CHAPTER - VI

SUMMARY

An investigation was carried out in Cooch Behar district of West Bengal to standardize seed (egg) production technologies of muga silkworm, *Antheraea assama* Westwood. Attempts were made to identify the seasonal influence on seed production and hatchability with special reference to host plant effect as well as to standardize the optimum combinations of key abiotic factors responsible for production of better quality and productivity of seed with higher hatchability in order to harvest better yield of commercial cocoon crop at desired level, to standardize techniques towards synchronization of male and female moth emergence as well as to standardize mating behaviours in view to manipulate them in production of quality eggs with higher hatchability, to characterize seed cocoons for practical use during commercial crop rearing for better quantity of quality seed and to standardized seed preservation technologies to overcome the seasonal adversity.

Muga silkworm rearings were conducted during nine (9) different periods of a season namely, February-March, April-May, May-June, July-August, August-September, October-November, November-December, December-February and January-March on two principal host plant namely Som (*Persea bombycina*) and Soalu (*Litsea polyantha*) and after harvesting cocoons subsequent grainage operations were done in the laboratory. Seeds for rearing were collected from Extension Centre, Cooch Behar, Central Silk Board. Influence of seasons were observed on grainage parameters like potential fecundity, realized fecundity, fecundity upto three days, egg retention within the female body, hatching number and hatching percentage. Manipulation of temperature, relative humidity and photoperiod, the key abiotic factors, were done taking four temperature regimes namely 15^0C, 20^0C, 25^0C and 30^0C, four relative humidity regime namely 65%, 75%, 85% and above 90% and 6L, 9L, 12L, 15L and 18L as photoperiod in Environmental Test Chamber for optimization of environmental factors. For synchronization of moth emergence both the normal and cold preservation condition were explored. For normal condition cocoons were allowed to emerge upto 4 days and allowed to couple in 16 possible combinations and for cold preservation of adult moth after emergence upto 3 days at 10 ± 1^0C in BOD were done and allowed to couple in 16 different combinations. To find out the optimum period of coupling for successful fertilization of eggs, male moths were allowed to mate for 11 different durations from 2

hours to 12 hours. After standardization of mating hours, subsequently another experiment was undertaken to determine the mating times : multiple coupling capacity of male moths. In this experiment males were exploited upto six (6) times during September-October and upto 4 (four) times during March-April and egg laying, retention and hatchability were taken as key parameters. For selection of seed cocoons, preliminary screening was done on the basis of female cocoon weight, length and diameter named as light, average, moderate and heavy and their individual as well as combined reflection on fecundity, hatchability and egg vigour were the key parameters studied. After preliminary screening, cocoons were grouped under seven weight ranges separately for male and female with a same limit of weight. The groups were extreme low, lower, low, medium, high, higher and extreme high. Distribution patterns of weight range percentage were calculated. After emergence, fresh males and females were utilized for mating. Altogether 49 combinations along with one control batch (randomly selected cocoon) were selected and parameters like fecundity, hatchability and egg vigour were recorded. To overcome the adversity of seasons during June-September, short-term cold preservation technique was investigated to design the preservation schedule. Cocoons, adults and eggs were preserved at different temperatures (5^0C – 10^0C for cocoon and adult and 4^0C – 10^0C for eggs) for varied days (18 days for cocoon 7 days for adult and 21 days for egg). Eggs were collected after 24 hrs., 48 hrs., 72 hrs. and 96 hrs. of incubation. Finally, continuous preservation of cocoon, moth and eggs was studied to formulate a schedule of cold preservation to overcome the adversity of the aforementioned period.

1. Influences of environmental factors had strong reflection on fecundity and hatchability. During October – November the potential fecundity (276.60), realised fecundity (274.70) and upto 3rd days realised fecundity (217.80) were highest among the treatments which followed the performance during April – May (potential fecundity 248.20, realised fecundity 244.80 and upto 3rd days realised fecundity 200.70). During November – December and February – March the performance of egg laying in terms of potential fecundity (242.60 and 231.50 respectively), realised fecundity (238.70 and 228.00 respectively) and upto 3rd days realised fecundity (188.30 and 192.50

respectively) were better. However, October – November and November – December were the main commercial crop rearing season where silk production was the prime objective. During August – September, the seed production season for the supply of seed during those main commercial crop-rearing seasons, the egg laying performance was below the above mentioned periods (potential fecundity 227.90, realised fecundity 216.30 and upto 3rd days realised fecundity 169.70 respectively). The low potential fecundity during August – September was due to high temperature and humidity and the less realized fecundity was due to highly significant egg retention (11.60).

The correlation studies of these observations confirmed that temperature was the prime influencing extrinsic factor regarding fecundity (-0.99) and light period regarding hatchability (-0.99). Increase in temperature decreased the fecundity during August – September while increasing light period decreased the hatching percentage during August – September as well as during April – May.

Som plant showed bett er performance over soalu plant for both the intrinsic factors and grainage parameters during all the seasons, still failed to improve the grainage performance during April – May and August – September.

As the conventional seed crop production seasons *i.e.* August – September and April – May were low productive, utilization of February – March as a seed crop-rearing season instead of April – May and October – November as seed crop rearing season instead August – September might be done for better commercial crop rearing.

This slight modification of rearing schedule of Assamese calendar was found suitable for terai region of West Bengal having micro climatic variation with Assam. Further more, to maintain the rearing schedule of Assam (if the modification is not possible), manipulation of environmental factors for seed production or utilization of cold preservation technology were investigated.

During two seed crop rearing seasons, namely April - May and August - September 70% eggs were collected from 3 days laying. which were 205 and 181 eggs respectively of which only 89 and 111 eggs were hatched respectively. Upon collection of total laying of only 104.00 and 130.00 hatched larva were obtained during April – May and August – September respectively which were far lower than the collection of first 3 days during October – November (232.00) and February – March (193.00) to supply seed

for commercial rearing. Moreover, this ultimately reflected in rearing hazards showing uneven rearing length and longer cocoon harvesting period as well as poor crop yield.

So, for supply of quality seed during commercial rearing collection of eggs from first three days was found effective for successful economic and synchronous rearing and it was further suggested that February – March and October - November found suitable as seed crop rearing period to have enough number of seeds during commercial rearing during March – April and November – December instead of May – June and October – November, which ultimately strengthened the suggestions made after observing seasonal influence on muga silkworm rearing and grainage operation.

2. Manipulation of temperature from 15^0C to 35^0C reflected that during April – May where normal temperature was 26.65^0C, manipulation of temperature to 25^0C increased the hatchability from 44.79% to 59.03% and during August – September when the normal temperature was 28.92^0C, manipulation of temperature to 25^0C increased the hatchability from 63.03% to 68.67%.

Relative humidity from 65% to above 90% manipulation showed that during April - May when normal RH was 68%, manipulation of RH to 75% increased the hatchability from 44.79% to 48.21% and during August – September when the normal RH is 77.5%, manipulation of RH to 75% could only level the normal hatching percentage while others failed.

Combined effect of temperature and RH manipulation showed a significant improvement of hatching percentage over control as well as over individual effect of temperature and RH during both the seasons. During April – May, when 44.79% was the normal hatching percentage and 25^0C temperature individually improved it up to 59.03% as well as 75% RH improved up to 48.21%, the combined effect of temperature and RH increased it up to 73.33% where the temperature and RH were 25^0C and 75% respectively. During August – September also, the combined effect of temperature and humidity improved the hatching percentage from 63.03% in normal condition or 68.67% at 25^0C temperature to 85% where the manipulated temperature and RH are 25^0C and 75% respectively.

Photoperiod influenced the uniform and perfect hatching; eggs should be incubated under proper light regimes for better hatchability. During April – May, where combined effect of temperature and humidity influenced the hatching percentage from 44.79% to 73.33%, 18 hour light improved it with a highest of 81.07%. During August – September also, photoperiod of 18 hour improved the hatching percentage from 85% to 92.97% where the manipulated temperature, RH and photoperiods were 25^{0}C, 75% and 18L. 25^{0}C temperature along with 85% RH at 18L.

Manipulation of 2 5^{0}C t emperature with 75% RH and 18 hours light regimes improved the hatching percentage to a great extent and in the present findings adding the photoperiod at 18L condition (with 25^{0}C temperature and 75% RH) 93% hatching was achieved in contrast to 63% hatching in normal condition during August – September and 81.07% hatching can be achieved in contrast to 44.79% hatching in normal condition during April – May.

3. Earlier emergence of male moth has been proved principal constraint for egg production because asynchronous male and female moth emergence decreased coupling efficacy.

In the present investigation, the coupling efficacy of freshly emerged male and female was always better than any other combination. However, up to three days old male were coupled with fresh female showing good coupling efficacy. Fecundity and hatchability decrease after two days combination.

Coupling efficacy was improved from 71.27% to 90.60% in March – April and from 46.40% to 65.54% in September - October as a whole by short-term preservation at 10±1^{0}C. One day preserved female showed higher coupling efficacy, fecundity and hatchability than fresh coupling. Moreover, the coupling efficacy of 3 days preserved female were also above 80%. Fecundity also increased after preservation, however, distinctive variation in hatching percentage was not so pronounced. It has been also observed that when preserved females took more crucial role than male.

Another way to overcome the constraint of asynchronous moth emergence reflecting less number of seed production was the repeated mating by exploiting the same male. For this, the optimum hours of mating should be recorded. So, in the first

experiment, effect of different mating hours on egg laying and hatching were recorded. Non-significant results obtained from mating hours reflected that upto 12 hours mating any duration from second hour was sufficient for successful fertilization and egg laying. Minimum mating hours could be exploited and decoupled male could be utilized for repeated mating. However, in practice mechanical injury might damage both the male and fertilized female during decoupling within 5 hours. In the next experiment, repeated mating was conducted exploiting the males for a maximum of four times during March-April and of 6 time during September - October. During both the seasons though potential fecundity of the female were nearly same, repeated mating changed the egg laying and hatching. March-April showed that utilization of male upto 3 times had no harmful effect on fecundity as well as hatchability. During September-October utilization of male upto 4th time was effective in terms of egg laying and hatching.

So, in mugaculture, as synchronization of male and female was found one of the principal constraints of egg production, repeated exploitation of male moth upto four times prior to main commercial crop rearing season and upto three times before second commercial rearing by artificial coupling for seven hours to supply higher number of quality eggs to the farmers, was found effective.

4. To perform the seed cocoon screening, one of the estimators should be selected, if possible, for the farmer's point of view. Based on the regression equations obtained estimated value of fecundity, hatchability and egg vigour were worked out and deviation from the mean observed fecundity, hatchability and egg vigour showed that all the estimated grainage parameters based on the weight of the cocoon was the nearest estimated values to the observed value by the least deviation. Hence, weight of the cocoon was considered as the best estimator even though the other parameters also gave the near estimates of the observed fecundity, hatchability and egg vigour. Moreover, female cocoon weight was more determining factor than male and the combinations of high weight groups (male and female) performed better.

It was inferred that proper care should be taken while segregating the 20.11 percent population of male and female seed cocoons where male and female seed

cocoons both overlapped each other between low, medium and high groups, in other groups the chances of error was negligible.

Keeping this view under consideration seven groups of female seed cocoon were selected on the weight basis namely extreme low (T_1 : 4.50 - 4.99 g), lower (T_2 : 5.00 - 5.49 g), low (T_3 : 5.50 - 5.99 g), moderate (T_4 : 6.00 - 6.49 g), high (T_5 : 6.50 - 6.99 g), higher (T_6 : 7.00 -7.49 g) and extreme high (T_7 : 7.50 - 7.99 g). It was observed that non-significantly best performing groups were extreme high, higher and high, meaning that female cocoons weighing above 6.50 g should be selected for seed production. Non-availability of these cocoons, moderate and low cocoon groups *i.e.* female cocoons weighing in between 5.50 g and 6.49 g could be selected for quality seed production.

5. Conventional main commercial rearing seasons (October – November) suffered badly due to poor supply of quality seed. Because the seed crop rearing failed (August – September) due to poor seed supply from pre seed crop rearing (June – July).

From the standpoint of more number of hatched larvae, 10^0C temperature was optimum for short-term preservation of cocoon as the emergence percentage and coupling efficacies are high. One day cold preservation of adult at 5^0C, 7^0C and 10^0C showed significantly better fecundity and hatchability than control. But the coupling efficacy of the adult was significantly lower when refrigerated at 5^0C and 7^0C than refrigeration at 10^0C which ultimately reflected in lower number of hatched larvae. So, from the standpoint of higher number of hatched larva, 10^0C temperature should be used for preservation of adult. Low temperature stress on eggs was exploited to control hatching period as and when needed. 24 hours old egg at 10^0C preserved for 21 days delayed hatching of 19 days having no deleterious effect on hatching percentage.

Keeping the results obtained from present experiment under consideration, the attempt was made to avoid rearing during June to August reflecting poor supply of seed during main commercial season (October – November) by refrigerating the cocoon from previous commercial crop (May – June), the subsequent adult and the eggs laid by them at 10^0C.

15 days cocoon preservation from preceeding commercial crop rearing delayed the moth emergence for 10 days, subsequent adult moth preservation for 5 days showed almost no deleterious effect on fecundity and hatchability. The eggs thus obtained preserved after 24 hours for 21 days delayed the hatching for 24 days. The eggs thus brushed were reared for supply of seed for commercial rearing. The grainage performance was also observed satisfactory.

So, by maintaining the schedule and preservation package collecting the cocoons from commercial crop of May – June, the adverse seasons were found to be avoided as well as only 35 paisa/dfl. additional expenditure was required to supply adequate amount of healthy seed to the farmers for main commercial crop rearing during October – November.