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fly *Zeugodacus cucurbitae*
Coquillett (Diptera: Tephritidae)
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based on phenology and
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by Sulaeha Thamrin

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Population dynamics of melon fly *Zeugodacus cucurbitae* Coquillett (Diptera: Tephritidae) and damage level of fruits based on phenology and altitude

S Sulaeha¹, E S Ratna², Purwantiningsih³ and A Rauf²

¹ Plant Pest and Disease Department, Faculty of Agriculture, Universitas Hasanuddin, Makassar, 90245, Indonesia.

² Faculty of Agriculture, Bogor Agricultural University, Bogor 16680, West Java, Indonesia

³ Faculty of Mathematics and Natural Sciences, Bogor Agricultural University, Bogor 16680, West Java, Indonesia

E-mail: sulaeha_t@yahoo.com

Abstract. The Melon fly, *Zeugodacus cucurbitae* (Diptera: Tephritidae), is one of the important pests on vegetables and fruits of Cucurbitaceae family. This study aims to observe population dynamics of fruit fly in three kinds of fruits based on altitude and the phenology of bitter melon (*Momordica charantia*), angled luffa (*Luffa acutangula*) and cucumber (*Cucumis sativus*). The observation was carried out through a transect line method at every five meters. Fruit sampling was taken every week. Population dynamics of *Z. cucurbitae* was significantly affected by altitude (< 250 m asl midland) and phenological fruits. With elevation < 250 m asl, the vast majority of *Z. cucurbitae* population was found in angled luffa fruit (237 ± 45.51) and the least was in cucumber (35.76 ± 17.95). In contrast, in midland or elevation 250-417 m asl, the most populated insect of interest was found in bitter melon (222 ± 89.15). Fruit with 17-18 days maturation (scale 3) was the most visited by insect.

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Introduction

The melon fly, *Zeugodacus cucurbitae* (Diptera: Tephritidae), is an insect species of Asian origin and it is a major pest in the plant Cucurbitaceae. The fruit fly is one of the most important pests in the cucurbit plants in Indonesia and in some countries [1-3]. The loss of results due to the *Z. cucurbitae* fruit fly attack can reach 30-100% [2, 4]. According to [5], the geographical location of Bogor area is between 6°19' LU - 6°7'10 LS and 106°23'45 – 107°13'30 BT with the topographical type of area varied, from lowlands in the north to the highlands in the south, as well as uniform rainfall conditions per month except at the end and the beginning of the year. This will support the growing population of fruit flies *Z. cucurbitae*. Air temperature, a factor influences the rate of development and determines the fluctuation of the young fruit fly's population, significantly affecting to the population activity of the whole fruit flies [6].

The development of fruit fly population is not only influenced by the climate and the environment, but also it is affected by the role of plant morphology in limiting fruit fly attack. Insect development differs from each host. For instance, the hardness of the outer layer [7] causes insect difficult to penetrate until the insect finds a preferable host. Although the host generally attracts to herbivorous insect, physical appearance and plant chemical components cause the insect to avoid host preference.



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The existence of the learning association process on host searched by insects will be faster to assist in a decision making to accept a chosen plant to be a host [7]. Thus, the combination of climatic factors, and the host physical factors, the physiological conditions of the fruit will determine the development of the fruit fly population. According to Schoonhoven, *et al.* [8] host conformity is determined by morphological factors, nutritional appropriateness and the absence of toxic chemicals on the host that can inhibit the development of insects.

Dynamics of population and injury level of *Z. cucurbitae* fruit fly's attack on Cucurbitaceae plants, especially cucumber, bitter melon and angled luffa based on phenology and altitude have not been reported yet. Thus, this study aims to determine injury level and population dynamics of *Z. cucurbitae* base in fruit age phenology and altitude. This research is important as the information is required in the management and control of *Z. cucurbitae* pest in tropical areas.

2. Methodology

2.1. Observation method

Fruits of interest were collected from the plantation of angled luffa (*Luffa acutangula* (L.) Roxb., bitter melon (*Momordica charantia* L.) and cucumber (*Cucumis sativus* L.) in Bogor district. The measurement of fruit tissue hardness was done in Food Analytical Laboratory, Food Technology Science, Faculty of Agricultural Technology IPB, Bogor.

The sampling method consisted of collecting fruit flies in angled luffa (*Luffa acutangula*), bitter melon (*Momordica charantia* L.), cucumber (*Cucumis sativus* L.) in different altitudes. The height of the place was divided into 2 altitude zones i.e. >250 m ASL and 250-500 m ASL with 18 points of observation location.

The sampling of the fruits of interest initiated to be undertaken following the phenological development of the fruit such as the presence of immature fruits with a length of ± 10 cm fruit and former traces in flowers. The determination of the sample unit was conducted by using line transect, every 5 meters. In each row of the plant, samples were taken, and the sample tree was marked. The determination of the stake line (standing) was done intermittently on every 3 lines. Fruit sampling was done continuously every week (6 days) with 5 samples of attacked fruit. Fruit size scale was divided into 5 sizes based on fruit age including scale 1: fruit aged 5-6 days, Scale 2: fruit aged 11-12 days, Scale 3: fruit aged 17-18 days, Scale 4: fruit aged 23-24 days, Scale 5: fruit aged 29-30 days.

The fruits were obtained and placed in a container before carried to the laboratory. Furthermore, the fruits of interest were placed in square containers measuring 20 cm x 25 cm x 5 cm, 1/3 part of the height of the container was given sterile sawdust, and then the container was closed tightly. If there was a puddle of water in the container, then the water was removed to avoid the death of the larvae. Harvesting pupa commenced to be conducted seventh day after initial sampling and it was daily undertaken until all pupae were transferred into a new plastic container with 6 cm diameter x 15 cm high. Furthermore, the pupae in plastic container was laid into a wooden enclosure (35 cm x 45 cm x 25 cm). Fruit flies were collected into the test tube, then put into the freezer for ± 8 hour and it was estimated that the fruit fly had died, then identified before putting it into a specimen box (5 cm x 5 cm x 5 cm) with a 5 g silica gel and coated a sheet of tissue to place the specimen. The exterior of the box was labelled by specifying the sampling time, location, and source of the host plant.

2.2. Insect collection

A week after sample collection, pupae commenced to be daily collected until all pupae on the container finished. Pupae were transferred into a plastic container (10 cm diameter and 15 cm high). The container containing the pupa was put into a wooden enclosure (35 cm x 45 cm x 25 cm). Fruit flies were collected into the test tube, then put into the freezer for about an hour before identified. The body was transferred into a specimen box (5 cm x 5 cm x 5 cm) with 5 g silica gel and was coated a paper sheet where specimen placed. Unidentified specimens were inserted into the refrigerator to

avoid any discoloration of the specimen. The exterior of the box was labelled by specifying the sampling time, location, and the source of the host plant.

2.3. Analysis of tissue softness

The tissue softness was measured by using the Penetrometer Controller Digital Precision 2000 by injecting into tissue surface with a 150-gram load per 5 seconds. Each fruit was injected at posterior, equator, and anterior of fruit. The deeper penetration of penetrometer indicates the lower level of tissue hardness, meaning that fruit fly's ovipositor easily penetrates to fruit tissue impacting to level of fruit damage.

2.4. Data analysis

Population dynamics, insect -host interaction and fruit age and egg laying preference of *Z. cucurbitae* were statistically analysed with variance analysis followed by Duncan's Multiple Range Test (DMRT) through IBM SPSS program ver. 22.

3. Results

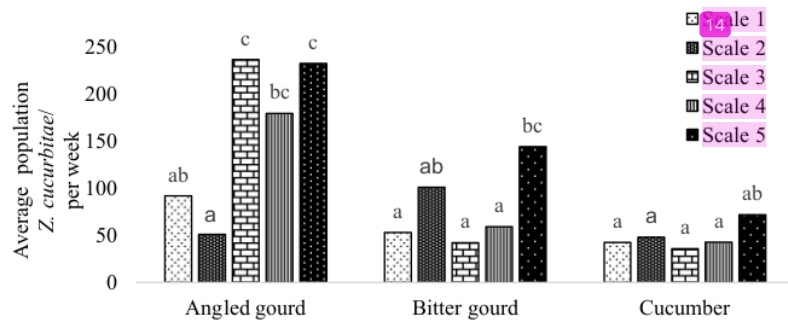


Figure 1. Average population of *Z.cucurbitae* fruit fly based on fruit scale size on the three host plant in < 250 ASL elevation

In figure 1, regarding the association between fruits and fruit flies in altitude < 250 asl, overall the population average of fruit fly in three kinds of fruits shown to have the highest population in Angled luffa (237 ± 45.51). The lowest population was in Cucumber (35.67 ± 17.95). in Angled luffa alone, population density of fruit fly was the greatest in fruits with scale 3 and 5. For bitter gourd, scale 5 of fruit was found to have the highest populated insect and similarly in Cucumber fruit, the highest population was in scale 5.

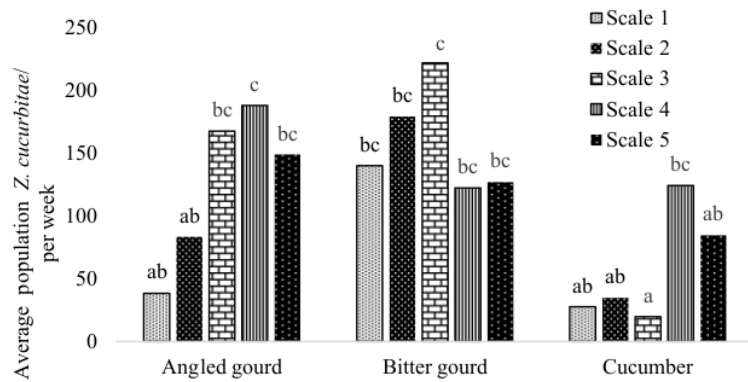


Figure 2. the average of the population of *Z. cucurbitae* fruit fly based on fruit scale measurement on three types host in the midland

In contrast to figure 1, fruit fly population in the fruits growing the midland shown to have the highest populated average in Bitter gourd with scale 3 and the lowest in Cucumber (figure 2). For Cucumber alone, populated average of fruit fly was found significantly in scale 4. And, in the fruit of Angled gourd its-self, fruit fly population was found the highest in scale 3.

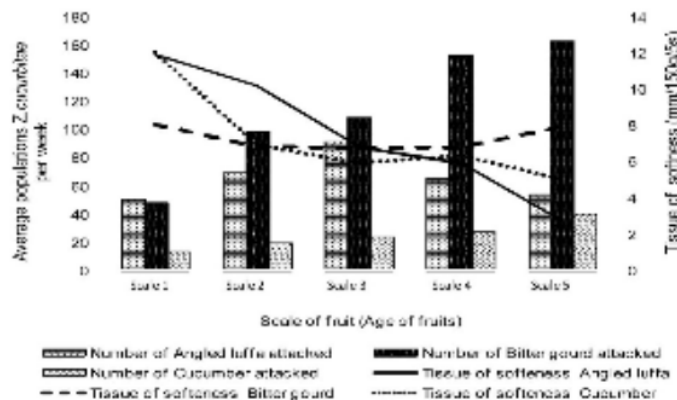


Figure 3. Average number of affected fruit and fruit tissue hardness levels in < 250 SAL elevation

Figure 3 shows that the association among fruit fly population, fruit development and tissue softness in three kinds of fruits was demonstrated. It clearly is seen that overall fruit scales of Bitter gourd were greatly visited by fruit fly population in altitude < 250 asl and this indicated to have a correlation with the softness of fruit, showing the higher softness tissue than others. Although the highest tissue softness was in fruit of Angle luffa, the population density was effectively found in the bitter gourd. Tissue softness of Angle luffa and Cucumber tended to decrease from scale 1 to 5.

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Table 1. The result of fruit tissue softness of Angled luffa, Bitter gourd, and Cucumber

Fruit types	Fruit size per week	Average fruit length	Average fruit diameter	Average tissue softness (mm/150g/5s)
Angled Luffa	Scale 1	12.37	4.99	11.88
	Scale 2	18.66	8.38	10.17
	Scale 3	21.43	10.36	6.80
	Scale 4	23.25	12.85	5.88
	Scale 5	23.39	14.07	5.82
Bitter gourd	Scale 1	9.63	5.83	8.06
	Scale 2	10.75	8.28	6.43
	Scale 3	11.74	9.44	7.14
	Scale 4	15.43	11.05	6.76
	Scale 5	16.81	14.82	7.89
Cucumber	Scale 1	7.52	5.59	12.04
	Scale 2	10.96	8.38	6.19
	Scale 3	13.76	9.68	5.86
	Scale 4	14.45	10.38	6.35
	Scale 5	19.03	14.74	4.99

*) Scale 1 (5-6 days age of fruits), scale 2 (11-12 days age of fruits), scale 3 (17-18 days age of fruits), scale 4 (23-24 days age of fruits), scale 5 (29-30 days age of fruits).

***) The softness of the fruit tissue is calculated based on the depth of penetration of the test needle (mm) with the load of 150 g within a certain time of 5 seconds.

The deeper penetration of penetrometer indicates the lower level of tissue hardness. Generally, fruit fly's ovipositor easily penetrates to soft tissue resulting in the increase of fruit damage level. In table 2, overall cucumber has much harder structure of tissue than other fruits and the findings suggests that Cucumber was slightly attacked by fruit fly (figure 3). Fruit tissue of Angled luffa seemed to have much softer and consequently fruit fly infestation was rather higher than any kinds of scales.

4. Conclusion

There were different number of *Z. cucurbitae* population and damage level of fruits attacked at <250 m asl and 250-417 m asl. In < 250 m asl, the highest population of *Z. cucurbitae* was found in angled luffa fruit and the lowest in Cucumber. In the midland, 250-417 m, the largest population was discovered in bitter gourd and the lowest was in cucumber. The population of *Z. cucurbitae* and fruits attacked were found t in 17-18 days old fruit (Scale 3).

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