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Effect of bagging time and fruit color on fruit fly attack and its impact on yield of crystal guava in Karanganyar, Indonesia

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ABSTRACT: Crystal guava is a popular fruit in Indonesia. One of the main obstacles in cultivating crystal guava is the fruit fly infestation which reduces productivity up to 100 per cent. The most effective way to control fruit flies is to do fruit bagging since the fruit is small. Studies were conducted to determine the effect of bagging time, fruit diameter, and fruit color on the intensity of fruit fly attacks and their impact on the quality and yield of crystal guava in Karanganyar. The research was carried out at the guava crystal center, Bangsri Karanganyar. The method used was purposive sampling, namely guava fruit that was three weeks old after the flowers bloomed, with variations in bagging time at weeks 3, 4, 5, 6, 7, 8, 9, 10 and 11. Measurements of diameter and color of fruit before bagging, observation of attack intensity and yield and quality of fruit were recorded shortly after harvest. The results showed that bagging time and fruit color affected the intensity of fruit fly attacks. Fruit fly attack significantly affected weight, external appearance and internal appearance.

Keywords: Fruit fly, bagging, crystal guava, fruit quality

INTRODUCTION

Guava is rich in vitamin C content (Tee *et al.*, 1988; Vora *et al.*, 2018) and play a role in maintaining health (Puspitasari and Wulandari, 2017), body immunity to avoid disease attacks. Crystal guava (*Psidium guajava* L.) is a superior variety of guava with a large fruit size and a few seeds (< 3 % of the total fruit mass), soft flesh, sweet taste, and vitamin C content of approximately 87mg in 100g. Guava production in Indonesia, in general, has increased. Based on data from Badan Pusat Statistik (2020), national guava production had significantly increased from 187,418 tons in 2014 to 230,697 tons in 2018. One of the obstacles in the cultivation of crystal guava plants is the attack of pests and diseases, which can reduce productivity and product quality. The fruit fly, *Bactrocera* spp. (Diptera: Tephritidae) is one of the important pests of crystal guava that causes damage, both in terms of quality and quantity of fruit (Taufik *et al.*, 2016). Fruit fly attack on crystal guava causes fruit to rot and fall before harvest time (Taufik *et al.*, 2016). Fruit fly attacks can reduce production by up to 100 percent, especially on star fruit and guava (Kardinan, 2016), so if it is not controlled it will cause crop failure.

Pre-harvest fruit fly management comprises several components including physical (packaging), mechanical, technical culture, biology, quarantine regulations, sterile insect techniques, and chemistry (Hasyim *et al.*, 2020). Physical control of fruit fly pests (packaging) is commonly applied by farmers because it is easy, inexpensive, and can reduce fruit damage by almost 100 percent (Sarwar, 2015). Efforts to control fruit flies on guava plants have been carried out by wrapping the fruit since it is small. However, if *bagging* is done on fruit that is too young, it will be at risk of dropping the fruit. Fruit fly attacks on crystal guava are influenced by many factors such as the shape, color, and texture of the fruit (Hasyim *et al.*, 2020), fruit flies tend to lay their eggs on fruits that are close to ripe or ripe.

MATERIALS AND METHODS

The research was carried out from November 2020 to February 2021 at the Crystal Guava Plantation Center, Bangsri Village, Karangpandan District, Karanganyar Regency. Meanwhile, laboratory activities were carried out at the Surakarta Pest and Disease Observation Laboratory. The research material consisted of 270 samples of crystal guava fruit obtained directly from the garden with fruitage 3 weeks after anthesis (flower blooms).

The research was carried out by purposive sampling, the research material was prepared by selecting fruit that was 3 weeks old after the flowers bloom (anthesis) / ± 20 mm in diameter, and the sample was selected on crystal guava trees that have been producing with a plant age ranging from 2 years with regular spacing. i.e 4 x 3.5 m. The study was arranged randomly with 30 replications, the factor to be studied was the time of fruit packaging, consisting of 8 times, namely the packaging of the 3rd

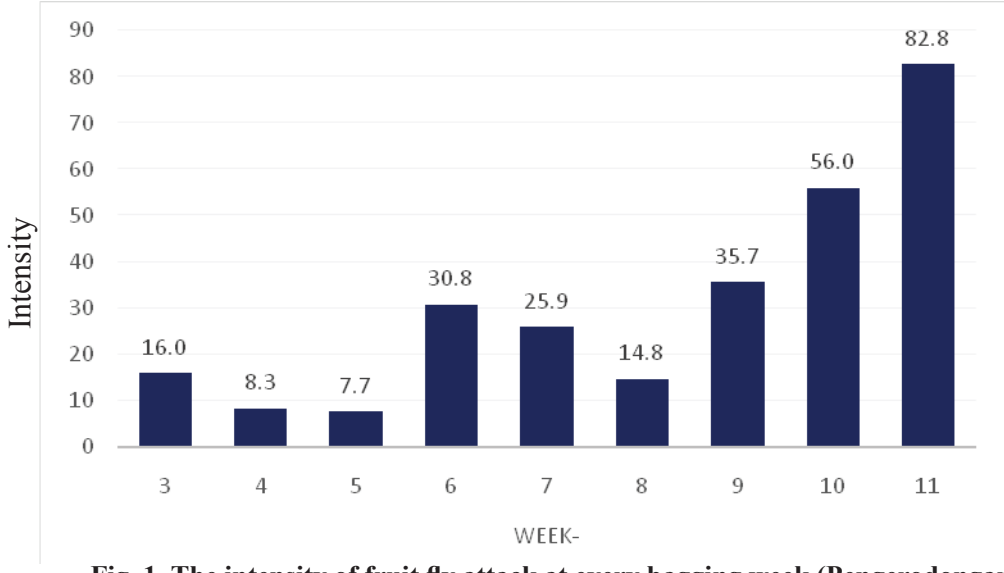

Fig. 1. The intensity of fruit fly attack at every bagging week (Pengerodongan)

week, 4th to the 10th week, and 1 control. All fruit samples were then harvested when 50 per cent of the fruit samples were ready for harvest or were bright green. After harvesting, all samples obtained were observed by splitting and matches to find fruit fly larvae that cause rotten fruit. The observed variables included fruit fly attack intensity, initial diameter, color, weight, external appearance, and internal appearance of the fruit.

Data analysis

The intensity of the attack was calculated in terms of per cent fruit damage. The data obtained during the study were compiled using Microsoft Excel. Statistical data processing was carried out using SPSS and Microsoft Excel software. This study used two statistical tests, *viz.,* Logistics Regression Test and Manova test (Multivariate Anova).

RESULTS AND DISCUSSION

Based on Figure 1, it can be seen that the intensity of the fruit fly attack was highest (82.8%) in the 11th week of grinding, while the lowest attack (7.7 was recorded in the 5th week of grinding.

The highest average initial fruit diameter was at the 9th week of fruit grinding at 67.51 mm while the lowest was 31.49 mm at the 5th week of fruit extraction. The color variables used in this study were CIE L, CIE a, and CIE b. The highest CIE L color at the 11th week of harvesting fruit was 67.68 while the lowest was at the 4th week of harvesting fruit, which was 38.44. In the CIE a color variable, the highest was at the 4th week of harvesting fruit at -17.72 while the lowest was at the 11th fruit-pulling week which was -26.91. For the CIE b color variable, the highest was at the 11th week of harvesting

Table 1. Fruit development parameters in different weeks

Week	Average Initial Diameter (mm)	CIEL	CIE a	CIE b
3	46.91	43.49	-20.25	32.99
4	40.24	38.43	-17.72	32.19
5	31.49	50.75	-21.69	43.41
6	33.40	52.13	-19.99	39.93
7	38,48	55.82	-20.31	41.38
8	61.33	56.24	-18.80	41.75
9	67.51	55.19	-22.09	40.71
10	58.04	67.60	-19.45	45.94
11	37.81	67.68	-26.90	50.88

Table 2. Fruit weight and diameter at different weeks

Week	Average Fruit weight (g)	Fruit diameter (mm)
3	169.08	122.15
4	195.59	71.35
5	152.69	67.23
6	167.42	68.46
7	132.04	63.98
8	139.07	110.43
9	146.57	159.14
10	128.00	64.24
11	86.07	53.87

fruit at 50.88 while the lowest was at the 4th week of grinding fruit, which was 32.19 (Table 1).

Data in table 2 reveal that the highest average fruit weight was in the 4th week of harvesting fruit, which was 195.59 grams, while the lowest was in the 11th week of harvesting at 86.07 g while the highest average final fruit diameter was during the 9th week of harvesting fruit, which was 159.14 cm, while the lowest was at the 11th week of drying, which was 53.87 cm.

Data in table 3 indicate that the variable outer appearance of the fruit with category 1 or the fruit peel is damaged and cannot be consumed. The highest (40%) was at week 10 of fruit extraction and the lowest was at week 5 and 6 of fruit extraction, which is 3, 8 percent respectyively. Meanwhile, for category 4 or suitable for consumption, the highest was in the 3rd week of fruit grinding by 56 percent and the lowest was in the 11th week of fruiting, which was 3.4 percent.

In table 4 it can be seen that the variable appearance in fruit with category 1 or damaged fruit pulp and cannot be consumed is the highest at week 10 of fruit grinding, which is 56 percent and the lowest is at week 5 and 6 of fruit grinding, which is 3, 8 percent, while for category 4 or very good and very fit for consumption, the highest was in the 4th week of fruit grinding at 62.5 percent and the lowest was in the 11th week of fruit grinding, which was 3.4 percent.

Effect of bagging time and fruit color on fruit fly attack

From the results of the logistic regression test, the variables that had a statistically significant effect on fruit fly attack were the week of grinding and fruit color (CIE L). initial diameter and the variables CIE a and CIE b did not have a significant effect. Fruit bagging time has a significant effect on the intensity of fruit fly attacks. Fruit bagging carried out early on will ensure that the fruit is saved from fruit fly attacks and every 1 week of bagging time increases the risk of fruit fly attack by 1.3 times. This means that ripe fruit has a greater chance of being attacked by fruit flies, this is in line with research (Grechi *et al.*, 2021) which states that ripe fruit has a higher chance of being attacked by fruit flies when compared to unripe fruit. Fruit bagging is proven to be able to protect the fruit from the insertion of fruit fly eggs (Abdurahim, 2020; Sharma *et al.*, 2020), so the fruit is relatively safe from fruit fly attacks. The diameter of the fruit does not affect the occurrence of fruit fly attacks, it means that fruit flies can lay their eggs on small or large fruit, size is not a preference for fruit flies in laying their eggs.

The color of the fruit has a significant effect on the attack rate of fruit flies, this is indicated by the higher the CIE L (light) value, the higher the attack rate, meaning that the lighter fruit has a higher chance of being

Table 3. Percentage of outer appearance conditions (PL) on every bagging week

Week	External appearance (per cent)			
	1	2	3	4
3	4	16	24	56
4	4,2	4,2	37,5	54,2
5	3,8	19,2	53,8	23,1
6	3,8	3,8	38,5	53,8
7	22,2	11,1	37	29,6
8	11,1	3,7	63	22,2
9	32.1	7.1	32.1	28.6
10	40	32	24	4
11	17.2	48.3	31	3.4

Table 4. Percentage of internal sighting conditions (PD) on every week of bagging

Week	Inner sight (per cent)			
	1	2	3	4
3	4	12	32	52
4	8.3	4.2	25	62.5
5	3.8	11.5	42.3	42.3
6	3.8	3.8	42.3	50
7	22.2	7.4	40,7	29,6
8	11,1	7,4	48,1	33,3
9	32,1	7,1	25	35,7
10	56	4	20	20
11	24,1	48,3	24,1	3,4

attacked by fruit flies. Fruit flies prefer bright green fruit to dark green fruit. Fruit flies are more attracted to bright or yellow-colored objects, this is also in line with the research results (Solihin, 2020; Syofia *et al.*, 2012; Wulan Sari *et al.*., 2017) which state that fruit flies are more attracted to yellow when compared to other colors. Fruit fly attacks are not affected by the CIE a value, which indicates the more positive the color will run from green to red and is also not affected by the CIE b value, which indicates the greater the value, the color will run from blue to yellow.

Impact on the quality of crystal guava fruit

Manova test with a significance level of 90 percent, attack status has a significant effect on weight, external appearance, and internal appearance. Meanwhile, for the final diameter variable, the attack status did not have a statistical effect on the final diameter of the fruit. For the weight variable, if it is not attacked by fruit flies, it will increase the weight of the fruit. Guava fruit that has been attacked by fruit flies will lose weight because the fruit contents will be consumed by fruit fly larvae. This is in line with research (Zulina *et al.*, 2020) which states that fruit grinding can increase fruit weight by 3 times when compared to fruit that is not bagged.

Fruit diameter is not affected by fruit fly attacks, it is suspected that this attack does not affect the development of the volume and size of the fruit so that when viewed from the size of the fruit, the fruit will appear normal like a healthy fruit. For the external appearance variable, if it is not attacked by fruit flies, it will increase the external appearance of the fruit by 1.1 points, so if it is not attacked by fruit flies, the external appearance will be better. Fruit that is attacked by fruit flies will visually have a stab wound or even a bigger hole which is the exit for the 3rd instar larvae that come out of the fruit to continue their life cycle to become pupae in the soil.

For the internal appearance variable, if it is not attacked by fruit flies, it will increase the appearance of fruit by 1.3 points, so if it is not attacked by fruit flies, the internal appearance will be better. If the fruit is split and observed, it will be seen that there are parts of the fruit that are still good so it can still be consumed in part, or the whole fruit becomes damaged due to too many larvae populations or the presence of other pathogenic infections.

CONCLUSION

The results showed that bagging time affected the intensity of fruit fly attacks. The longer the fruit bagging is carried out, the higher the fruit fly attack. Crystal guava fruit that is lighter or lighter in color is preferred by fruit flies. Fruit fly attacks have a significant effect on weight loss and make the fruit unattractive and unfit for the market.

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