The Journal of Animal & Plant Sciences, 21(3): 2011, Page: 556-560
ISSN: 1018-7081

STUDIES ON BIOLOGY OF A NEW STRAIN (K_2) OF SILKWORM (*BOMBYX MORI* L.) UNDER DIFFERENT SETS OF TEMPERATURE AND HUMIDITY

S. Kaleem, I. Mahmood[*], M. Ahmad[*], M. A. A. H. A. Bukhsh, A. Wasaya[*], A. Qayyum[*], and M. A. Raza[**]

Agriculture Adaptive Research Complex, Dera Ghazi Khan, Pakistan.
[*]Department of Agronomy, PMAS, Arid Agriculture University Rawalpindi, Pakistan.
[**]Department of Animal Husbandry in the Tropics & Subtropics, Faculty of Organic Agricultural Sciences, University of Kassel, Germany
Corresponding author: durraiz70@yahoo.com,

ABSTRACT

Silkworm rearing is an applied science based on theory of anatomical physiology of silkworm and silk worm diseases. With an ultimate aim of producing more and better quantity and quality of silk (a natural protein fiber) and to expand the areas for its production country wise regions, many strains have been introduced date to date. A new strain of silkworm (K_2) was evaluated to include it in the efforts to raise our national productive potential of natural silk. For this purpose the biology of this strain was determined under different sets of temperature and humidity. The study was carried out in the old insectary, Department of Agri. Entomology, University of Agriculture, Faisalabad, Pakistan. The eggs of silkworm were brought from Directorate of Sericulture, Muzaffarabad, Azad Jammu & Kashmir. The eggs were shifted to four different sets of temperatures, 30, 25, 20^{o}C and at room temperature as reference. The relative humidity (R.H) 60, 70 and 80% for first three temperatures was maintained, respectively. In each group equal number of larvae was placed and groups were assigned as: T_o = Room Temperature and R. H., T_1 = 30^{o}C with 60% R. H., T_2 = 25^{o}C with 70% R. H. and T_3 = 20^{o}C with 80% R. H. The experiment was laid out in completely randomized design. It was observed that the longest period (4440 minutes) during first instar was taken when silkworm larvae were subjected to 20^{o}C and 80 % R.H, where as the shortest period (2010 minutes) was recorded when silkworm larvae were subjected to 30^{o}C and 60 % R.H. The longest moulting period after first instar (1680 minutes) was recorded in control and the shortest period (1270 minutes) was observed when larvae were subjected to 30^{o}C and 60% R.H. The longest period for second instar was 4560 minutes where as the shortest period (2876.66 minutes) was recorded when larvae were subjected to 30^{o}C and 60% R.H. The longest moulting period (1620 minutes) after second instar was recorded when larvae were subjected to 20^{o}C and 80% R.H. and the shortest period (1438.33 minutes) was observed when larvae were subjected to 30^{o}C and 60% R.H. The longest period for the third instar (6662.07 minutes) was observed when larvae were subjected to 20^{o}C and 80% R.H, where as the lowest period (4305 minutes) was observed when larvae were subjected to 30^{o}C and 60 % R.H. The longest period for the moulting after third instar (2760 minutes) was observed when larvae were subjected to 20^{o}C and 80% R.H., where as the lowest period (1437 minutes) was noted when larvae were subjected to 30^{o}C and 60% R.H. The longest period of fourth instar (7413.33 minute) was observed when larvae were subjected to 20^{o}C and 80% R.H.; where as the lowest period (4318.33 minutes) was noted when larvae were subjected to 25^{o}C and 70% R.H. The longest period for the moulting period after fourth instar (2520 minutes) was observed when larvae were subjected to 20^{o}C and 80% R.H., where as the lowest period (1613.33 minutes) was noted when larvae were subjected to 30^{o}C and 60% R.H. The longest period for fifth instar (13010 minutes) was observed when larvae were subjected to 20^{o}C and 80% R.H.; where as the lowest period (10080 minutes) was noted when larvae were subjected to 25^{o}C and 70% R.H. The longest period for total life (44635 minutes) was observed when larvae were subjected to 20^{o}C and 80% R.H.; where as the shortest period (29650 minutes) was noted when larvae were subjected to 30^{o}C and 60% R.H.

Key words: Silkworm; new strain; biology; temperature; relative humidity.

INTRODUCTION

Silk originating in the spittle of an insect is a natural fibrous substance and is obtained from pupal nests or cocoons spun by larvae known as silkworm, preferred over all other types of fibres due to its remarkable properties like water absorbency, heath resistance, dyeing efficiency, and luster (Fenemore and Parkash, 1992; Ahmed and Muzaffar, 1987). Silk is a natural protein fiber. It contains about 75% actual fibre fibrion and 25% of sericin gummy protein that holds filaments. These filaments are about 1000 to 1300 yards in length and can be as long as 3000 yards (Mathew, 1996). Silk has benefited man not only by producing fabrics due to its lighter weight, suppleness, luster, grace, durability, dyability and tenacity but also used in making artificial blood vessels, surgical sutures, electrical insulation materials and tyre linings (Ahmed, 1990). Besides this, silkworm is considered as a treasure house from head to

foot because nothing gets waste in sericulture; the by products such as mulberry shoots serve as fire wood and fuel, the left over larvae and excreta as cattle feed, manure and in the production of biogas, reeled out pupae and used male moths as poultry feed and in the manufacturing of certain medicines and amino acids; mulberry roots and bark in preparing anti-hypertension drugs (Siddiqui, 1988). In the view of its immense uses and output involving less input, time and energy, serious attention is needed to promote both the exploited and unexploited potential of sericulcutre through out the country not only to earn foreign exchange but also alleviate poverty among rural community.

With an ultimate aim of producing more and better quantity and quality of silk and to expand the areas for its production country wise regions, many strains have been introduced date to date. A new strain of silkworm (K_2) was evaluated in the present study to include it in the efforts to raise our national productive potential of natural silk. For this purpose the biology of the strain was determined under different sets of temperature and humidity.

MATERIALS AND METHODS

The study for testing the effects of environment on its growth, development and fecundity of silkworm was carried out in the old Insectary, Department of Agri. Entomology, University of Agriculture, Faisalabad. The eggs of silkworm were brought from Directorate of Sericulture, Muzaffarabad, Azad Jammu & Kashmir. The eggs were shifted to four different temperatures, 30, 25, 20 ^{o}C and at room temperature as reference. The relative humidity at each temperature was also different respectively 60, 70 and 80% for first three temperatures. Humidifier was used to control the humidity for the best of the results of the project under study. Soon after hatching, the larvae were placed in small cardboards measuring 12 x 9 inches (30.48 x 22.86 cm). In each group equal number of larvae was placed and the groups were assigned as: T_0 = Room Temperature and relative humidity, T1 = 30^{o}C with 60 % relative humidity, T_2 = 25^{o}C with 70% relative humidity, T_3 = 20^{o}C with 80% relative humidity. The experiment was laid out in completely randomized design.

Fecundity rate of each group of silkworm moth was found out. For the mating purpose the silkworm moths of opposite sexes were allowed to mate in separate Card. They were allowed to mate for four hours and egg laying sheets were provided too. White paper sheets were used as beds for the mating couples of silkworm moths for an easy counting of eggs laid by females. At the next days eggs were counted to check the effects of different temperatures and relative humidities on the fecundity rate of the K_2 line of *Bombyx mori* L. To measure the mortality of silkworm larvae only at 5th instar, 20 larvae were selected and their respective mortality potential was calculated from each group. For the measurement of cocoon, 10 cocoons from each group were selected randomly. Finally cocoon shell ratio was measured by the formula as follows. Cocoon shell ratio = average shell weight x 100/ average cocoon weight.

Statistical analysis was carried out by using "MSTAT-C". Data recorded were analyzed using the Fisher's analysis of variance technique and treatment's means were compared at 5% level of probability by using LSD test (Steel *et al*., 1997).

RESULTS AND DISCUSSION

The comparison of treatments presented in Table 1 showed that 2010 minutes (the shortest period) were taken by 1st instar larvae when they were subjected to 30^{o}C and 60% relative humidity, where as 3605 minutes were taken on 1st instar larvae when they were subjected to 25^{o}C and 70 % relative humidity. Similarly, 4440 minutes (the longest period) were taken by 1st instar larvae when subjected to 20^{o}C and 80% relative humidity, while 3900 minutes were recorded when larvae were subjected to room temperature and R.H. to complete the first larval instar. All the treatments significantly differed from each other. Our Results are in accordance with those of Benchmin *et al.* (1989) who reported that length of 1st instar period of silkworm larvae was increased by decreasing the temperature for 10 days. Similarly, Reddy *et al.* (2002) found that temperature and R.H. exert synergistic impact regarding silkworm instar larval periods.

The treatment means presented in Table 1 depicted statistically significant results and showed that 1270 minutes were taken for the moulting period after first instar when larvae were subjected to 30^{o}C and 60% relative humidity, where as 1503.33 minutes were taken for the moulting period after first instar when larvae were subjected to 25 ^{o}C and 70 % relative humidity. Similarly, 1650 minutes were taken on an average for the moulting period after first instar when larvae were subjected to 20^{o}C and 80 % R.H. The longest moulting period (1680 minutes) was recorded in control and the shortest period (1270 minutes) was observed when larvae were subjected to 30^{o}C and 60 % relative humidity. These results are in conformity with those of Mishra and Upadhyay (2002) who reported that change in temperature along with RH has pronounced effect on moulting period. Similarly, Kamilli and Masoodi, (2004) found that decrease in temperature enhances the moulting duration in silkworm. All treatments significantly differed from each other.

The treatment means of second instar length (table 1) showed that 2876.66 minutes were taken when larvae were subjected to 30^{o}C and 60% R.H, where 3720 minutes were taken by larvae when subjected to 25^{o}C and 70%. R. H. Similarly, 4560 minutes were taken on an

average when larvae were subjected to 20°C and 80% R.H, while 3919.33 minutes were recorded when larvae were subjected to room temperature and R.H. to complete the second larval instar. The longest period for second instar was 4560 minutes at 20°C and 80% R.H, where as the shortest period (2876.66 minutes) was recorded when larvae were subjected to 30°C and 60 % R.H. All the treatments significantly differed from each other. Our Results are in line with those of Benchmin *et al.* (1989) who reported that length of 2nd instar period of silkworm larvae was increased by decreasing the temperature for 10 days. Similarly, Kumar, *et al.* (1997) found low temperature better than higher one with reference to productivity of silkworm and larval duration for different instars.

The treatment means presented in Table 1 depicted statistically significant results and showed that 1438.33 minutes were taken in the moulting period after second instar when the larvae were subjected to 30°C and 60 % R. H. where 1503.33 minutes were taken for the moulting period after second instar when the larvae were subjected to 25°C and 70 % R. H. Similarly, on an average, 1620 minutes were taken when larvae were subjected to 20°C and 80 % R. H. while, 1455 minutes were taken in the moulting period after second instar when the larvae were subjected to room temperature and R. H. The longest period (1620 minutes) were noted for the moulting period after second instar when larvae were subjected to 20°C and 80 % R. H. and the shortest period (1438.33 minutes) was observed when larvae were subjected to 30°C and 60 % R. H. All the treatments significantly differed from each other. These results are in accordance with those of Reddy *et al.* (2002) who found that temperature and R.H. exert synergistic impact regarding silkworm rearing and moulting duration.

The treatment means showed that 3405 minutes were taken for third instar when larvae were subjected to 30°C and 60% R. H, where as 5910 minutes were taken for third instar when larvae were subjected to 25°C and 70% R.H. Similarly, on an average, 6662.07 minutes were taken for the third instar when the larvae were subjected to 20°C and 80 % R. H. and 4503.33 minutes were taken by larvae for the third instar when the larvae were subjected to room temperature and R. H. The longest period for the third instar (6662.07 minutes) was observed when larvae were subjected to 20°C and 80 % R. H., where as the lowest period (4305 minutes) was noted when larvae were subjected larvae were subjected to 30°C and 60 R.H. All the treatment significantly differed from each other. Our Results are in accordance with those of Benchmin *et al.* (1989) who reported that length of 1st, 2nd and 3rd instar periods of silkworm larvae was increased by decreasing the temperature for 10 days. Tribhuwan *et al.* (1998) also reported that temperature and R.H. were among the various factors that influence growth, behaviour and instar larval periods in silkworm.

The treatment means showed that 1437 minutes were taken for moulting period after third instar when larvae were subjected to 30°C and 60 % R.H, where as 1528 minutes were taken for moulting period third instar when larvae were subjected to 25°C and 70 % R.H. Similarly, on an average, 2760 minutes were taken for the third instar when the larvae were subjected to 20°C and 80 % R.H and 2220 minutes were taken by the larvae when subjected to room temperature and R.H. The longest period for the moulting period after third instar (2760 minutes) was observed when larvae were subjected to 20°C and 80 % R.H., where as the lowest period (1437 minutes) was noted when larvae were subjected to 30°C and 60 R.H. All the treatments significantly differed from each other. These results are in conformity with those of Mishra and Upadhyay (2002) who reported that change in temperature along with RH has pronounced effect on moulting period. Similarly, Veturik, (2002) found that optimum R.H. was from 80-90% for different silkworm generations and moulting periods after various instars.

The treatment means showed that 4440 minutes were taken for fourth instar period when larvae were subjected to 30°C and 60% R.H, where as 4318.33 minutes were taken for period of fourth instar when larvae were subjected to 25 °C and 70% R.H. Similarly, on an average, 7413.33 minutes (the longest period) were taken for the fourth instar period when the larvae were subjected to 20°C and 80% R.H and 6240 minutes were taken by larvae for the fourth instar when the larvae were subjected to room temperature and R.H. All the treatments significantly differed from each other. Veturik, (2002) found that optimum R.H. was from 80-90% for different silkworm generations and larval periods after various instars decreased when humidity fell below 80%. Similarly, Mishra and Upadhyay (2002) also reported that change in temperature along with R.H. has pronounced effect on silkworm larval periods at different instars.

The treatment means showed that 1613.33 minutes were taken for moulting period after fourth instar when larvae were subjected to 30°C and 60 % R.H, where as 2168.33 minutes were taken for moulting period after fourth instar when larvae were subjected to 25°C and 70 % R.H. Similarly, on an average, 2520 minutes (the longest period) were taken for the moulting period after fourth instar when the larvae were subjected to 20 °C and 80% R.H and 2280 minutes were taken by larvae for the moulting period after fourth instar when the larvae were subjected to room temperature and R.H. Our results are supported with the findings of Kamilli and Masoodi, (2004) and Mishra and Upadhyay (2002) those found that decrease in temperature enhances the moulting duration in silkworm. All the treatment significantly differed from each other.

The treatment means showed that 10260 minutes were taken for fifth instar period when larvae were subjected to 30°C and 60% R.H. where as 10080 minutes were taken for period of fourth instar when larvae were subjected to 25°C and 70 % R.H. Similarly, on an average, 13010 minutes (the longest period) were taken for the fifth instar period when the larvae were subjected to 20°C and 80 % R.H. while, 11762.07 minutes were taken for the fifth instar when the larvae were subjected to room temperature and R.H. All the treatments significantly differed from each other. Tribhuwan *et al.* (1998) also reported that temperature and R.H. were among the various factors that influence growth, behaviour and instar larval periods in silkworm. Our results are also in line with those of Kamilli and Masoodi, (2004) who found that decrease in temperature enhances the various instar larval duration in silkworm.

The treatment means presented in Table 1 depicted statistically significant results and showed that 29650 minutes (the shortest period) were taken for total life period when larvae were subjected to 30°C and 60 R.H, where as 34366.67 minutes were taken for total life period when larvae were subjected to 25°C and 70 % R.H. Similarly, on an average, 44635 minutes (the longest period) were taken for total life period when the larvae were subjected to 20°C and 80% R.H and 37953.33 minutes were taken for total life period when the larvae were subjected to room temperature and R.H. These results are in conformity with those of Mishra and Upadhyay (2002); Veturik, (2002); Reddy *et al.* (2002) and Greiss and Patkov (2001) those found that life period is influenced by change in temperature along with R.H.

Table 1: Studies on biology of a new strain (K2) of silkworm (Bombyx mori L.) under different sets of temperature and humidity.

Treatments	1st instar larval duration (minutes)	Moulting period after 1st instar (minutes)	2nd instar larval duration (minutes)	Moulting period after 2nd instar (minutes)	3rd instar larval duration (minutes)	Moulting period after 3rd instar (minutes)	4th instar larval duration (minutes)	Moulting period after 4th instar (minutes)	5th instar larval duration (minutes)	Total life Period (minutes)
T0	2010.00^{d}	1270.00^{d}	2876.66^{d}	1438.33^{d}	4305.00^{d}	1437.00^{d}	4440.00^{c}	1613.33^{d}	10260.00^{c}	29650.00^{d}
T1	3605.00^{c}	1503.33^{c}	3720.00^{c}	1503.33^{b}	5910.00^{b}	1528.00^{c}	4318.33^{d}	2168.33^{c}	10080.00^{d}	34366.67^{c}
T2	4440.00^{a}	1650.00^{b}	4560.00^{a}	1620.00^{a}	6662.07^{a}	2760.00^{a}	7413.33^{a}	2520.00^{a}	13010.00^{a}	44635.00^{a}
T3	3900.00^{b}	1680.00^{a}	3919.33^{b}	1455.00^{c}	4503.33^{c}	220.00^{b}	6240.00^{b}	2280.00^{b}	11762.07^{b}	37953.33^{b}
CV (%)	0.41	0.60	0.24	0.17	0.17	0.63	0.18	0.46	0.63	0.22

Where T_0 = Room temperature and Relative Humidity (R.H), T_1 = 30 °C and 60% (R.H),
T_2 = 25 °C and 70% (R.H), T_3 = 20 °C and 80% (R.H),
(Means followed by different letters in treatments are significantly different at P<0.01).

Conclusion: In the present investigations, attempt was made to determine the biology of a new strain (K_2) of silkworm under different sets of temperature and humidity. On the basis of these studies, we can conclude that varying sets of temperature and humidity affect both quantity and quality of silkworm as 40 % mortality of larvae was recorded at 25°C whereas development was good at 80 % R.H and the losses occurred as the humidity fell below 80 %.

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