EFFECT OF MULCHES, BOTANICAL INSECTICIDES, AND TRAPS AGAINST FRUIT FLIES INFESTATION AND YIELD OF CHILI (*CAPSICUM ANNUUM)*

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ABSTRACT

The objective of this research was to evaluate the effects of different kinds of mulches, botanical and synthetic insecticides and repellent crop on the fruit fly infestation to chili variety 'Keriting 09' and its yield at a farmer field at Katulampa, Bogor, Indonesia. The study was arranged as a factorial experiment in a randomized complete block design. Each treatment was replicated three times. Observation was done from 4 until 12 weeks after planting (WAP). Observation variables were the level of fruit fly attack and chili yield. Fruit fly attack and chili yield data were analyzed by analysis of variance followed by Duncan's multiple range test at 5% significance level. The results show that the use of straw and plastic mulches did not significantly affect the fruit fly attack. However, the use of straw mulch could increase chili yield. Application of *Annona squamosa* and *Piper retrofractum* extract mixture, *Cymbopogon nardus* extract, spinosad (Tracer 120 SC), and imidacloprid (Confidor 5 WP) did not significantly affect the fruit fly attack, but could reduce chili yield loss compared with the control. A trap crop (SP Hot 77 chili variety) and repellent crop (citronella grass, *C. nardus*) could decrease fruit fly attack on the main crop (Keriting 09 chili variety). The fruit fly traps with attractant also caught two species of fruit flies, i.e. *Bactrocera (B.) dorsalis* complex and *B. (B.) umbrosa.* In conclusion, the use of trap crop, repellent crop, and traps with attractant has the potential for fruit flies management. In the future, we can design the best composition of chili and other plants for a better yield and sustainable agriculture.

Key words: Indonesia, integrated pest management, repellent crop, plant extract.

INTRODUCTION

The major insect pests in chili cultivation are fruit flies (*Bactrocera* spp.) belonging to the order Diptera, family Tephritidae (White and Harris, 1992). A fruit fly species commonly attacking chili is the Oriental fruit fly, *B. (B.) dorsalis*. Some other studies showed that *B. (B.) carambolae* and *B. (B.) papayae* can also attack chili fruit (Siwi et al. 2006). According to Wardani and Purwanta (2008), the average rate of chili fruit fly attack is about 20-25%. Furthermore, according to Balai Karantina Pertanian (1995), losses due to fruit fly attack can reach 90%. Because fruit fly attacks can decrease yield, farmers attempt to control this pest by using various techniques, such as cultural techniques using trap crops, biological control, physical control using mulches and traps, and chemical control using insecticides (Vos and Duriat, 1995).

The success of integrated pest management (IPM) is determined by the effectiveness of its combined components. According to Norris et al. (2003), IPM is a decision support system for the

selection and use of pest control tactics harmoniously coordinated into a management strategy, based on cost-benefit analysis that considers the interests and the impact on producers, society, and environment. IPM requires a series of field trials to determine the effectiveness of some control components needed to create programs in an integrated fruit fly control model (Dent, 2000). The integrated pest management of chili fruit flies requires the series of field trials to determine the effectiveness of various control programs at different growth stages of chilies to get higher chili yield with the least fruit fly infestation.

Therefore, this study was undertaken to evaluate the effects of different kinds of mulches, botanical and synthetic insecticides, and repellent crop on the fruit fly infestation to chili variety 'Keriting 09' and its yield.

METHODS

Place and Time of Studies

Field experiments were conducted at a farmer's field at Katulampa area, Bogor, Indonesia, from May until December 2011.

Chili Cultivation

Chili seed varieties used were 'Keriting 09' and 'SP Hot 77'. The seeds were soaked in Actigrowth (mixture of *Bacillus polymyxa* and *Pseudomonas fluorescens*) suspension 10 ml/l for 6 hours. Then, the soaked seeds were sown in a plastic container (30 cm x 15 cm x 5 cm) containing soil and manure (1:1). After 14 days, chili seedlings were transferred into small polybags containing soil and manure (1:1). After one month, young chili plants were transferred to a field plot 5 m x 1 m x 0.5 m. Spacing between plants was 50 cm x 50 cm. 'Keriting 09' variety was used in all the experiments as main cultivation, whereas SP Hot 77 variety was only used as trap crop in the study.

Mulch Treatments

There were three treatments of mulches: silver and black plastic mulch, paddy straw mulch, and without mulch. The treatments were arranged as a factorial experiment in a randomized complete block design. Each treatment was replicated three times. Observation variables were plant height, level of fruit fly attack, and chili yield.

Botanical Insecticides Treatment

Each plot was treated with different insecticide treatments as follows:

T1 = mixture of *Annona squamosa* and *Piper retrofactum* extracts at a concentration of 0.2%;
T2 = *Cymbopogon nardus* extract at a concentration of 0.2%;
T3 = spinosad (Tracer 120 SC) at the recommended formulation concentration of 0.8 ml/l;
T4 = imidacloprid (Confidor 5 WP) at the recommended formulation concentration of 0.8 g/l;
T5 = control or without insecticide treatment.

Application of insecticides was done using a knapsack sprayer at 6, 8, 10, dan 12 weeks after planting (WAP). The observation variables were fruit fly attack and chili yield.

The plant extracts were prepared by grilling *A. squamosa* seeds, *P. retrofractum* fruits, and *C. nardus* stems separately to get powders. Each of plant powder was dipped in methanol (1:10; w/v) for

48 hours. Filtrates were evaporated using a rotary evaporator under reduced pressure to yield crude extracts. The crude extracts were kept under low temperature (-2 ºC) in a freezer until use.

A. squamosa and *P. retrofractum* extract mixture and *C. nardus* extract were diluted with methanol, and added with water containing Latron 77L as emulsifier and sticker to obtain the desired concentrations. The final concentration of methanol and Latron 77L in the extract emulsion was 1% and 0.1%, respectively. The concentrations of extract mixture (*A. squamosa* and *P. retrofractum*) and *C. nardus* extract used for field test were 0.2%.

The Use of Trap and Repellent Crops against Fruit Fly

Chili 'Keriting 09' that is resistant to fruit flies was used as a production crop. Chili 'SP Hot 77', which is known to be susceptible to fruit fly attack according to preliminary experiments that the author ever did, was used as a trap crop. Furthermore, citronella grass (*C. nardus)* was used as a repellent crop. In the field, the trap plants (chili 'SP Hot 77') were placed between the repellent plants (citronella grass) and production plants ('Keriting 09) (Figure 1).

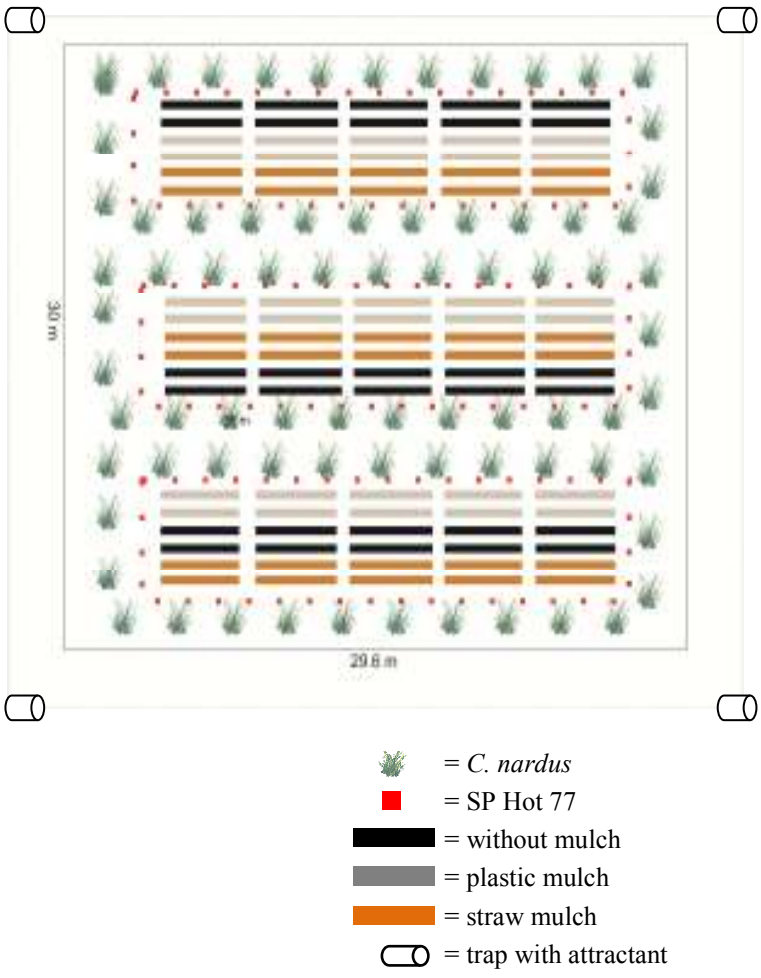

Fig. 1. Design of field trial at Katulampa Bogor 2011

In order to identify of fruit fly species attacking the chili crops, methyl eugenol in the trap was used as attractant of fruit fly. Fruit fly traps were prepared from plastic containers (600 ml capacity, 7 cm diameter, 15 cm high, with holes 4.3 cm diameter) with a cotton wick (3.8 cm long, 1.9 cm diameter) containing 0.25 ml methyl eugenol (Petrogenol 800 L). Fruit fly traps were placed at the four corners of the field trials spaced ± 10 m from the production crop (Figure 1). Observations on fruit fly traps were done every week to count the number of different fruit fly species attracted towards the traps. Identification of the species was done using Morphology and taxonomic characters of subfamily Dacinae (Drew, 1994).

Observation

Observations in each experimental treatment were done from 4th to 14th WAP (weeks after planting) on weekly basis. From each plot, ten plants were marked selected for the observations. Infestation level of fruit flies was calculated as follows:

$$\text{Level of fruit fly attack} = \frac{\text{Total number of infested samples}}{\text{Total number of observed samples}} \times 100\%$$

Experimental design

The treatments in all experiments were arranged as a factorial experiment in a randomized complete block design where each treatment was replicated three times.

Data Analysis

Data obtained for fruit fly infestation and chili yield was analyzed with analysis of variance followed by Duncan's multiple range test for comparison among treatment means at 5% significance level. The data analyses were done using a statistical software package Statistical Analysis System (SAS Institute, 1990).

RESULTS AND DISCUSSION

Mulch and insecticide treatments, as well as a combination of both treatments, did not significantly affect fruit fly attacks (Table 1). Fruit fly attacks in the treatment with two types of mulches and control plot were very low but no significant difference was observed (Table 2). However, significant difference in chili yield was observed with plastic mulch showing the least yield, but no significant difference was observed for chili yield in straw mulch and control (Table 3). Moreover, similar results were obtained for chili height with plastic mulch showing the significantly least height as compared to straw mulch and control. Additionally, the height of chili plants in the plastic mulch treatment was lower than that of chili plants in the straw mulch treatment or without mulches (Figure 2).

According to Hamdani (2009), the effect of mulch application is influenced by the type of mulch material. Crop residues (litter or straw) and plastic materials can be used as mulches. Mulches provide many benefits in terms of both physical and chemical soil properties, because mulches can keep soil temperature more stable and retain moisture around plant roots. The use of mulches will affect the temperature of the soil and prevents direct solar radiation (Hamdani 2009). The use of mulches can suppress weed growth, soil compaction, and erosion (Alviana and Susila 2009). According to Mahmood *et al.* (2002), straw mulches have a low thermal conductivity. Therefore, the

heat that reaches the soil surface would be less than plastic mulches or mulches possessing higher conductivity.

Table 1. Results of analysis of variance of the effect of mulches and insecticides on fruit fly attack

Treatment	Level of fruit fly attack (%) at n WAP[a]		
	10	**11**	**12**
Block	0.15	0.82	0.12*
Mulch	0.02	0.54	0.01
Insecticide	0.20	0.84	0.03
Mulch*Block	0.21	0.43	0.01
Mulch*Ins	0.18	0.45	0.03

[a] *: Significant at α=5% ; WAP: weeks after planting.

Table 2. Level of fruit fly attack in mulch treatments

Mulch types	Level of fruit fly attack (%) at n WAP[a]		
	10	**11**	**12**
Plastic	0.13a	0.00a	0.03a
Straw	0.06a	0.28a	0.08a
Control	0.13a	0.36a	0.05a

[a] Means in the same column followed by the same letter are not significantly different (DMRT α = 0.05)

Table 3. Yield of chili on mulch treated plots

Mulch types	**Yield[a] (g/15 m^2)**	**Yield (kg/ha)**
Plastic	188.41b	125.61
Straw	544.09a	362.73
Control	383.19a	255.46

[a] Means in the same column followed by the same letter are not significantly different (DMRT α = 0.05)

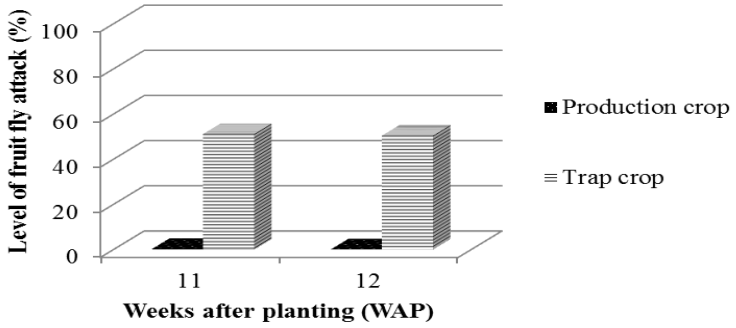

Fig. 2. Effect of mulches on chili plant height

No significant effect of different insecticide treatments were observed on the fruit fly infestation except for week 8 and 11 (Table 4) and accordingly, chili yield also showed no significant difference in different treatments (Table 5). However, the treatment of insecticides gave higher yield of chili than control. It seems that the attack of fruit fly does not correlate to the chili production. It may be caused by the low intensity of fruit fly attack.

Table 4. Effect of insecticide treatments on level of fruit flies attack

Insecticide Treatment	Level of fruit fly attack (%) at n WAP[a]					
	7	8	9	10	11	12
A. squamosa and *P. retrofractum* extract mixture 0.2%	0.00a	3.09b	6.16a	2.45a	3.08b	3.71a
C. nardus extract 0.2%	0.56a	7.26a	7.54a	4.10a	7.26a	7.69a
Spinosad 0.8 ml/l	2.65a	3.10b	4.05a	2.55a	3.09b	6.09a
Imidacloprid 0.8 g/l	0.75a	1.65b	5.25a	1.53a	1.65b	5.13a
Control	3.25a	1.10b	2.48a	3.96a	1.10b	6.28a

[a] Means in the same column followed by the same letter are not significantly different (DMRT $\alpha = 0.05$)

Table 5. Effect of insecticide treatments on yield

Insecticide Treatments	Yield (g/15 m^2) ± SD[a]	Yield (kg/ha)
A. squamosa and *P. retrofractum* extract mixture 0.2%	1027.5 ± 591.9a	685.00
C. nardus extract 0.2%	947.5 ± 544.5a	631.67
Spinosad 0.8 ml/l	1070.0 ± 477.1a	713.33
Imidacloprid 0.8 g/l	1016.7 ± 495.5a	677.80
Control	834.2 ± 436.2a	556.13

[a] Means in the same column followed by the same letter are not significantly different (DMRT $\alpha = 0.05$)

The level of fruit fly infestation / attacks in the production crop 'Keriting 09' was very low or close to zero whereas susceptible crop 'SP Hot 77' that was used as trap crop showed 51.1% and 50.4% infestation during 11th and 12th WAP respectively (Figure 3). This was in contrast to fruit fly attacks in chili 'SP Hot 77' trap crop, which averaged 51.1% and 50.4% at 11 and 12 WAP, respectively (Figure 3). Hokkanen (1991) mentioned that pest control strategies that work well can be achieved in several ways including the use of species or cultivars that are most preferred by the target pest and the use of the same plant species with a different time of planting.

In order to know the fruit fly species and their composition attacking chili crops, the traps containing methyl eugenol had been used. The results showed that two fruit fly species *B. (B.) dorsalis* complex and *B. (B.) umbrosa* were captured. The number of fruit fly *B. (B.) dorsalis* complex caught was higher than *B. (B.) umbrosa* (Figure 4). According to White and Harris (1992), *B. (B.) dorsalis* complex is commonly found on chili, whereas *B. (B.) umbrosa* is commonly found in "kluwih" and jackfruit (Siwi et al. 2006). This result could be explained by the occurrence of more host crops of *(B.) dorsalis complex* in the surrounding area than those of *B. (B.) umbrosa*. Besides chili, host crops of *B. (B.) dorsalis* complex include rose apple, banana, and papaya (Siwi et al. 2006).

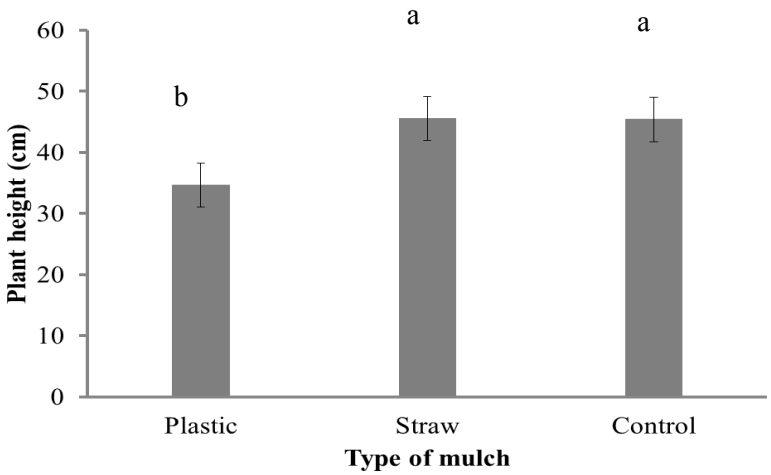

Fig. 3. The effect of mulch on plant height

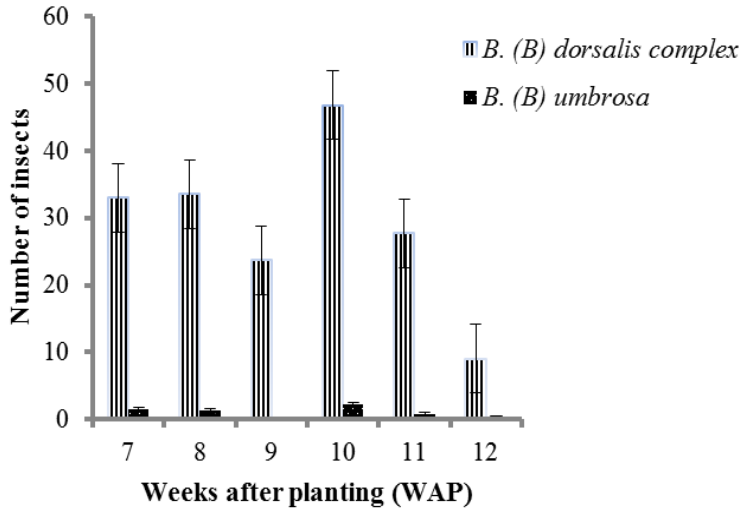

Fig. 4. Species and numbers of fruit flies in traps

CONCLUSION

Use of straw and plastic mulches as well as botanical insecticides and two synthetic insecticides did not significantly affect the level of fruit fly attack in chili. However, the use of trap crop, repellent crop, and traps with attractant can reduce the level of fruit fly attack in chili and resulted in higher yield than control (untreated). For further studies, we need to determine the best plant spacing and number of trap crops, repellent crops, and traps with attractant that are effective for controlling fruit flies and economically efficient.

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