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Seasonal Rearing Performance of Multivoltine Pure Mysore Silkworm in Southern dry Zone of Karnataka, India

Vinayak Hosamani [a++*], R. H. Chandrashekar [b#], Venkatesh Hosamani [c†] and G. R. Manjunath [d++]

[a] P2 Basic Seed Farm, National Silkworm Seed Organization, Central Silk Board, Banasageri Haliyala, Karnataka-581 329, India.
[b] SSTL, NSSO, Kodathi, Bangalore, India.
[c] COH, Munirabad, UHS, Bagalkot India.
[d] RCS, Central Silk Board, Bangalore, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

The differences in the seasons and environmental components considerably affect the quality of the multivoltine silk worm seed crop such as cocoon weight, shell weight, and cocoon shell ratio. Frequent fluctuations in the environmental conditions day to day and season to season point up the importance of management of temperature and relative humidity for sustainable seed cocoon production in the basic seed farms. Hence to know the role of seasonal temperature and humidity on growth and development of Multivoltine silkworm, present study conducted at P2 Basic Seed Farm Nagenahalli, Central Silk Board, Karnataka to assess the seasonal performance of the

[++] *Scientist-C;*
[#] *Scientist-D;*
[†] *Assistant Professor (Entomology);*
**Corresponding author: E-mail: vinayakhosmani2033@gmail.com;*

multivoltine silkworm using various parameters. In the study all the data were recoreded were subjected to the correlation and the correlation results revealed significantly higher hatching per cent yield (number and weight)/ 100 dfls (Kg),single cocoon weight(gm) and single cell weight (gm) were 95.67, 43414.45 (by number) and 57.70 kg (by weight), 1.233 and 0.180, respectively) during the winter season, whereas significantly higher weight of 10 matured larvae (28.01g) and shell weight (0.180) were recorded during rainy season. Further, significantly lower fecundity (480), hatching% (94.98), larval duration (28 days), weight of 10 matured larvae (25.80g), cocoon yield/100dfl (43.29 kg), single cocoon weight (1.146g), single cell weight (0.169g), pupation (95.22%) and cocoon leaf ratio (21.95) were recorded during summer.among the seasons. In all, winter season was more ideal for the rearing of multivoltine silkworm in the southern dry zone seed area of Karnataka with superior cocoon and egg characters due to lower temperature and humidity fluctuations.

Keywords: Silkworm; Bombyx mori; multivoltine.

1. INTRODUCTION

Silk, discovered in China between 2600 and 2700 BC and considered the queen of textiles due to its glittering luster, softness, elegance, durability, and tensile properties is produced by rearing of silkworm.In India, multivoltine sericulture has been identified as one of the important components for economic development especially in the preparation of raw silk from the silkworm cross breeds which engages the rural households in the cultivation of mulberry and silkworm rearing, besides in reeling and weaving. Climatic factors, however, affect immensely the fertility of multivoltine silkworm and production of quality eggs, and in that temperature is the key environmental factor that influences the physiology of *Bombyx mori* insects [1]. Quality of silkworm seed refers to richness of laying, egg viability, hatching uniformity and more importantly good rearing performance of the progeny [2]. Average fecundity, fertility of the moth, larval duration and cocoon characters are the main factors influencing silk worm seed production.

Pure Mysore, local, MSC (Mysore Seed Cocoon) are some of the synonyms of the famous polyvoltine silkworm races of Karnataka where silk industry prospers besides in other southern states. At present, more than 75% of the raw silk produced in south India is by Pure Mysore x bivoltine cross-breed combination. As silkworms are cold-blooded organisms, temperature plays a vital role on the growth of the silkworms with direct effect on various physiological activities, and wide fluctuation in temperature is harmful to the development of multivoltine silkworm. Rise in temperature increases various physiological functions, while a fall in temperature decreases the pace of these functions.The P2 Basic Seed Farm Nagenahalli is the only Multivoltine Farm which is playing a vital role in maintaining the Nucleus stocks of Pure Mysore silk worm in south India. In the resent years both the rearing performance of the multivoltine silk worm and cocoon quality are lagging behind due to fluctuation in the climatic factors. Hence rearing of silkworm under varying climatic conditions and generation of good quality cocoons for seed production is a big challenging task in the recent years. The present study, therefore, was conducted to find out the effect of variation in climatic factor on seasonal rearing performance of multivoltine pure Mysore Silkworm at P2-Basic Seed Farm, Nagenahalli village (2017-20).

2. MATERIALS AND METHODS

National Silkworm Seed Organization established at Pure Mysore Multivoltine Basic Seed Farm, Nagenahally, a centre of excellence, located at an altitude of 773m AMSL and latitude and longitude of 13.02^0 N and 77.02^0E, respectively is playing a vital role in maintaining the nucleus stocks of Pure Mysore silk worm besides the generation of P2 seed cocoons to support silkworm seed production centers of south India for F1 production.The average rainfall of the study area is 750 to 900 mm. The soil of the Farm was sandy loam with optimum bulk density, medium organic carbon, and low, medium and medium ranges of available soil nitrogen, phosphorus and potassium, respectively.

Pure Mysore silkworm cv. was selected for rearing, and cellular rearing was carried out in all the three seasons for three consecutive years (2017, 2018 and 2019) with 10 replications. 300 worms were kept separately after third molt, and at the time of harvesting 20 cocoons were randomly selected from each replication and their average was taken for bioassay and for recording all the commercial characters namely average fecundity, hatching per cent, larval duration(day), weight of 10 matured larvae(gm), cocoon yield (kg), single cocoon weight (gm), single shell weight(gm), pupation (Per cent) cocoons/kg and cocoon leaf ratio and the data were subjected for RCBD analysis. Further, correlation analysis was carried out ascertain the relation and draw conclusions.

3. RESULTS AND DISCUSSION

Significant differences were observed in quality parameters during all the three seasons (Table 1 and Fig. 1). The pooled data revealed significantly higher yield per 100 Disease Free Layings (dfl) (43414 and 57.70 kg), single cocoon weight (1.233g), single cell weight (1.80g), pupation % (96.39)and higher pupation and lower cocoons per kg during winter season. This could be attributed to availability of optimum climatic condition particularly humidity and temperature throughout the larval and mounting periods during winter compared to other seasons.

Increased temperature during silkworm rearing as observed in summer particularly in later instars accelerates larval growth and shortens the larval period, while at lower temperature normally prevailing during winter slows down growth while extending larval period. The optimum temperature for normal growth of silkworms is between 20°C and 28°C and the desirable temperature for maximum productivity ranges from 23°C to 28°C. Temperature above 30°C directly affects the health of the worm, while temperature below 20°C retards all the physiological activities, especially in early instars; as a result, worms become too weak and susceptible to various diseases. The temperature requirements during the early instars (I, II, III) are high and the worms feed actively, grow very vigorously, and lead to high growth rate. Such vigorous worms can withstand better even at adverse conditions in later instars [3] Such ambient conditions prevailed during winter season in the present study area.

Humidity also indirectly influences the rate of withering of the leaves in the silkworms rearing beds. Under dry conditions especially winter and summer the leaves wither very fast and consumption by larvae will be low. This affects their growth and results in wastage of feed stock in the rearing bed. Retarded growth of young larvae makes them weak and also susceptible to diseases [4], Kumareshan [5] and Bukhari [6]. In the study, significantly higher weight of 10 matured larvae (28.01g) was recorded in the rainy season as higher humidity and soil moisture favored higher leaf moisture and consequently eating by the growing worms which in turn helped in improving cocoon weight of individual larvae.

During the course of investigation, significantly higher larval duration and leaf cocoon ratio were observed during winter season as dry conditions especially in winter and also during summer resulted in rapid withering of leaves thereby causing slower and prolonged consumption by larvae in winter while accelerated worm maturity in summer besides affecting growth of the larvae and causing wastage of leaf in the rearing bed. Consequently average requirement of leaf to spin the cocoon was more. Nevertheless, the quality of the cocoon was good in the winter season.Like temperature, humidity also fluctuates widely not only from season to season but also within the day itself. Therefore, it necessitates the silkworm rearers to regulate humidity for the successful crop. For this purpose, wax coated (paraffin) paper is used to cover the rearing beds during young-age rearing to raise humidity and to slow down leaf withering [7]. Otherwise, wet foam rubber pads or paper pads soaked in water are also be used commercially to increase humidity in the rearing beds.

On the other hand, significantly poor silkworm quality parameters like hatching per cent ,weight of 10 matured larvae cocoon yield, single cocoon weight, single cell weight, pupation %, number of cocoons per kg and cocoon to leaf ratio during all the years were recorded with summer season (94.98, 28.00, 25.80,41238.91& 43.29, 1.146, 0.169g, 95.22, 21.95, respectively). This could be attributed to lower soil moisture, and dry atmosphere coupled with high temperature (>30^o C) in summer lowered leaf moisture affecting feeding intensity. Besides, prevailing high temperature and lower humidity also affect the cocoon characters during summer. The reason being rapid completion of metabolic activities under high room temperature as evidenced from lower larval duration (28 days) during summer season, consequently quantity of the leaf used to complete the life cycle, and silk spun in the cocoon by silkworm are less (1.95:1) during summer season [8-11].

Table 1. Seasonal Performance of Multivoltine Pure Mysore Silkworm at P2-Basic Seed Farm, Nagenahalli (2017-20)

Seasons	Fecundity (#)	Hatching (%)	Larval Duration (days)	Wt. of 10 matured larvae (g)	Yield/100dfls (No.)	Yield/100 dfls(kg)	Cocoon Wt. (g)	Shell Wt. (g)	Pupation (%)	Cocoons/kg (#)	C: Lratio(kg)
Summer	480	94.98	28	25.80	41238.91	43.29	1.146	0.169	95.22	904.46	21.95
Rainy	484	95.25	30	28.01	42645.09	47.77	1.161	0.180	94.78	873.80	23.07
Winter	483	95.67	32	26.15	43414.454	57.70	1.233	0.170	96.39	807.82	25.34
C.D.	3.55	NS	0.79	0.87	1286.04	3.32	0.031	0.005	N/A	35.25	0.57
SE(m)	1.19	0.28	0.27	0.29	432.90	1.12	0.011	0.002	0.65	11.87	0.19
C.V.	0.82	0.99	2.93	3.66	3.38	7.74	2.969	3.123	2.25	4.57	2.71

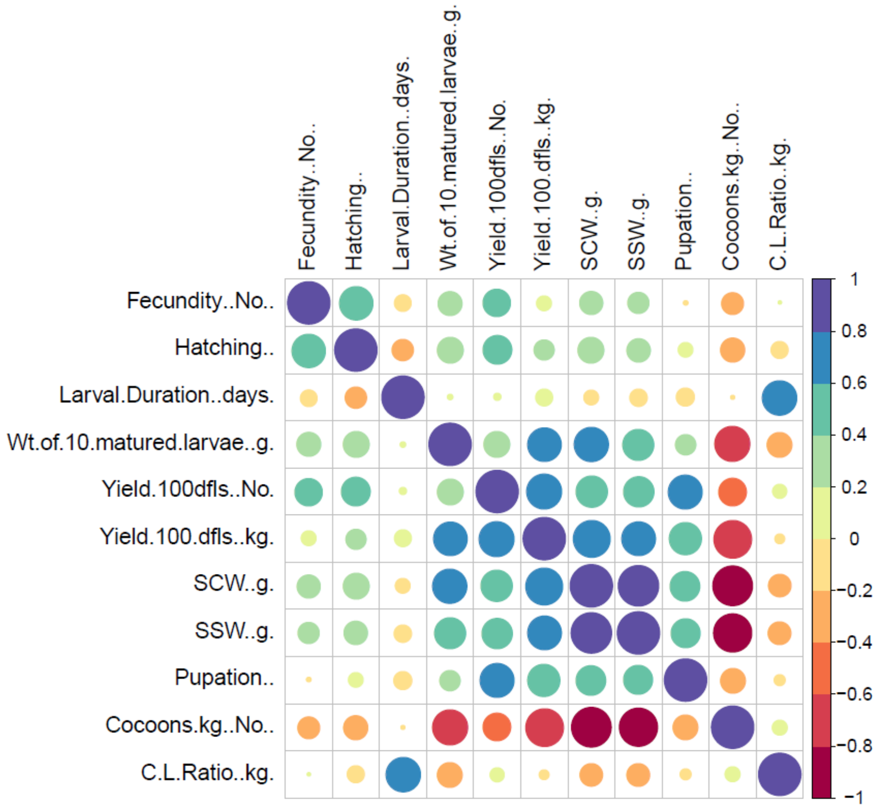

Fig. 1. Correlation Plot of rearing performances of Multivoltine Pure Mysore Silkworm (2017-20)

Table 2. Correlation Analysis of rearing performances of Multivoltine Pure Mysore Silkworm (2017-20)

Rearing Parameters	Fecundity (No.)	Hatching (%)	Larval Duration (days)	Wt. of 10 Matured Larvae (g)	Yield/ 100dfls (No)	Yield/ 100 dfls (kg)	SCW (g)	SSW (g)	Pupation (%)	Cocoons/ kg (No.)	C:L Ratio (kg)
Fecundity (No.)	1	0.600^{**}	-0.150^{NS}	0.304^{*}	0.401^{**}	0.118^{NS}	0.288^{*}	0.239^{NS}	-0.012^{NS}	-0.255^{NS}	0.006^{NS}
Hatching (%)	0.600^{**}	1	-0.244^{NS}	0.357^{**}	0.441^{**}	0.216^{NS}	0.358^{**}	0.293^{*}	0.116^{NS}	-0.313^{*}	-0.157^{NS}
Larval Duration (days)	-0.150^{NS}	-0.244^{NS}	1	0.016^{NS}	0.028^{NS}	0.153^{NS}	-0.119^{NS}	-0.163^{NS}	-0.176^{NS}	-0.010^{NS}	0.634^{**}
Wt. of 10 Matured Larvae (g)	0.304^{*}	0.357^{**}	0.016^{NS}	1	0.355^{**}	0.608^{**}	0.627^{**}	0.515^{**}	0.223^{NS}	-0.660^{**}	-0.330^{*}
Yield/100dfls (No)	0.401^{**}	0.441^{**}	0.028^{NS}	0.355^{**}	1	0.656^{**}	0.525^{**}	0.493^{**}	0.618^{**}	-0.410^{**}	0.107^{NS}
Yield/100 dfls (kg)	0.118^{NS}	0.216^{NS}	0.153^{NS}	0.608^{**}	0.656^{**}	1	0.730^{**}	0.613^{**}	0.554^{**}	-0.765^{**}	-0.051^{NS}
SCW (g)	0.288^{*}	0.358^{**}	-0.119^{NS}	0.627^{**}	0.525^{**}	0.730^{**}	1	0.912^{**}	0.472^{**}	-0.880^{**}	-0.271^{*}
SSW (g)	0.239^{NS}	0.293^{*}	-0.163^{NS}	0.515^{**}	0.493^{**}	0.613^{**}	0.912^{**}	1	0.448^{**}	-0.814^{**}	-0.279^{*}
Pupation (%)	-0.012^{NS}	0.116^{NS}	-0.176^{NS}	0.223^{NS}	0.618^{**}	0.554^{**}	0.472^{**}	0.448^{**}	1	-0.328^{*}	-0.064^{NS}
Cocoons/kg (No.)	-0.255^{NS}	-0.313^{*}	-0.010^{NS}	-0.660^{**}	-0.410^{**}	-0.765^{**}	-0.880^{**}	-0.814^{**}	-0.328^{*}	1	0.119^{NS}
C:L Ratio (kg)	0.006^{NS}	-0.157^{NS}	0.634^{**}	-0.330^{*}	0.107^{NS}	-0.051^{NS}	-0.271^{*}	-0.279^{*}	-0.064^{NS}	0.119^{NS}	1

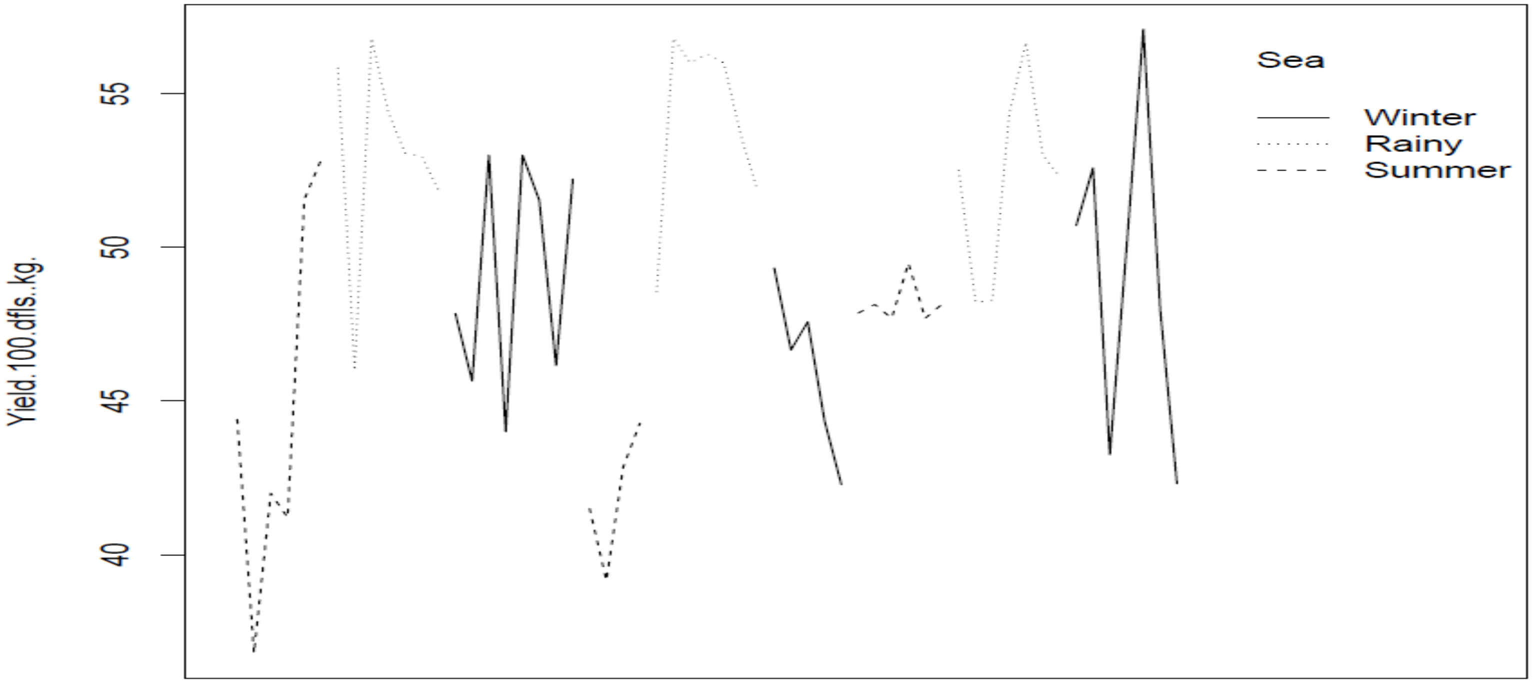

Fig. 2. Cocoon Yield Performances of Multivoltine Pure Mysore Silkworm across Seasons (2017-20)

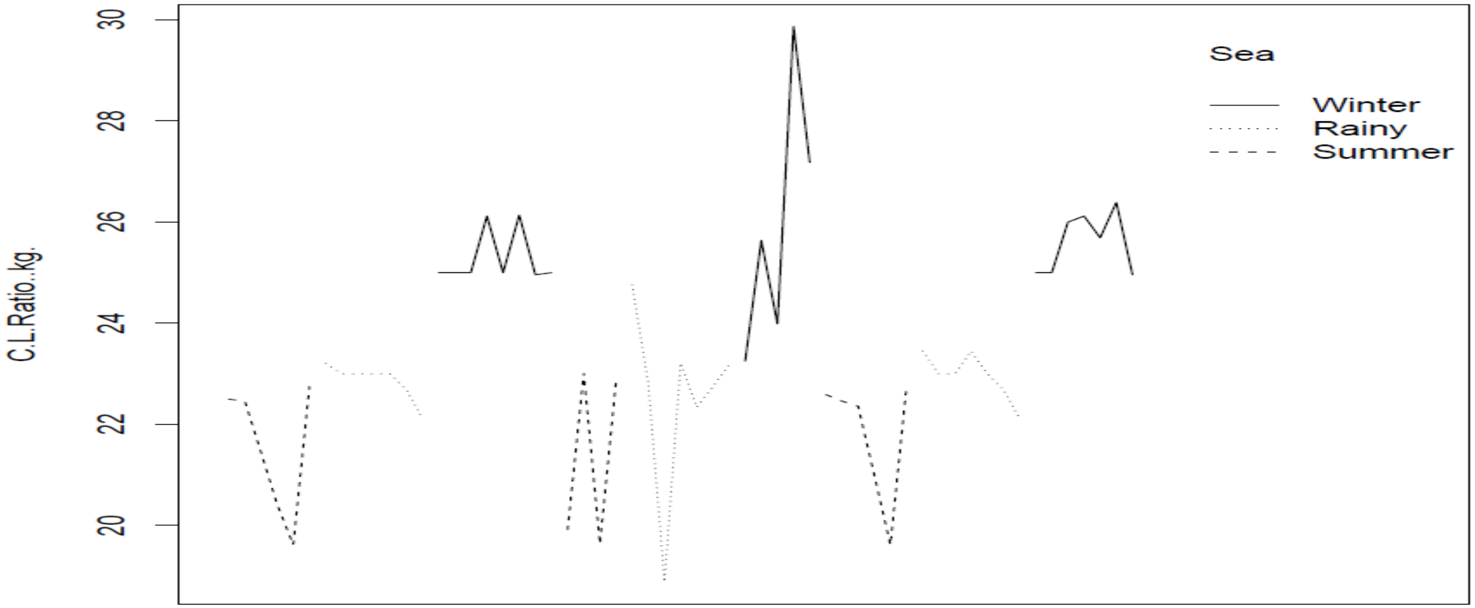

Fig. 3. Cocoon: Leaf ratio of multivoltine Pure Mysore Silkworm across Seasons (2017-20)

3.1 Correlation

Fecundity: Fecundity of the pure Mysore silkworm is negatively correlated with larval duration, pupation % and number of cocoons per kg, whereas average fecundity was highly positively correlated with hatching % (0.60**), weight of 10 matured larvae (0.304*), yield per 100 dfls (0.401*) and single cocoon weight (0.288*) (Table 2 and Fig. 2).

Hatching %: It was significantly and positively correlated with weight of larvae (0.357*), yield per 100 dfls (0.441*), single cocoon weight (0.358*) and single cell weight (0.293*), while hatching was negatively correlated with other silkworm characters (Table 2 and Fig. 2).

Larval Duration: Larval duration was negatively and significantly correlated with all silkworm characters except cocoon leaf ratio (0.634*).

Weight of 10 Matured Larvae: It was negatively correlated with cocoons per kg (-0.660*) and cocoon to leaf ratio (-0.330*), whereas it was positively correlated with all other commercial quality characters. Further, larval body weight was significantly and highly positively correlated with single cocoon weight (0.627**).

Yield per 100 (Disease Free Layings): Yield in terms of number as well as weight per 100 dfls was positively correlated with single cocoon weight, single cell weight and pupation %, while it was significantly and negatively correlated with cocoons weight per kg. Total cocoon number was highly and positively correlated with hatching % (0.441**), pupation % (0.618*), whereas yield in terms of cocoon weight was highly and positively correlated with single cocoon weight (0.730**) and single cell weight (0.613**).

Single Cocoon Weight: Single cocoon weight was either positively or negatively correlated with each of the worm characteristics. Results revealed high positive correlations with single cell weight (0.912**) and yield per 100 dfls kg (0.730**). While, pupation % and pupation % were negatively correlated with cocoons per kg (-0.328*) and were positively correlated with yield/100dfls (0.618** & 0.554**), single cocoon weight (0.472**) and single cell weight (0.448**).

Cocoon to Leaf Ratio: More the larval duration better and higher is the leaf consumption by the silkworm. Cocoon to leaf ration was significantly and positively correlated with larval duration (0.634**) and was negatively correlated with remaining quality characters in the study.

4. CONCLUSION

Ambient climate plays a prominent role in the pure Mysore silkworm rearing and seed cocoon generation. Variation in the relative humidity and temperature during larval period and mounting period affect the growth and development o the silkworm and seed cocoon quality.In the study area, during monsoon season temperature falls< $23^{o\,C}$ and relative humidity is > 90 %,while during summer season temperature raises up to 34^{o} to40^{o}C and relative humidity falls <50 %. These being less favorable during the seasons for pure Mysore seed crop rearing affected the pupation % and egg laying by the moth while increasing their susceptibility to diseases. Whereas, during post monsoon and winter season (August-January) temperature falling around 25^{o} C to 29^{o} C and relative humidity hovering around 65 to 80 % provided more congenial environment for the multivoltine silkworm seed cocoon generation.Hence, post rainy and winter season is suggested as ideal for the multivoltine seed cocoon generation in the southern dry zone of Karnataka.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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