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INFLUENCE OF TEMPERATURE ON THE DEVELOPMENT OF BLACK SOLDIER FLY *HERMETIA ILLUCENS*

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ABSTRACT

Black soldier fly *Hermetia illucens* L (Stratiomyidae: Diptera) was raised on a diet of rice bran and groundnut oil cakes at different temperatures (20± 2, 24± 2, and 27± 2°C) with a relative humidity of 75.5%; lifecycle was found to be the shortest at 27± 2°C, and adult longevity increased by two days. Also, there was a higher survival rate for larvae, prepupae, pupae and adults, and the fecundity and hatchability increased at this temperature.

Key words: *Hermetia illucens*, growth, temperature, larvae, prepupae, pupae, adults, fecundity, hatchability, survival, lifecycle, periods, rice bran, groundnut oil cakes.

In a globalised world, waste streams are the major problem but there are only fewer methods for disposing it. This makes the researcher to create a new strategy for the management of waste streams. One such method is using black soldier flies (*Hermetia illucens*) larvae. This is seeking attention towards the farmers as it decomposes waste and can be used as alternative meal for fish and poultry (Lohri et al., 2017). Black soldier flies are found in nutrient-rich ecosystems such as manure heaps and compost heaps (Tomberlin et al., 2002). Furthermore, larvae are nutrient-rich, with 42.1-43.2% crude protein, 28-33% fat, and micronutrients (Newton et al., 2005, St-Hilaire et al., 2007, Fitriana et al., 2022). Black soldier fly is capable of effectively transforming livestock and poultry manure into larval biomass and compost for producing animal feed and biofertilizer. Black soldier fly integrates three major terms waste composting, nutrient recovery and income generation in its application (Lalander et al*.,* 2019). Temperature is an important factor in the growth of the black soldier fly. The parameters such as development time, adult longevity and egg eclosion helps to understand the environmental particulars of black soldier fly (Holmes et al., 2016; Tomberlin et al., 2009, Opare et al., 2022) which is useful for small to medium farmers. The aim of the study was to find the suitable temperature for the development of black soldier fly.

MATERIALS AND METHODS

The present study was carried out at the Department of Entomology, Faculty of Agriculture, Annamalai University, Annamalainagar, Chidambaram (11.3918° N, 79.7132° E) during 2021. The culture of Black Soldier Fly (BSF) was established with the egg mass collected from the Freshrooms Lifesciences Private Limited at Elavathadi, Villupuram district, Tamil Nadu. The experimental method for culturing black soldier fly used in this study followed the procedure described by (Qomi et al., 2021). To find the suitable temperature range for culturing BSF, an experiment was conducted at controlled conditions. The BSF was cultured on rice bran: groundnut oil cake: water @ 1:1:1 ratio at various temperature ranges such as 20± 2°C, 24± 2°C and 27± 2°C and the relative humidity maintained was 75± 5%. The experiment was initiated with newly emerged first instar larvae. There were three treatments and seven replications and fifty larvae were used per replication. There were no differences in the weight of the food supplied. The data obtained from laboratory experiment were analyzed in a Completely Randomized Block Design. Duncan's Multiple Range Test (DMRT) was used to compare the treatment mean at p=0.05 using R software version 4.3.1.

RESULTS AND DISCUSSION

The data analysis showed that the shortest development time from larva to adult is about 39.9 days and highest survival was ranging from 93.10 to 94.25 (larva to adult) at 27°C (Table 1). Highest fecundity and hatchability were observed at 27± 2°C (922.55 eggs/ female, 94.25%). Longest development time, lowest survival percentage, lowest hatchability and lowest

Table 1. Effect of temperature on the growth and development of black soldier fly

Sl. No.	Treatment	*Longevity (days)					**Survival (%)				Egg	
		Larva	Prepupa	Pupa	Adult	Total	Larva	Prepupa	Pupa	Adult	Fecundity	**Hatchability (%)
1.	20± 2°C	19.71 (1.76)^{c}	8.72 (3.03)^{c}	8.66 (2.94)^{c}	8.37 (2.89)^{c}	45.46	74.24 (59.50)^{c}	68.20 (55.67)^{c}	68.20 (55.67)^{c}	68.91 (56.11)^{c}	169.11 (13.00)^{c}	71.61 (57.81)^{c}
2.	24± 2°C	18.44 (1.77)^{b}	7.12 (2.75)^{b}	7.27 (2.69)^{b}	9.12 (3.02)^{b}	41.95	90.95 (72.50)^{b}	82.92 (65.59)^{b}	82.92 (65.59)^{b}	84.35 (66.72)^{b}	472.68 (21.74)^{b}	86.28 (68.35)^{b}
3.	27± 2°C	17.16 (2.46)^{a}	6.22 (2.59)^{a}	6.22 (2.49)^{a}	10.30 (3.20)^{a}	39.9	93.10 (74.79)^{a}	93.10 (74.79)^{a}	93.10 (74.79)^{a}	94.25 (76.15)^{a}	922.55 (30.37)^{a}	94.25 (76.15)^{a}
	S. Ed.	0.09	0.05	0.06	0.04		0.32	0.32	0.32	0.55	0.03	0.86
	CD (p=0.05)	0.04	0.12	0.13	0.10		0.69	0.68	0.68	1.17	0.06	1.82

Values mean of seven replications, *Values in parentheses transformed values, **Values in parenthesis arc sin transformed.

fecundity were observed at 20°C. Qomi et al. (2021) stated that the survival of larvae varied from 70- 93%, at 20- 30°C. The same trend was observed in the present study on the survival of pupa as observed earlier by Qomi et al. (2021); hatchability varied as 50, 55 and 50% at 20, 25 and 30°C, respectively, in contrast to the observations now. Qomi et al. (2021) stated that the time taken for larval development of BSF was shortest at 30°C (13 days) and 25°C (18 days). The pupal development of BSF was 30°C (7 days) and 25°C (9 days). These finding are similar to our present findings. Qomi et al. (2021) observed that the longevity decreased with the increase in temperature which is contradictory to our present findings. Shumo et al. (2019) observed the highest fecundity at 30°C (916.1 eggs/ female) followed by 25°C (472.9 eggs/ female) and the lowest at 20°C (169.9 eggs/ female). These findings are similar to our present findings. He also stated that the time taken for larval development decreased gradually with the increase in temperature and was the shortest under 30°C (24.7 days) and 35°C (83.4 days) when fed on grains and cow dung. Further, cow dung fed larvae took 180 and 86.8 days at 20°C and 25°C respectively. While spent grain fed larvae took 96.3 and 32.8 days at 20°C and 25°C respectively. Cow dung fed BSF had an adult longevity of 9.8, 9.6 and 8.37 days and grain fed BSF had an adult longevity of 12.6, 10.2 and 9.2 days at 20°C, 25°C and 30°C respectively. The same trend was observed in our study related to fecundity and larval development. In our results, the adult longevity was found to be increasing with the increase in temperature, but the results of Shumo et al. (2019), explained that the longevity decreased with increasing temperature. This is contradictory to our findings.

Chia et al. (2018) reported that the survival percentage of larvae and pre pupae increased as 74.6, 93, 92.6 and 68.4, 83.1, 83.2% when reared at 20, 25 and 30°C respectively. These findings are similar to our findings. The same trend was observed in our study related to the survival percentage of pupa as reported by Chia et al. (2018) with the values of 61.6%, 67.4%, 77.1% at 20°C, 25°C and 30°C respectively. Gligorescu et al. (2018) stated that the larvae were found to develop faster when fed on the control Gainesville diet, followed by the protein diet, and lastly by the Carbohydrate diet when compared to 20°C. The same trend was observed in our study related to larval development. Holmes et al. (2016) reported that the time taken for larval, pupal development and survival percentage was 60.96 days, 11.52 days and 31.90% at 19°C which was contradictory to our present findings. Our findings are on par with the findings of Holmes et al. (2012) who stated that the time taken for larval, pupal development and survival percentage was 13 days, 8.41 days and 93% at 27°C. Tomberlin et al. (2009) stated that the time taken for larval development of BSF decreased gradually with the increasing temperatures and was the shortest at 30°C (17.7 days) and 27°C (19.5 days). These findings are similar to our findings. In our results, the adult longevity was found to be increasing with the increase in temperature, but the results of Tomberlin et al. (2009), reported that the longevity decreased with the increasing temperature. This is contradictory to our findings. This study demonstrates that temperature has a significant impact on the development and growth of BSF. Our findings indicated that temperature has an impact on an organism's fecundity, longevity, survival rate, and hatchability. The substrate (artificial diet), in addition to temperature, has an impact on development and growth of BSF.

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AUTHOR CONTRIBUTION STATEMENT

Mohammad Ikram, S Arivudainambi and R Janarthanan conceived and designed research, Mohammad Ikram conducted the experiment and wrote the manuscript while S Arivudainambi provided guidance and advice.

CONFLICT OF INTEREST

No conflict of interest.

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