Contributions of Central Research Institute for Agriculture
Vol. 15, No. 4, October 2021, pp. 106~111
ISSN: 0126-1894, DOI: 10.35335/ccria
Published by: Central Research Institute for Agriculture (CeRIA)

Effect of Light Intensity and Duration of Light on the Fecundity and Development of the Fruit Fly Bactrocera carambolae (Diptera: Tephritidae)

Bakti Prima Dewi
Fakultas Perikanan dan Ilmu Kelautan, Universitas Brawijaya, Malang, Indonesia

Article Info

Article history:

Received : Aug 15, 2021
Revised : Sept 10, 2021
Accepted : Oct 26, 2021

Keywords:

Light intensity;
Exposure Time;
Fecundity;
Bactrocera carambolae.

ABSTRACT

The purpose of this study was to determine the effect of light intensity and duration of light on the fecundity and development of the B. carambolae fruit fly. The experiment was conducted at the Pest Laboratory, Department of Plant Pests and Diseases, Faculty of Agriculture, Brawijaya University, Malang from April to July 2008. This research consisted of two experiments, namely, (1). Effect of different light intensity and length of light on fecundity and longevity of B. carambolae fruit flies (2). Effect of different light intensity and duration of light on the development of B.carambolae fruit flies. Each experiment was arranged using a factorial Randomized Block Design (RBD) consisting of 2 factors, namely light intensity with 3 levels (100 lux, 2000 lux and 3000 lux) and light duration with 4 levels (10 hours light and 14 hours dark, 12 light and 12 hours dark, 14 hours light and 10 dark, 24 hours light and 24 hours dark). The results showed that the use of a light intensity of 2000 lux with a light duration of 12 hours of light and 12 hours of darkness had a good effect on the fecundity of the B.carambolae fruit fly by 80 eggs, while the developmental yield of B.carambolae fruit fly from hatching eggs was 51.33%, The duration of the larval stage was 10.17 days, the number of pupae formed was 61 eggs, the pupal weight was 0.012 g, the pupal stage was 9.39 days long, and the number of adults formed was 53 individuals, given a light intensity of 2000 lux with 12 hours of light and 12 hours of light. dark insects, hormone manipulation techniques, for the purposes of biological control as well as research on the physiology, ecology, genetics and biology of the fruit fly.

Corresponding Author:

Bakti Prima Dewi
Fakultas Perikanan dan Ilmu Kelautan, Universitas Brawijaya
Jl. Veteran, Ketawanggede, Kec. Lowokwaru, Kota Malang, Jawa Timur 65145
Email: dewiprima@gmail.com

1. INTRODUCTION

Fruit and vegetable plants known as horticultural crops are one of the mainstays of the Indonesian people both as a source of food and a source of foreign exchange. Approximately 70% of Indonesian people live from agricultural businesses and horticultural land area covers 27% of all agricultural businesses (Putra, 1997). The cultivation of a type of plant, both fruits and vegetables, is often attacked by pests. Fruit flies are pests that are very damaging to horticultural crops, especially fruit and vegetable crops. These pests cause considerable damage and losses.

Damage can be qualitative and quantitative. Quantitative damage occurs due to a decrease in the number of fruit yields and qualitative damage, namely in the fruit experiencing a decrease in quality due to damage to certain parts or all parts, for example decay (Putra, 1997). The fruit fly

Bactrocera carambolae is a member of the Tephritidae family (fruit fly) and one of the most important pests economically worldwide. The B. carambolae fruit fly undergoes a complete body change or metamorphosis (holometabola).

In each of these metamorphosis fruit flies will go through the stages of egg, larva, pupa and imago in one life cycle (Borror, et al 1996). In Indonesia there are at least 40 species that economically attack fruit cultivated by humans (Kuswadi 1997 in Hardy 1983), but only a few species damage fruit. B. Carambolae is the most important pest in Indonesia because it attacks mangoes, guavas, star fruit and chilies (Kalshoven, 1981).

The population of fruit flies in nature is highly dependent on environmental factors that support the emergence of pest populations. The population level of a species of insect pest is basically the result of the interaction between the ability to reproduce (biotic potential) and external factors where the insect lives. External factors can be grouped into three groups, namely physical, feed and biology. Similarly, insect life is influenced by temperature, humidity, rainfall, wind and light (Anonymous).

The difficulty that occurs in the propagation of fruit flies is the unavailability of a large number of fruit flies due to the limited availability of the number of eggs produced by B. carambolae fruit flies, so that in meeting the needs of insects in large numbers for research purposes and to complement the results of previous research it is necessary to develop Maintenance techniques that can supply insects in large numbers and continuously are tested using artificial lighting by providing lights with different light intensity and duration of light on the fecundity and development of B. carambolae fruit flies. Light intensity and duration of irradiation can affect female flies in feeding, egg laying and copulation activities.

Female fruit flies are active in bright light conditions, namely during the day and mate at low light intensity, namely 1000 lux. Female flies that are placed in a place that gets a lot of light mature faster and lay eggs faster, but on the other hand, fruit fly pupae will not hatch when exposed to light.

Based on the research of Schwarz, Zambada, and Sorozco (1985) in the mass propagation of Mediterranean fruit flies, constant lighting is required with a value of 3000 lux through the provision of lights. According to Arahaki (1984) Dacus dorsalis mate at dusk when the light intensity is less than 1000 lux.

2. METHOD

2.1 Types of research

The research method used is the experimental method and consists of 2 experiments, namely the first experiment aims to determine the effect of light intensity and light duration on the fecundity of B. carambolae fruit flies, used imago 1 day after eclosion and the second experiment aimed to determine the effect of light intensity and length of light on the development of flies.

2.2 Research variable.

Observational variables in this experiment included fecundity and longevity of male and female imagos. Observation of the number of eggs of B. carambolae was carried out every day after 8 10 days of imago emergence, this was because at that time the imago had shown feeding activity and after that they had copulated and laid eggs. Laying bottles installed for 24 hours from 08.00 am.

2.3 Research design

The experimental design used in this study was light duration on the fecundity of the B. Carambolae fruit fly and this experiment was arranged using a factorial Completely Randomized Design (CRD) consisting of 2 factors. The first factor is the intensity of lighting with levels of 1000 lux, 2000 lux, 3000 lux. The second factor is the length of lighting / 24 hours with periods of 24 hours dark, 10 hours light, 12 hours light, 14 hours light, 24 hours light, and 24 hours dark. These two factors were combined to obtain 15 treatment combinations.

2.4 Sampling location

This research was conducted with samples of B. carambolae fruit fly eggs for the first infestation. The eggs were obtained from the rearing of the fruit fly B. carambolae at the Pest Laboratory, Department of Plant Pests and Diseases, Faculty of Agriculture, University of Brawijaya, Malang. B eggs

2.5 Time and Place of Research.

The research was conducted at the Pest Laboratory, Department of Plant Pests and Diseases, Faculty of Agriculture, Brawijaya University, Malang, from April 2008 to July 2008

2.6 Tools and materials

The tools used were treatment cages (200x111cm) covered with white cardboard, cages (15x15x15cm) made of cardboard, cages (58x42x38cm) made of cardboard covered inside with black linen paper, handsprayer, handcounter, petri dishes with diameter 9cm, sponge, light microscope (binoculars), 18 watt Osram lamp, timer, electric scales, egg bottles, tweezers, vials, plastic cage, thermometer and plastic jar.

The materials used in the study were protein hydrolyzate, granulated sugar, distilled water, water, sawdust, wheat bran, nipagen, sodium benzoate, yeast, imago and eggs.

2.7 Research procedure

The light intensity test was carried out in the Advanced Physics Laboratory, MIPA Department, Brawijaya University, Malang. Light intensity is measured using a light meter where the light meter sensor is placed perpendicularly under the light until it shows the desired intensity. The lamp used is an osram lamp 18 watt / 865, 1140 lm, 220 240 V and 50/60 Hz. The results obtained from the test were a light intensity of 1000 lux with a distance of 36 cm, a light intensity of 2000 lux with a distance of 18 cm and for the magnitude of the light intensity of 3000 lux with a distance of 12 cm followed by the construction of an experimental cage and experiments on B. carambolae fruit flies and their effects the interaction of light, both the duration of lighting and the speed of lighting on the growth of B. carambolae fruit flies.

2.8 Data analysis.

The data obtained were analyzed using the F test at the 5% level, then if there was a significant difference it was continued with the BNT level test 5%.

3. RESULTS AND DISCUSSION

3.1 Research result

The results of the tests on fruit flies and the effect of light on the growth of fruit flies were observed from two experiments, namely the first and second experiments, and in the two experiments the results were different.

3.1.1 First try

The results of the analysis of variance showed that there was a relationship between light intensity and light duration on the number of B. carambolae eggs produced by one female in the first experiment .

Table 1. Average Number of Eggs Produced by One B.carambolae Female During His Life at Different Light Intensity and Long Lighting Time

Light intensity	Lighting duration / 24 hours				
	24 dark	10 light	12 light	24 light	24 light
1000 lux	42.63 ab	51.15 abc	32.40 ab	28.02 a	101.10
2000 lux	42.63 ab	33.20 ab	80.00 cds	48.43 abc	58.72 abc
3000 lux	42.63 ab	65.98bcd	51.60 abc	62.10 abc	60.63 abc

Note: The mean value followed by the same letter indicates that the treatment given is not significantly different at BNT 5%. - For statistical analysis the data has been transformed to (X+0.5)0.5

The results of the analysis of variance in the longevity of male B. carambolae imago did not shows the effect of the relationship between light intensity and duration of exposure, as well as the intensity of light, however, duration of exposure has a significant effect. Table 2 shows that the average life span of male B. carambolae imago at light intensities of 1000 lux 67.06 days, 2000 lux 65.33 days and 3000 lux showed no significant effect. Meanwhile, on the light duration factor on the average length of life of male imago, the average light duration of 14 hours of light was not different from the light duration of 12 hours of light, 10 hours of light, 24 hours of light and 24 hours of darkness. In the 24-hour light factor, the light duration is different from the light duration of 12 hours and 24 hours of darkness, while the light duration of 12 hours is different from the light intensity average. There is a difference towards the light duration of 10 hours. It can be seen that the highest average is at a light intensity of 1000 lux with a light duration of 14 hours while the lowest average is at a light intensity of 1000 lux with a light duration of 12 hours.

Light intensity and duration of light influence female imago during the oviposition period for 10 days after emergence until day 10 due to the oviposition period requiring excessive lighting to

trigger and produce a large number of eggs. The female imago experiences the post-oviposition period, which is the period when the female imago no longer produces eggs even though she has a long life span and is still alive, but the female imago no longer has the ability to decrease her activity so she cannot maintain her life longer.

3.1.2 Second try

The results of the analysis of variance showed that there was a relationship between light intensity and duration of light on the percentage of hatching eggs.

Table 2. Average percentage of hatching eggs of B. carambolae at light intensity and Different Exposure Length. Light intensity

Light intensity	Lighting duration / 24 hours				
	24 dark	10 light	12 light	24 light	24 light
1000 lux	43.00 cds	43.67 de	35.67 abcd	38.33 abcd	29.67 a
2000 lux	43.00 cds	33.00 abc	51.33 e	33.33 abcd	31.67 ab
3000 lux	43.00 cds	36.67 abcd	40.33bcd	38.33 abcd	39.67 abcd

Note : -The mean value followed by the same letter indicates that the treatment given t is not significantly different in the 5% BNT test.
-For statistical analysis the data has been transformed to arsine.

Table 2 shows that the average percentage of hatching eggs at light intensities of 1000 lux, 2000 lux and 3000 lux with a light duration of 24 hours dark 10 hours light 12 hours light, 14 hours light and 24 hours light shows the difference. The combination of treatments that affect the percentage of egg hatching is the intensity of 1000 lux for 24 hours of light, different from the light intensity of 1000 lux for 10 hours of light, 2000 lux for 12 hours of light, 3000 lux for 12 hours of light. hours of light and 24 hours of darkness.

The results of the analysis of variance showed that there was a relationship between light intensity and light duration on the larval stage of B. carambolae. In Table 5 it can be seen that the light intensity and duration of lighting are significantly different from the average length of the larval stage, seen in the combination of treatments, the light intensity of 2000 lux with a light duration of 14 hours is different from the average duration of the larval stage in the treatment of light intensity of 2000 lux with a duration of 24 hours light intensity 1000 lux for 10 hours of light, 3000 lux for 14 hours of light, 1000 lux for 14 hours of light, 1000 lux for 24 hours of darkness and average stadium length B larvae

The longevity of the larvae can produce a lot of pupae where it is suspected that the energy needed in the formation of pupae is sufficiently fulfilled in terms of storing food reserves in the body. The results of the analysis of variance on the number of B. carambolae pupae formed showed that there was no relationship between light intensity and exposure time as well as the light intensity factor, however, exposure duration could have a significant effect. The results of the analysis of variance showed that there was no interaction between light intensity and light duration on pupal weight in all treatments.

The results of the analysis of variance showed that there was no relationship between light intensity and length of exposure to the duration of the pupal stage, however, duration of light had a significant effect on the contrary, the light intensity factor did not have a significant effect and in this case the duration of light can also affect the fruit fly metabolic processes that take place. at the pupal stage. The duration of light can slow down and speed up the metabolic processes of fruit flies, the more light intensity increases, the more results in the formation, but in terms of the length of time, the longer the light, the less the results in the formation of imago.

3.2 Discussion

Light is a factor that affects the life of insects both on their development and activities. According to Jumar (1999), some insect activity is influenced by responses to light, resulting in insects that are active in the morning, afternoon, evening or night. A number of insects are also attracted to the light. The intensity of the light and the duration of the irradiation can affect the activity of female flies in feeding, egg laying and copulation activities. Flies are active in bright light, i.e. during the day and mate at low light intensity. Light intensity and duration of irradiation can affect the activity of female flies in feeding, egg laying and copulation activities.

In observing the number of pupae formed, the duration of the pupal stage, and the number of imagos formed against the light intensity of 1000 lux, 2000 lux, and 3000 lux there was no effect, but there was an effect on the length of light. B. carambolae observed the percentage of eggs

hatching was 51.33, the number of pupae formed was 61 eggs and the number of imagos formed was 53 which had a high yield even though the larval stage was 10.17 days long and the pupal stage was 9.39 days. the long time in the process of forming pupae and imago is suspected by the length of time needed for the formation of pupa and imago in getting a lot of production,in the larval stage has food reserves in the body obtained from artificial feed so that the energy needed is sufficiently fulfilled.

4. CONCLUSION

The highest fecundity of B.carambolae fruit flies was found in the light intensity treatment of 2000 lux with a light duration of 12 hours of light and 12 dark of 80 grains while the lowest fecundity was found in the treatment of light intensity of 1000 lux with a duration of light of 14 hours of light and 10 hours of darkness of 28.02 grains and development of B. carambolae fruit flies at a light intensity of 2000 lux with a light duration of 12 hours light and 12 hours dark is an appropriate treatment for the development of B. carambolae with an average percentage of hatching eggs of 51.33%, an average length of larval stage of 10.,7 days, the average number of pupae formed was 61.00 eggs, the average pupal weight was 0.011 g, the average pupal stage was 9.39 days and the average number of imagos formed was 53.00.

ACKNOWLEDGEMENTS

In the mass rearing of B. carambolae fruit flies in the laboratory it is better to use lighting with a light intensity of 2000 lux and a light duration of 12 hours light and 12 hours dark.

REFERENCES

Andrewartha, H. G., L.C. Birch. 1974. The Distribution and Abundance Of Animal. The University Of Chicago Press. Chicago and London. 764 hlm

Anonymous, 2002a. Pedoman Pengendalian Hama Lalat buah. Direktorat Jendral Perlindungan Bina Produksi Hortikultura Direktorat Perlindungan Hortikultura. Jakarta

Borror, D. J., C. A. Triplehorn dan N. F. Johnson. 1989. Pengenalan Pelajaran Serangga. Edisi Keenam. (Terjemahan) Gadjah Mada UniversityPress. Yogyakarta.

Calvert, J.B. 2003. Vision and Colour: Eyes and the visual sense. Available at. http://www.du.edu/~jgalvert/optics/colour.html

Carrol, L. E., A. L. Norrbom, M. J. Dollwitz, dan F. C. Thompson, 2002. Pest Fruit Flies of the World Larvae Online . http://delta-intkey.com (Verified 24 April 2008).

Djumar.1999. Entomologi Pertanian. Rineka Cipta. Jakarta. Hal 94

Drew, R.A.I dan D.L. Hancock. 1994. The Bactrocera dorsalis complex of Fruit Flies (Diptera : Tephritidae : Dacinae) in Asia. Bulletin of Entomologycal Research : Suplement Series Number 2. In Suplement 2. Departement of Prymary Industries. Australia. Hal 11-13.

Gullan, P.J. 2005. The Insect an Outline of Entomology Third Edition. Blackwell Publishing..158-161

Hendrawan, D. 2007. Pengaruh Jenis Bahan Dasar Pada Pakan Buatan Terhadap Pertumbuhan Dan Perkembangan Lalat Buah Bactrocer carambolae Drew dan Hancock (Diptera : Tephritidae). Skripsi. Fakultas Pertanian Universitas Brawijaya. Malang.

Himawan, T. 2003. Studi Populasi Lalat Buah Bactrocera dorsalis complex Pada Tanaman Mangga Dengan Pola Tanam Monokultur dan Campuran Di Jawa Timur. Disertasi. Program Pasca Sarjana Universitas Brawijaya. Malang. Hal 40-68.

Kardinan, A. 2002. Pedoman Pengendalian Hama Lalat Buah. Direktorat Jenderal Bina Produksi Hortikultura.Jakarta.

Kusmaryono. Y. 1999. Hubungan Cuaca Iklim Dengan Hama Tanaman. Materi Kuliah Online Geomet.FMIPA. IPB

Kuswadi, A.N., Darmawi dan M. Indarwatni. 1997. Biologi Lalat Buah Bactrocera carambolae dalam Biakan Di Laboratorium dengan Makanan Buatan. Pro. Seminar Nasional Biologi XV. PEI dan Univ. Lampung. Bandarlampung :1510-1514.

Putra, N.S. 1997. Hama Lalat Buah dan Pengendaliannya. Kanisius. Yogyakarta.64 hal.

Raharjo. A. P. 2008. Pengaruh Suhu Terhadap Lama Stadia Lalat Buah B.carambolae Drew dan Hancock (Diptera: Teprithidae). Skripsi. Fakultas Pertanian Universitas Brawijaya. Malang.

Raspi. A., Angelo.C., dan Augusto. L., 2005. Presence of Mature Eggs in OliveFruit Fly, Bactrocera oleae (Diptera Tephritidae), at different constant phothoperiod and at two temperature. Available at http://www.mass rearing/photoperiod/bulletin of insectology.html.

Sarwono,. Rosmahani dan Nur Imah.1990. Distribusi dan Tingkat Serangan Lalat Buah (Dacus dorsalis komplek) di beberapa sentra produksi mangga di Jawa Timur dan Bali. Penl. Hort.5 (1) : 79-84

Schward, A. Zambada, D. H. Sorozco, J. 1985. Mass Production Of The Mediterranean Fruit Fly at Metapa Mexico.Available at http://fcla.edu/florida entomology/mass production of medfly.html. Siwi, S.S. 2002. Report on Development of a Database and Upgrading of Associated Reference Speciments of Agriculturally Important Insect. Badan Litbang Pertanian-PAATP. Page 4-21.

Suputa, Cahyaniati, A. Kustaryati, Issusilaningtyas, M. Railan, W. P. Mardiasih. 2006. Pedoman Pengelolaan Hama Lalat Buah. Direktorat Perlindungan Tanaman Hortikultura. Jakarta. p 43.

Walker,G.P, 1997 . Laboratory Rearing Techniques for Tephritid Fruit Flies in Pasific Island Countries and Territories. http://www.spc.int/pacifly/fruit fly manual htm.(verified 5 april 2008).