traps with the height of 0.5 m while in the 65 and 80 DAP observations the height of plants ranged between 75- 100 cm and the flying insects around the canopy of plants focused on the traps with the heights of 0.75 and 1.0 m. Consequently, the treatment of trap height did not give different effects because the traps with the heights of 0.75 and 1.0 m had no effects in 35 and 50 days after planting and the traps with the height of 0.5 m had no effects in 65 and 80 days after planting. Sinubulan *et al.* (2013) states that the further the traps are placed from the plant canopy, the less the pests are trapped.

The most effective traps in capturing pests were those that were placed around the plant canopy, and the trap height must be adjusted to the height of the plants. Only a small number of captured insects were able to be identified into species while the rest were able to be identified into family due to poorly damaged insecticular conditions. The trapped insects belonged to 5 orders presented in Table 3. The trapped insects did not show any specific color selection.

The working principle of the color traps is to divert the attention of the insects to the color traps set with the aid of the beam of light, so that the insects are attracted to the color traps and will approach them, and even adhere to them and die when the objects have been coated with glue or other adhesive (Southwood, 1978). In Table 3, most of the captured insects have their status as natural enemies (predators or parasitoids). That these natural enemies are trapped and die means that these sticky color traps can reduce the number and performance of natural enemies. The effects of different colors in the insect living environment are able to change the natural enemies' searching behavior; therefore, many parasitoids and predators are attracted to the plant colors and the reflected light suspected as the dwelling of their prey (Blackmer *et al.*, 2008; Roubos and Liburd, 2008) and colors can also attract the presence of pollinating insects (Clare *et al.*, 2000; Knight and Miliczky, 2003; Atakan and Pehlivan, 2015).

Color traps will usually attract certain types of insects that like certain types of colors. Therefore, a careful consideration in setting up the color traps is required; when the trap placement aims at monitoring or controlling pests, the traps should be placed at the locations that tend to be attacked by pests in order to minimize the effects on non-targeted insects.

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