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EFFECT OF SEASONAL VARIATION ON MULTIVOLTINE COCOON YIELD AND GRAINAGE PERFORMANCE IN POPULAR MULTIVOLTINE HYBRIDS OF *BOMBYX MORI* L.UNDER TROPICAL CONDITION IN WEST BENGAL

L.M. SAHA, S. CHANDA, N.B. KAR, P. MITRA AND K. MANDAL*
CENTRAL SERICULTURAL RESEARCH AND TRAINING,
BERHAMPORE-742 101, INDIA.
ZONAL SILKWORM SEED ORGANIZATION,
CENTRAL SILK BOARD, MALDA-732 101, INDIA*.
(e-mail : saha.lalmohan@rediffmail.com)

The present study is an attempt to evaluate the role of seasonal variation on silkworm seed cocoon and commercial seed production. Rearing of Nistari and M_{12}(W) (*Bombyx mori* L.) P1 disease free layings (Basic seeds) of two multivoltine silkworm breeds were conducted at seed farmers' level in 2 villages, in Uttar Dinajpur district, West Bengal, during Summer (May), Rainy (June-July) and Spring (Feb-March) in 03 consecutive years under agro-climatic conditions. Similarly grainage was conducted with the seed cocoons in the same seasons in 03 consecutive years for production of multivoltine hybrid silkworm seed at Silkworm Seed Production Centre (SSPC), Raiganj, Uttar Dinajpur, West Bengal in microclimatic conditions by following standard seed production technique. The hybrid commercial seeds Nistari x M_{12}(W) and its reciprocal, the popular multiviltine silkworm hybrids were prepared in West Bengal state for unfavourable seasons (April to August). The cocoon yield/100 dfls, cocoon to pair percentage, pair to dfl (disease free laying) percentage and recovery of dfls/kg. seed cocoon were recorded beside agro-climatic, microclimatic parameters *i.e.* temperature and relative humidity (RH) in rearing and grainage period repectively. The results revealed that yield of seed cocoons/100 dfls was significantly higher in spring crop followed by the summer and rainy. Similarly, grainage performance in respect of cocoon to pair percentage, pair to dfls percentage and recovery per kg. seed cocoon were significantly higher in spring season followed by rainy and summer seasons.

Key words : *Bombyx mori,* Rearing, Grainage, Temperature, Humidity, Cocoon weight, Egg recovery.

INTRODUCTION

The success of silkworm rearing depends upon several factors of which the impact of abiotic factors is having immense importance. Among the abiotic factors temperature and relative humidity (RH) play a major role on the growth and productivity of silkworm, as silkworm is a poikilothermic insect (Adkinson 1965; Scriber & Laderhouse, 1983; Benchamin & Jolly, 1986). On the other hand, the effect of temperature and RH on oviposition behaviour of silk moth, *Bombyx mori* L. is less known to have considerable impact. But virgin female requires optimum condition of environment for oviposition, which must be met, failing which it will lay only few eggs or none (Singh, 1998).

In *B. mori* growth is heterogenic and varies greatly with the races, quality and quantity of food intake (Krishnaswami *et al.*, 1973) and climatic conditions (Vijay, 1985). These informations are very useful in planning for improvement of rearing and grainage in tropical condition (Mathur *et al.*, 1989). Production and supply of disease free silkworm layings (dfls) is highly specialised task. Apart from the technical and scientific skills, environmental factors also pose a great hindrance for silkworm rearing and grainage at different levels i.e. from P4-P1 and in production of industrial/ commerccial layings. Environmental condition of the rearing and grainage rooms/building including temperature, humidity, air circulation, gases and light influence the growth and development of silkworms and in turn on production of quality seed cocoons (Selvakumer *et.al.*, 2008). Though effect of temperature and relative humidity play a vital role in the life cycle of the silkworm and have direct impact on its physiological function, maintenance of climatic condition during rearing and grainage is not strictly adhered which results in production of inferior quality seed cocoons resulting adverse effect on production of quality layings.

West Bengal, a major silk producing state in Eastern and North Eastern India enjoys an exceptionally varied climatic condition ranging between extreme cold in the foot hills of Himalayan regions and high temperature and high humidity in plains during summer and rainy seasons respectively. The climate of West Bengal can broadly be divided into dry summer from April - early June, monsoon from late June - October and winter from November - February. These capricious conditions affect both growth of mulberry and silkworm rearing. Within the wide variable climatic condition of West Bengal there is a lack of systematic information on the effect of temperature and humidity on production of multi x multi hybrid industrial silkworm eggs in above mentioned three seasons.

Keeping in view of above, the study was undertaken on the effect of temperature, humidity on production of seed cocoon as well as grainage performance *i.e.* pair percentage, pair to egg recovery and overall egg recovery in g/kg of seed cocoon in three seasons where multi x multi hybrid layings are produced in commercial grainages in West Bengal for commercial exploitation.

MATERIALS AND METHODS

P1 dfls (basic seeds) of Nistari and M_{12}(W) were collected from Basic Seed Farm under Central Silk Board and incubated dfls were supplied to the seed farmers in two villages at Uttar Dinajpur district of West Bengal. Out of the total farmers, 12 were selected in three batches as three replications @ 4 farmers in each replication. Each farmer reared Nistari and M_{12}(W) breeds in equal proportion in three seasons-Summer (May), Rainy (June-July) and Spring (Feb-March). All rearings were conducted following the standard technique (Krishnaswami *et al.*, 1973). On completion of rearing seed cocoons were purchased from the farmers on 6^{th} day of spinning by maintaining the norms of National Silkworm Seed Organization for Eastern Zone. From each farmer of each batch 12.50 kg good seed cocoons of each breed in each season was kept for this study. Thereafter, seed cocoons of each breed were kept separately @ 4 x 12.50 kg. = 50 kg. for each replication. After sex separation, female pupae were kept in plastic perforated trays (90 cm x 60 cm x 7 cm) @700 pupae/tray. Male pupae were kept in bamboo flat dalas of 4 ft. x 5 ft. @ 2500 pupae/ dala. Before keeping the pupae on trays/dalas at first news paper then empty cut cocoons were spread in single layer in order to soak the urine discharged by the moths. After emergence, male moths were collected in plastic trays @ 1000 males/tray and stored in cold storage at 10°C ± 2°C. On availability of female moths pairing were given for production of Nistari x M_{12} (W) dfls and its reciprocal in early morning. After 3 hrs of pairing moths were de-paired mechanically and female moths were kept in the plastic perforated trays on brown starch coated paper @ 400 females per tray and were allowed for 24 hrs. to lay eggs. After 24 hrs, examination of female moths were conducted replication wise by adopting the standard procedure. Then layings were successively washed, surface sterilized, air dried and weighed. In commercial grainage of West Bengal loose eggs are produced for easy handling. Temperatures and humidity were recorded during rearing and grainage period.

RESULTS

Seasonal effect on seed cocoon rearing in respect of yield/100 dfls of silkworm, *Bombyx mori* L. in summer, rainy and spring have been shown breed wise as well as season wise in Table I. Data presented in the table are the mean of breed wise/ season wise data of three years. Indoor range of agro-climatic conditions in three years *i.e.* maximum and minimum temperature and relative humidity (RH) in the rearing periods in all seasons have also been shown in Table I. Season wise statistical analysis on yield/100 dfls on cocoon production indicate that seasonal variation of the temperature and RH influenced significantly ($P<0.01$) on the performance of both of the breeds. Maximum average cocoon yield/100 dfls was observed in spring 30.590 kg and 28.050 kg/100 dfls in Nistari and M_{12}(W) followed by summer 27.170 kg and 25.950 kg and rainy 19.650 kg and 18.420 kg respectively. This trend of result has also been recorded in case of seasonal mean. However, in comparison to the Nistari and M_{12}(W) in respect of same trait the performance of former is significantly better ($P<0.01$) than later in all seasons. The effect of climatic condition in case season x breed is non significant.

Similarly, grainage was conducted to produce hybrid dfls of Nistari x M_{12}(W) and its reciprocal from the seed cocoons procured in the three seasons of the consecutive three years. Combination wise as well as season wise mean grainage performance in respect of

Table I : Seasonal seed cocoon rearing performance of multivoltine breeds at farmers' level.

Name of breed	Season	Yield /100 dfl (Kg)	Climatic condition during rearing period			
			Temp. (°C)		Relatively Humidity (%)	
			Max	Min	Max	Min
Nistari	Summer	27.170	30 - 33	26 - 28	73 - 85	55 - 65
	Rainy	19.650				
	Spring	30.590				
M_{12}(W)	Summer	25.980				
	Rainy	18.420	31 - 33	26 - 28	92 - 96	78 - 81
	Spring	28.050				
Seasonal Mean	Summer	26.570				
	Rainy	19.030				
	Spring	29.320	26 - 27	21 - 23	70 - 77	65 - 70
Breed mean	Nistari	25.800				
	M_{12}(W)	24.150				
CD at 1 % level	Season	01.100				
	Breed	00.900				
	Season x Breed	NS				

Rearing period : Summer: May 05-May 30, Rainy: June 06-July 04, Spring: February 08 - March 03.

Table II : Seasonal commercial grainage performance of multi x multi hybrid dfls production.

Combination	Season	Pair percentage	Pair to dfls percentage	Egg recovery in gram/Kg cocoon
Nistari x M_{12}(W)	Summer	31.42	64.96	38.13
	Rainy	31.32	77.99	45.53
	Spring	44.27	86.07	69.07
M12(W) x Nistari	Summer	21.32	81.59	32.20
	Rainy	26.75	84.62	40.73
	Spring	39.04	95.35	65.73
Seasonal mean	Summer	26.37	73.27	35.17
	Rainy	29.04	81.30	43.13
	Spring	41.65	90.71	67.40
Combination mean	Nistari x M_{12}(W)	35.67	76.34	50.91
	M_{12}(W) x Nistari	29.04	87.18	46.22
CD at 1% level	Season	01.54	05.89	01.92
	Combination	01.26	04.91	01.57
	Season x Combination	NS	NS	NS

Grainage period : Summer : May 30-June 12, Rainy : July 10-July 25, Spring : March 12-March 22

Table III : Micro-climatic condition during grainage period.

Season	Micro-climatic condition during grainage period							
	Seed cocoon presevation room				Oviposition room			
	Temp. (°C)		Relative Humidity(%)		Temp. (°C)		Relative Humidity(%)	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
Summer	32 - 36	27 - 32	60 -75	45 - 65	29 - 30	26 - 28	80 - 95	70 - 80
Rainy	31 - 32	27 - 29	85 - 90	73 - 75	28 - 29	26 - 27	90 - 95	80 - 85
Spring	28 - 29	24 – 26	75 - 84	60 - 71	27 - 28	25 - 26	90 - 95	80 - 85

pair percentage, pair to dfls percentage and recovery of dfls in g/kg seed cocoon has been recorded in Table II. Range of maximum and minimum microclimatic conditions *i.e.* temperature and humidity in seed cocoon preservation room and in oviposition room in three years has been recorded in Table III. Here also after statistical analysis of season wise data on grainage performances indicate that pair percentage, pair to dfls percentage and egg recovery in g/kg seed cocoon is significantly higher ($P<0.01$) in both the combinations in spring season followed by rainy and summer. However, in case of Nistari x M_{12}(W) there has no significant difference between summer and rainy season in case of pair percentage. Further, in between the Nistari x M_{12}(W) and its reciprocal performance of later is significantly higher ($P< 0.01$) in respect of pair percentage and egg recovery in gram, however, in case of pair to dfls recovery it was significantly higher ($P< 0.01$) in M_{12}(W) x Nistari. These data are non significant when compared with season x combination.

DISCUSSION

The success of silk industry specially rearing and grainage depends upon multiple factors of which the impact of environmental factors has vital importance. Vijoy (1985), Benchamin & Jolly (1986), Gowda & Reddy (2006). Krishnaswami *et al.* (1973) also stressed that growth of silkworm also depends on the quality and quantity of food intake by the worms. In the present investigation the seasonal variation in cocoon yield in Nistari and M_{12}(W) breeds are attributed to the fluctuation in temperature and humidity. The same effect is also observed in pair percentage, pair to dfls percentage and egg recovery in g/kg seed cocoon. Cocoon yield was observed maximum in spring. Temperature and humidity during the period was low in comparison to the summer and rainy. Poor cocoon yield in rainy season in comparison to other two seasons may be due to combined effect of high temperature and high humidity (Gowda & Reddy, 2006).

Similarly, good performance on grainage parameters was observed in spring season. It may be due to good seed cocoons, near to optimum temperature (25°C-28°C) and humidity (80-90%) in oviposition room (Jayaswal *et al.*, 2008). There are ample literatures showing good quality cocoons are produced when silkworm rearing is conducted within the temperature ranges from 22°C-27°C and humidity 65% - 85% according to the stages (Khatri *et al.*, 2008). Above and below this temperature and humidity cocoon quality produced is worse (Narasimhanna, 1988). In spite of maintenance of congenial climate in oviposition room, poor performance in grainage per unit seed cocoon during summer in comparison to the spring may be due to rearing of P1 dfls above the optimum temperature. However, in case of rainy season both temperature and humidity were above the optimum level during the rearing period. The poor performance in grainage during summer may be due to high pupal mortality and poor emergence of moth as there was maximum 33°C temperature during rearing time. Another plausible cause of poor egg recovery may be due to sterility of male moths at high temperature (30°C above) during rearing period and as a result females lay maximum unfertilised eggs. This observation is in accordance with Sugai & Ashoush (1968), Narasimhanna (1988), Sugai & Hanaoka (1972) and Fugo & Ariswa (1992). All the unfertilised eggs are washed away during washing and surface sterilization of the eggs. Further, in all the three seasons performance of Nistari breed and Nistari x M_{12}(W) combination is significantly better ($P<0.01$) than M_{12}(W) and M_{12}(W) x Nistari. It indicates that Nistari breed has more resistance capacity than M_{12}(W) in adverse climatic condition. On the other hand pair to dfls conversion was higher in M_{12}(W) x Nistari than its reciprocal. Reason behind it is not yet known. However, it may be due to the effect of fertilizing potentiality of Nistari male on M_{12}(W) female.

The above significant interactions among seasons, breeds and combination in cocoon yield and egg recovery in respect of climatic conditions in different seasons further confirm that seasonal fluctuation of temperature and humidity has vital role in cocoon productivity as well as egg recovery. This information is essential for silk industry.

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