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SUITABLE METHOD OF YOUNG INSTAR (CHAWKI) REARING OF SILKWORM, *BOMBYX MORI* L. FOR EASTERN INDIA

T. Datta (Biswas), A. K. Saha, N. B. Kar and S. Nirmal Kumar

Central Sericultural Reseach & Training Institute, Berhampore - 742 101, Murshidabad, India.
email : tdattabiswas@rediff.com

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ABSTRACT – Highly fluctuating climatic condition of Eastern India stands in the way of expansion of sericulture inspite of luxuriant growth of mulberry for its fertile soil and adequate rainfall. For qualitative and quantitative improvement in cocoon production, scientific method of young instar (Chawki) silkworm rearing is important. To maintain proper microclimate for Chawki rearing as well as to avoid frequent feedings, different methods of Chawki rearing is in practice. All methods aim to prevent drying of mulberry leaves fed by maintaining proper temperature and humidity in the rearing bed. Adequate spacing should also be provided for proper growth of the larvae. For boosting up of quality cocoon production in agro climatic condition of Eastern India, an attempt was made in this study by testing different methods of chawki rearing to find out a suitable one along with bed spacing to provide the optimum environment needed by young instar silkworms for its proper growth

Key words: *Bombyx mori*, chawki rearing method , cocoon production, reeling parameters.

INTRODUCTION

Sericulture is the science that deals with the production of silk by rearing of silkworm. Silk is called the queen of textiles due to its glittering luster, softness, elegance, durability . Silkworm is one of the most important domesticated insects, which produces luxuriant silk thread in the form of cocoon by consuming mulberry leaves during larval period. Silkworm rearing is differentiated into young instar or Chawki rearing (up to $_2$nd moult) and late instar rearing based on their management requirements. A scientific method of young silkworm rearing is important to raise a healthy cocoon crop. Maintenance of temperature of 27– 28 °C and relative humidity of 80–90 % are ideal for young instar silkworms (Tanka, 1964; Krishnaswami *et al,* 1973; Krishnaswami , 1978. Jolly, 1987; Sengupta, 1989; ESCAP, 1993; AICEF, 1995). Growth rate of silkworm larvae during 1st and 2nd instar is very fast as a result of high metabolism. High temperature, high humidity and nutritious leaves are therefore required to accelerate metabolism. Humidity affects directly the physiological functions of silkworm and indirectly the drying of leaves in bed (Benchamin and Nagaraj, 1987).

Chawki reared under ideal conditions would reduce the problems experienced during late instar rearing considerably, resulting in higher cocoon yield (Omura,1980; Patil and Goda, 1986; Jolly, 1987, Benchamin, 1989; Krishnaswami, 1988). The success of chawki rearing technology depends upon the perfect understanding of the requirements of young instar silkworms and their physiology, where manipulation of nutritional and environmental conditions suited to maximum growth of silkworms is the aim (Benchamin and Nagaraj, 1987). By adopting the perfect chawki rearing procedure, maximum potential can be exploited.

Eastern India is generally characterized by luxuriant growth of mulberry for its fertile soil and adequate rainfall. But due to highly variable climatic condition, rearing of productive silkworm breeds and hybrids are restricted. This agro-climatic region has extremely hot and humid as well as hot and dry summer and severe winter with very low humidity. During summer the temperature reaches about 45ºC with low humidity while in rainy season, the temperature sometimes reaches 38ºC with 90% humidity. Generally five distinct commercial crops are practiced in this region viz. Spring (Feb. – Mar.), Early Summer (Mar.- Apr.), Rainy (June – July and Aug. – Sept.) and Autumn (Nov. – Dec). Amongst these, Spring, Early Summer and Autumn are considered as **Favourable** due to more or less congenial climatic condition while June-July and August – Sept. are **Unfavourable** due to high temperature and high humidity conditions.

The secret of success in silkworm rearing lies in proper manipulation of rearing technology, so as to maintain the proper microclimatic condition of the rearing bed (Rangaswami et al. 1976; Jolly, 1987; Krishnaswami, 1988; Narasimhanna, 1988; Sengupta, 1989). In mechanically advanced countries like Japan, young instar rearing is done in a separate controlled room where the desired

temperature and humidity can be maintained. To avoid frequent feedings as well as to maintain proper microclimate for young instar rearing , different methods of young instar rearing are in practice in the temperate and tropical countries. All methods aim to prevent drying of mulberry leaves fed by maintaining proper temperature and humidity in the rearing bed.

Adequate spacing should also be provided while practicing different methods of chawki rearing so that the silkworm develop in conformity with their full genetic potential (Sengupta and Yusuf ,1974, Roychoudhury, 1990, 1991) . Iyenger *et al* (1988) pointed out that spacing schedule differs in respect of region season and breed. Crowded conditions of rearing lead to conditions of starvation in spite of availability of a large quantity of leaf in the bed, and also building up of bed humidity beyond tolerance limit. These in turn lead to poorer cocoon harvest in terms of number of cocoons as well as the average weight of cocoons.

Hence, an attempt was made in this study to provide the optimum environment needed by young instar silkworms for its proper growth by testing different methods of chawki rearing along with bed spacing to find out a suitable one for boosting up of quality cocoon production in agro climatic condition of Eastern India.

MATERIALS AND METHODS

The study was taken at the Silkworm Physiology and Rearing Technology Innovation Laboratory of Central Sericultural Research &Training Institute, Berhampore, West Bengal, India during five commercial crop seasons i.e. November, February, April, June-July and August-September. For rearing, S1635 / S1 variety of mulberry was used in all the seasons to avoid any nutritional effect. Standard package of practices were followed for mulberry cultivation.

Methods of chawki rearing tested : (Fig. 1)

Box rearing

Trays with bottom and top paraffin paper surrounded by wet foam pad are arranged one above the other to a convenient height on a chawki-rearing stand like a box. Thirty to forty minutes before feeding and during the moulting period , paraffin paper cover and wet foam pads are removed and the trays are arranged in a criss cross pattern for allowing the rearing bed to dry and for better aeration. This method requires minimum space for conducting rearing .

Wrap up method

Rearing bed in the trays are wrapped up with paraffin paper on all the four sides. Thirty to forty minutes before feeding and during the moulting period , paraffin paper wrap is removed for getting proper aeration.

Open type of shelf rearing

Individual trays are kept in rearing racks with only bottom paraffin paper .

Shelf rearing (Control)

Individual trays are kept in rearing racks with top and bottom paraffin paper as well as wet foam pads surrounding the rearing bed.

Bed spacing considered

Two type of spacing i.e. 5.0 – 45 sq. ft./ 100 dfls (earlier recommendation for Southern India) and 6 – 54 sq. ft. / 100 dfls (20% increase over earlier recommendation) were tested keeping 3 – 35 sq ft. bed spacing / 100 dfls as control. The larvae were fed with mulberry leaves four times a day at 6 am, 10 am, 4 pm & 9 pm *ad libitum* till the initiation of spinning. Incubation, black boxing, bed cleaning, moulting care, maintenance of environmental condition etc. were done as per standard schedule (Krishnaswami, 1986). Late instar rearing also was done following standard method.

Combination used

Multi x Bi hybrid was used during **favourable** crop seasons where as Multi x Multi hybrid was utilized during **unfavourable** crop seasons.

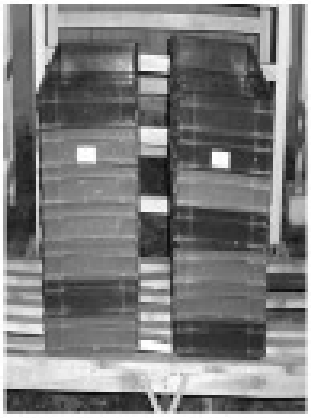
Treatments

T_1	=	Open Type Shelf Rearing with 5–45 sq. ft. bed spacing
T_2	=	Open Type Shelf Rearing with 6–54 sq. ft. bed spacing
T_3	=	Box Rearing with 5–45 sq. ft. bed spacing
T_4	=	Box Rearing with 6–54 sq. ft. bed spacing
T_5	=	Wrap up Rearing with 5–45 sq. ft. bed spacing
T_6	=	Wrap up Rearing with 6–54 sq. ft. bed spacing
Con*	=	Shelf Rearing with 3.00–35 sq. ft. bed spacing

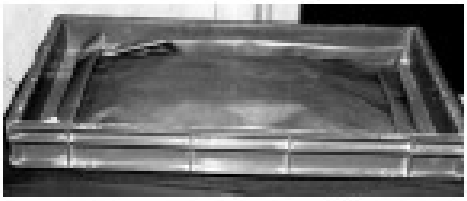
*farmers' practice.

Parameters Recorded

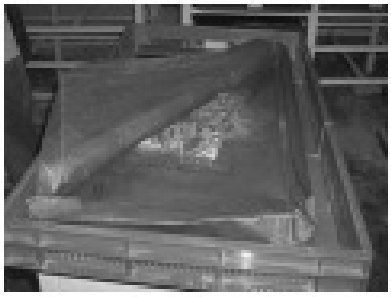
Larval period (hrs), yield /10,000 larvae (No.& Wt. in kg), single cocoon weight (g), single shell weight (g), shell%, filament length (m), denier, renditta and reelability % were considered. During rearing each treatment was replicated three times with 300 larvae per replication after



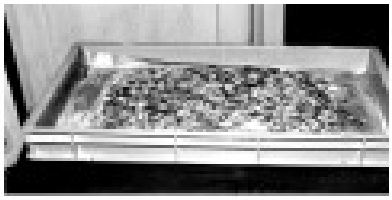
Box Rearing



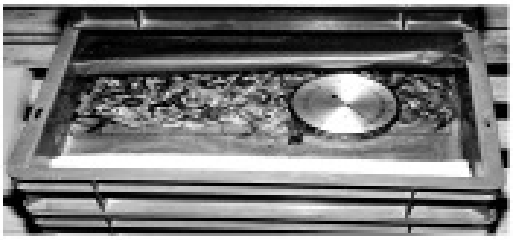
Wrap-up Method



Open type of Shelf Rearing



Control



Measurement of bed humidity

Table 1: Rearing performance during favourable seasons (Multi x Bi).

Treat	Yield / 10,000 larvae (no.)				Yield / 10,000 larvae wt. (kg)				Shell %			
	Nov.	Feb.	Apr	Mean	Nov.	Feb.	Apr	Mean	Nov.	Feb.	Apr	Mean
T1	7657	8756	5511	7308	11.92	13.71	7.29	10.97	15.80	16.44	16.07	16.10
T2	**8688**	**9220**	**7441**	**8449**	**13.88**	**15.06**	**10.00**	**12.96**	**17.52**	**17.54**	**16.60**	**17.22**
T3	8371	9016	6444	7914	12.90	14.60	8.53	12.01	16.29	17.38	16.46	16.71
Con	7780	8769	5258	7269	10.09	13.30	7.08	10.16	16.07	16.48	16.15	16.23
Mean	8124	8918	6163		12.20	14.17	8.23		16.42	16.96	16.32	
CD at 5%												
S	90.72				0.18				0.13			
Treat	138.57				0.28				0.20			
S x T	240.01				0.49				0.34			
CV%	3.309				4.42				2.181			

Table 2 : Reeling performance during favourable seasons (Multi x Bi).

Treat	Filament Length (m)				Renditta				Reelability%			
	Nov.	Feb.	Apr	Mean	Nov.	Feb.	Apr	Mean	Nov.	Feb.	Apr	Mean
T1	653	671	658	661	8.63	7.92	8.75	8.43	75.29	80.39	73.22	76.30
T2	**740**	**713**	**702**	**718**	**8.23**	7.87	**8.11**	**8.07**	**80.22**	81.17	**77.67**	**79.69**
T3	683	701	683	689	8.57	**7.79**	8.73	8.36	78.13	**82.71**	75.48	78.44
Con	633	690	616	646	8.81	7.95	8.77	8.52	75.25	80.21	72.24	75.90
Mean	**677**	**694**	**664**		**8.56**	**7.88**	**8.59**		**77.22**	**80.87**	**74.65**	
CD at 5%												
S	**8.13**				**0.08**				**0.62**			
Treat	12.42				0.12				0.95			
S x T	21.52				0.20				1.65			
CV%	3.392				2.591				2.274			

3rd moult. Data were collected for three consecutive years in all the 5 commercial crop season. Three years pooled data were statistically analyzed separately for favourable seasons (Nov., Feb. and April) and unfavourable seasons (June-July and Aug.-Sept.) to get the season specific recommendation. Analysis of variance was done for three consecutive years. Critical difference value ($P<0.05$) for season, treatment and season x treatment were calculated. Bed humidity was measured by using dial hygrometer.

Cocoon Assessment

Yield per 10,000 larvae

$$\text{By number} = \frac{\text{Total no. of good cocoons harvested}}{\text{Total no. of larvae retained}} \times 10{,}000$$

after 3rd moult

$$\text{By weight} = \frac{\text{Weight of good cocoons harvested}}{\text{No. of good cocoon harvested}} \times \text{ERR by number}$$

$$\text{Single cocoon Weight (SCW)} = \frac{\text{Weight of 10 male + 10 female cocoons (g)}}{\text{No. of cocoons taken (20)}}$$

$$\text{Single shell weight (SSW)} = \frac{\text{Total shell weight of 10 male + 10 female cocoon s (g)}}{\text{Total no of cocoons taken (20)}}$$

$$\text{Shell percentage} = \frac{\text{Single shell weight (g)}}{\text{Single cocoon weight (g)}} \times 100$$

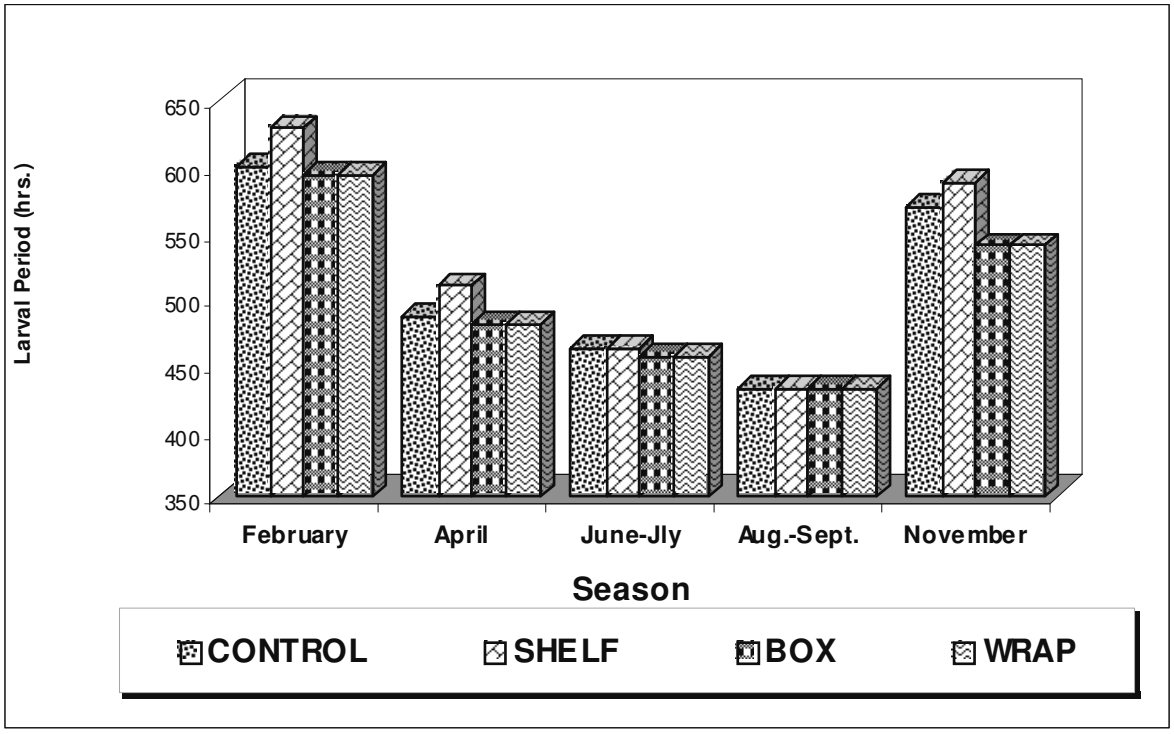


Fig. 2 : Larval period (hrs) in different methods of chawki rearing.

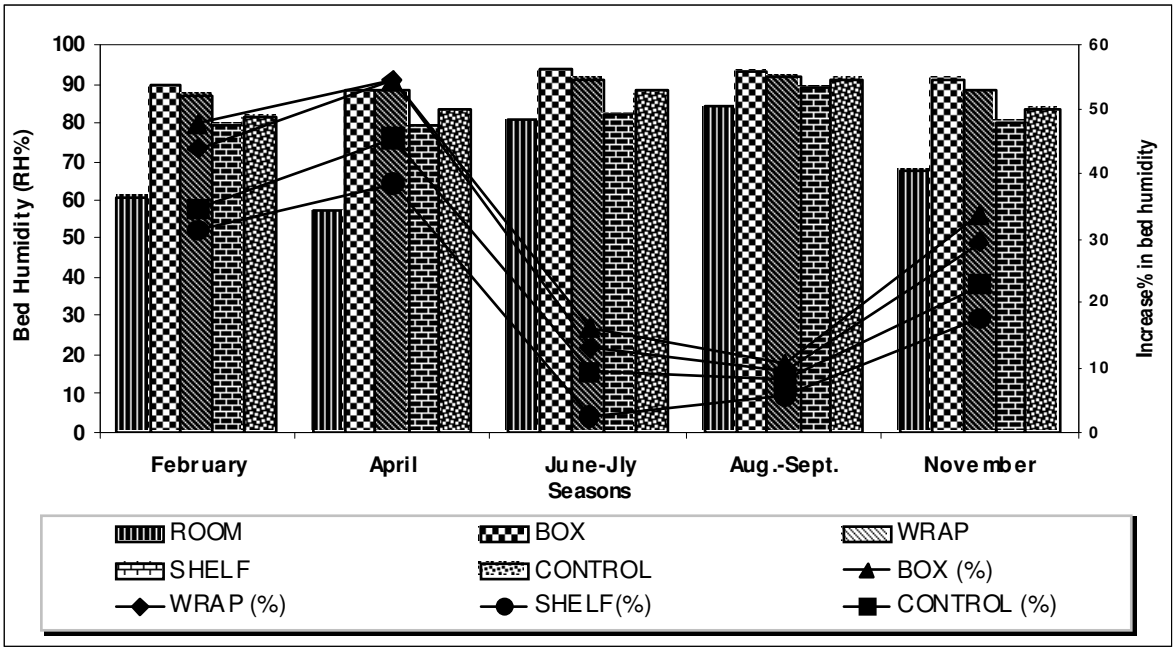


Fig 3 : Bed humidity with percent increase in different methods of chawki rearing.

$$\text{Reelability percentage} = \frac{\text{Reeled cocoon number}}{\text{Number of ends feeding}} \times 100$$

Renditta : Quantity of Silk Cocoons required to produce 1 Kg of raw silk.

RESULTS

I. Observation of economic parameters

A. Favourable Seasons

In most of the cases, February season was found significantly superior than November & April seasons. Moreover November was found significantly superior ($P < 0.05$) than April.

Yield /10,000 larvae (no)

In respect of Season x Treatment interaction ,T4 registered significantly higher value during all the crop seasons although in February T3 & T4 were at par. While considering the treatments, it was found that T4 was statistically superior to other treatments except T3 which was at par. Treatments with Box rearing (T3 & T4) and Wrap up method (T5 & T6) were found significantly superior than farmers' practice although T2 was inferior even than farmers practice and T1 showed at par performance.

Yield /10,000 larvae (Wt.)

In respect of Season x Treatment interaction, T4 registered significantly higher values during all the crops although T3 showed at par value with T4 and during February T5 & T6 were also at par with T4. While reviewing the performance of treatments, T4 registered highest value which was statistically superior than other treatments.. All the treatments differed significantly than control i.e. farmers practice .

Shell%

Interaction between Season and Treatment was found non significant. Regarding the treatments, T4 registered highest value which was significantly higher than other treatments except T3. Farmers' practice was found significantly inferior than all other treatments except T1 which showed at par value. T2 was inferior than farmers' practice. T4 was significantly higher than T3. Shell % did not differ significantly during November and February Season although April was significantly inferior than the

Table 3 : Rearing performance during unfavourable seasons (Mullti x Multi).

Treat	Yield / 10,000 larvae (no.)			Yield / 10,000 larva wt. (kg)			Shell %		
	Jun-Jul	Aug.-Sep	Mean	Jun-Jul	Aug-Sept	Mean	Jun-Jul	Aug-Sep	Mean
T1	**8456**	**9265**	**8861**	**9.57**	**11.30**	**10.43**	**14.44**	14.52	**14.48**
T2	7916	8809	8363	8.74	10.83	9.78	14.19	14.10	14.14
T3	8136	9002	8569	9.22	11.01	10.11	14.25	**14.57**	14.41
Cont	7702	8398	8050	7.94	8.82	8.38	13.98	14.15	14.07
Mean	8053	8869		8.90	10.50		14.21	14.34	
CD at 5%									
S	193.06			0.305			NS		
Treat	294.91			0.466			NS		
S x T	NS			0.81			NS		
CV%	6.271			8.444			4.251		

Table 4 : Reeling performance during unfavourable seasons (Mullti x Multi).

Treat	Filament Length (m)			Renditta			Reelability%		
	Jun-Jul	Aug.-Sep	Mean	Jun-Jul	Aug-Sept	Mean	Jun-Jul	Aug-Sep	Mean
T1	**381**	474	**428**	**12.42**	**10.80**	12.11	**67.14**	**75.00**	**71.07**
T2	373	**478**	426	12.65	11.56	**12.00**	65.16	71.86	68.51
T3	377	469	423	12.79	11.20	12.04	61.39	73.02	67.20
Cont	354	416	385	12.62	11.47	11.94	61.09	68.07	64.58
Mean	371	459		12.62	11.26		63.10	71.71	
CD at 5%									
S	8.670			0.130			0.328		
Treat	13.240			0.200			3.556		
S x T	NS			0.350			NS		
CV%	5.881			3.124			9.388		

other two season.

Filament Length

It was found significantly superior in T4 during all the crop seasons although T3 was found at par. During February T5 & T6 and during April T6 were also found at par with T4. Regarding the performance of different treatments, T4 registered highest value which was significantly higher than the other treatments except T3 which was found at par. Farmers practice was significantly inferior than all other treatments except T1 which showed at par value.

Renditta

Renditta was found significantly superior in T4 during November and April and in T6 during February but T2 , T3 and T4 were at par. Moreover during April T3 and T4 were recorded at per. While considering treatments, lowest Renditta was recorded in T4 which was statistically superior than other treatments. Farmers practice was found significantly inferior than all other treatments, only T1 was found at par. February season was found best amongst the three seasons and November and April seasons were found at par. T4 differed significantly than T3.

Reelability

Reelability % was found significantly higher in T4 during November and April crops and in T6 during February crop although during November T3 and T5 were at par with T4 and during February T4 and T5 were at par with T6 and during April T5 and T4 were statistically at par. T4 was found statistically superior than all other treatments Farmers' practice was found inferior than T3, T4 T5 and T6 although T1 and T2 were found at par. T4 was found significantly superior than T3.

B. Unfavourable Season

S x T was found non significant with respect of most of the economic parameters. Aug.- Sept. season was found significantly superior than June- July.

Yield /10,000 larvae (no)

T2 was found significantly superior than all other treatments although during Aug.–Sept. T5 was found at par with T2. Farmers' practice was found significantly inferior than all other treatments.

Yield /10,000 larvae (Wt.)

T2 was found significantly superior than all other treatments. Farmers' practice was found significantly inferior than all other treatments.

Shell %

T2 showed highest value, which was found at par with T1, T5 & T6. Farmers practice and treatments with box rearing i.e. T3 & T4 were found significantly inferior than rest of the treatments.

Filament Length

T2 showed highest value which was however at par in all other treatments except control & T3

Renditta

T3 showed lowest value which was significantly superior than rest of the treatments.

Reel ability %

T2 showed highest reelability %, which was significantly superior than all other treatments. Farmers practice was inferior to all other treatments.

II. Observation on larval period & bed humidity

During dry seasons of February, April and November minimum larval period was observed in Box rearing and Wrap up method of chawki rearing. Maximum larval period was observed in Open type of shelf rearing. But during high humid seasons of June – July and Aug – Sept. not much difference was noted in the larval period among the treatments. (Fig. 2)

While measuring the bed humidity in different methods of chawki rearing, it was found that during dry months maximum increase in bed humidity was recorded in box rearing followed by wrap-up method and control batch. Open type of shelf rearing showed least capability of increasing the bed humidity. In high humid months not much difference was noted in the bed humidity for which not much variation was noted in larval period by using different chawki rearing methods (Fig. 3).

General observation

During **Favourable Season B**ox rearing with 6 – 54 sq. ft. bed spacing (T4) was found significantly superior than all other treatments with respect of most of the economic parameters. Box rearing (T3 & T4) and wrap-up method (T5 &T6) were found superior than farmers' practice but open type of shelf rearing performed either at par with or inferior than the traditional farmers' practice. Moreover, Box rearing with increased spacing (T4) registered its superiority over T3 i.e. box rearing with recommended density in respect of yield/10,000 larvae, shell %, Filament length, Renditta and Reelability %. Amongst the three favorable seasons, February performed best followed by November and April . Farmers' practice was found significantly inferior than treatments with Box Rearing and Wrap – Up method. Open type of shelf rearing performed at par or sometimes-even inferior than Farmers' practice.

During **Unfavourable Season** no seasonal impact was found on treatment. T2 i.e. open type of shelf rearing with increased spacing excelled in most of the rearing and reeling parameters. Moreover, significant difference was noticed between T2 i.e. open type of shelf rearing with increased spacing & T1 i.e. open type of shelf rearing with recommended spacing in respect of most important rearing parameter i.e., yield / 10000 larvae (both no. & wt.) and reeling parameter i.e. Reelability %. Amongst the two unfavourable seasons Aug.- Sept. performed better than June- July. Farmers' practice was found significantly inferior than all other treatments in most of the important economic parameters,.

DISCUSSION

It is well known that the growth and development of the silkworm is greatly influenced by microclimatic conditions such as rearing bed humidity and temperature. Therefore, the rearing management assumes special importance in order to create the optimum environment for the larval growth (Rajan *et al* , 1995).

In Eastern India, Box rearing with 6 – 54 sq. ft spacing per 100 dfls (T4) performed best for most of the rearing and reeling parameters during all the three favourable seasons i.e. November, February and April. Amongst the treatments T4 also excelled in most of the economic parameters. Moreover, significant differences were noted between T4 and T3 i.e. Box rearing with 5 – 45 sq. ft spacing confirming the importance of wider spacing along with the Box rearing method. Experiments with Wrap-Up methods were found superior than open type of shelf rearing as well as control. Larval period was found significantly lower in Box rearing and Wrap-up method in comparison to control i.e. farmers' practice. However, larval period in open type of shelf rearing was significantly increased than all other treatments as well as control. The decrease in the larval duration, increase in larval weight and improvement of cocoon characters are mainly due to the narrow fluctuation in temperature, better maintenance of humidity and better leaf moisture retention.

Box rearing and Wrap-up method of chawki rearing were found significantly superior than farmers' present practice i.e. control which may be due to the fact that both this method provide more or less optimum micro-climatic condition for optimum growth and development of larvae leading to improvement of economic characters. However, open type of shelf rearing performed inferior to or at par farmers' practice establishing that the farmers of Eastern India for their economic upliftment may practice Box Rearing with increased spacing.

Himantharaj *et al* (2000) concluded that the use of wrap up method during young instar rearing will certainly help in providing the required micro-climatic condition for optimum growth and development of larvae leading to improvement of the economic characters. The present investigation revealed that the same is true for Box Rearing also where the bed humidity is increased even better than the Wrap-Up method of Chawki Rearing.

During unfavourable seasons of Eastern India, analyzed data revealed the superiority of T2 i.e. open type of shelf rearing with 6 - 54 sq. ft. Spacing with respect of most of the rearing and reeling parameters. Amongst the treatments T2 also excelled in most of the economic parameters. Moreover, significant differences were noted between T2 and T1(open type of shelf rearing with 5 – 45 sq. ft spacing) confirming the importance of wider spacing along with the open type of shelf rearing method. During these seasons Box rearing, Wrap-up method of chawki rearing and Open type of shelf rearing performed significantly better in rearing and reeling parameters in comparison to present farmers' practice (control) establishing the fact that farmers' practice should be modified in order to get qualitative and quantitative improvement in cocoon production of this agro climatic region.

Box rearing method performed best in dry summer by providing the required microclimatic condition for optimum growth and development of larvae leading to improvement of economic characters. For the same reason open type of shelf rearing registered its superiority during high humid seasons. Box type of rearing with paraffin paper as a bed and cover along with wet foam pads was also recommended by Krishnaswami (1978) to achieve optimum relative humidity during chawki stage . Sengupta (1989) and Datta (1992) reported that for successful silkworm crop, regulation of temperature and relative humidity is necessary for young instar silkworm

Providing optimum humidity is of paramount importance for the healthy growth of young instar silkworm. If bed humidity falls below 70%, fast drying of mulberry leaves takes place which ultimately leads to loss of nutritive value of leaves. Thus leaves become unsuitable for consumption and the larval growth slows down. The Box method of rearing has not only minimized the leaf driage in the rearing bed but also increased the physiological efficiency of the larvae as reflected by the improvement of some of the commercial characters viz., ERR by number and weight. Reduction in leaf driage and increase in bed humidity and leaf moisture is reported to have a positive influence on the growth of silkworms and cocoon yield. The present observations are in agreement with the findings of Narayanprakash *et al* (1985) and Rajan *et al* (1995).

It may thus be concluded that farmers of Eastern India may practice Box Rearing and Open type of shelf Rearing both with 6 - 54 sq. ft. spacing during favourable and unfavourable seasons respectively during young rearing which will certainly help in providing the required microclimatic conditions for optimum growth and development of larvae leading to improvement of the economic characters. Moreover, by adopting the above practices a farmer can gain additional 10 kg and 8 kg cocoons yield per 100 dfls during favourable and unfavourable crop seasons respectively, thus fetching an additional income of Rs. 1000/- and Rs. 800/- respectively @ Rs. 100 per kg of cocoon).

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