EVALUATION OF EGG PRESERVATION SCHEDULES FOR BIVOLTINE BREEDS OF THE MULBERRY SILKWORM, *BOMBYX MORI* L.

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ABSTRACT: Two newly developed bivoltine silkworm breeds SK_6 and SK_7 were evaluated at Silkworm Seed Technology Laboratory, Kodathi, Bangalore by preserving the eggs for 4, 6, 8 and 10 months preservation schedules following 10, 20, 40 and 60 days aestivation period respectively. The results indicated that fecundity ranged from 519 to 574 and 531 to 573, hatching percentage ranged from 92.39 to 96.30 % and 92.99 to 97.60, effective rate of rearing (ERR) ranged from 9075 to 9560 and 8941 to 9445, pupation percentage ranged from 91.70 to 96.88 and 89.70 to 95.99 %, cocoon weight ranged from 1.528 to 1.647 and 1.584 to 1.626 g, cocoon shell weight ranged from 0.244 to 0.284 and 0.269 to 0.279 g and cocoon shell percentage ranged from 15.97 to 17.53 and 16.65 to 17.61 % in SK_6 and SK_7 respectively. The hatchability and rearing performance of SK_6 and SK_7 were almost similar in 4, 6, 8 and 10 months preserved eggs. Both bivoltine silkworm breeds SK_6 and SK_7 were test verified in the field through Basic Seed Farms of National Silkworm Seed Organization (NSSO), Central Silk Board and the cocoon yield ranged from 50 to 75 kg and 51 to 71.840 kg/100 dfls in SK_6 and SK_7, respectively.

KEY WORDS: Bivoltine breeds, *Bombyx mori*, Egg preservation, Evaluation, SK_6 and SK_7.

Studies on long-term preservation schedules have been carried out in diapause (Reddy et al., 2004; Shirota, 2004; 2005; Khatri et al., 2005; Machida, 2007; 2009; Iizuka et al., 2008; Rajanna et al., 2008; Banno et al., 2013; Ravindra Singh et al., 2014;) and non - diapause eggs (Kumareshan et al., 2004; Ravindra Singh et al., 2010; Rajanna et al., 2009; 2011) of the mulberry silkworm, *Bombyx mori* L. Two bivoltine silkworm breeds SK_6 and SK_7 developed at CSRTI, Berhampore, West Bengal, do not have the full-fledged seed technology aspects so as to handle these breeds with proper approaches at different stages. The foundation cross SK_6 x SK_7 is being used in East and North-east India for commercial cocoon production as well as preparation of cross breed eggs. Studies on these breeds will help in the development of suitable seed handling techniques and facilitate the sericulturists to produce quality cocoons. In South India, 4 and 6 months schedules are commonly used for the preservation of bivoltine seed. Whereas, in the temperate or sub-temperate zones of North India, one year schedule is being used to conduct silkworm rearing only during spring season. The present study has been undertaken to know the performance of two bivoltine breeds SK_6 and SK_7 following 4, 6, 8 and 10 months egg preservation schedules to obtain quality silk and sustainable cocoon crops in the northeastern regions of India.

MATERIALS AND MEHODS

Eggs of two bivoltine breeds SK_6 and SK_7 were generated and preserved for 4, 6, 8 and 10 months preservation schedules following 10, 20, 40 and 60 days

aestivation period. Eggs of SK_6 and SK_7 were released as per the schedule and rearing was conducted. Three replications were maintained with 250 larvae in each replication. Data were recorded for seven economic characters *viz*., fecundity, hatching percentage, effective rate of rearing, pupation percentage, cocoon weight, cocoon shell weight and cocoon shell percentage. Besides, data pertaining SK_6 and SK_7 for seven economic characters *viz*., fecundity, hatching percentage, cocoon yield/100dfls, pupation percentage, cocoon weight, cocoon shell weight and cocoon shell percentage reared at different units of NSSO were also collected. Different egg preservation schedules have been depicted in Figs. 1-4.

RESULTS AND DISCUSSION

Performance of bivoltine breed SK_6 during different preservation schedules has been given in Table 1. Maximum fecundity (574) was observed following 6 months preservation schedule followed by 8 months hibernation schedule (568). Hatching percentage was recorded maximum (96.30%) during 4 months schedule followed by 6 months schedule (94.48%). Effective rate of rearing (ERR) was observed maximum (9560) followed by 6 months hibernation schedule (9293) whereas pupation was recorded maximum (96.88%) during 4 months hibernation schedule followed by 10 months schedule (93.86). Maximum cocoon weight was observed during 4 months schedule (1.647 g) followed by 6 months schedule (1.621 g). Cocoon shell weight was recorded maximum (0.284 g) in 4 months hibernation schedule followed by 6 months schedule (0.282 g) and maximum cocoon shell percentage (17.53 %) was observed during 10 months hibernation schedule followed by 4 months schedule (17.24 %).

Mean performance of bivoltine breed SK_7 during different preservation schedules has been given in Table 2. Maximum fecundity (573) was observed following 4 months preservation schedule followed by 6 months hibernation schedule (566). Hatching percentage was recorded maximum (97.60 %) during 4 months schedule followed by 6 months schedule (95.01 %). Effective rate of rearing (ERR) was observed maximum (9445) during 4 months hibernation schedule followed by 6 months hibernation schedule (9401) whereas pupation was recorded maximum (95.99 %) during 4 months hibernation schedule followed by 10 months schedule (94.97 %). Maximum cocoon weight was observed during 8 months schedule (1.626 g) followed by 6 months schedule (1.615 g). Cocoon shell weight was maximum (0.279 g) in 10 months hibernation schedule followed by 4 months schedule (0.278 g) and maximum cocoon shell percentage (17.61 %) was recorded during 10 months hibernation schedule followed by 4 months schedule (17.28 %). Larval and cocoon photographs of SK_6 and SK_7 have been depicted in Plate 1.

Rearing performance of SK_6 and SK_7 reared from March,2012 to March, 2014 utilizing 1000 dfls of each breed at 5 units of NSSO namely, P3, BSF, Majra, P3, BSF, Mysore, P2, BSF, Gavimata, P2, BSF, Nagamangala, and P1, Madakasira have been given in Table 3 and 4 respectively. The results indicated that fecundity ranged from 420 to 563 and 451 to 550, hatching ranged from 90.11 to 97.00 % and 94.10 to 98.30, cocoon yield/100dfls ranged from 50.000 to 75.000 kg and 51.000 to 71.840 kg, pupation ranged from 89.50 to 96.20 and 81.40 to 98.00 %, cocoon weight ranged from 1.401 to 1.800 g and 1.356 to 1.795 g, cocoon shell weight ranged from 0.232 to 0.377 g and 0.235 to 0.375 g and cocoon shell percentage ranged from 16.13 to 20.94 % and 16.32 to 20.89 % in SK_6 and SK_7 respectively. The mean fecundity was 501 and 497, hatching 95.00 and 95.62, cocoon yield/100 dfls 64.502 and 62.489 kg, pupation 92.52 and 92.14 %, cocoon weight 1.563 and

1.524 g, cocoon shell weight 0.283 and 0.285 g and cocoon shell percentage was 18.03 and 18.68 % in SK_6 and SK_7, respectively.

Studies on long-term preservation schedules have been carried out in tropical univoltine "Barpat" (Ravindra Singh et al., 2014), bivoltine eggs (Reddy et al., 2004; Rajanna et al., 2008) and non - diapause eggs (Kumareshan et al., 2004 The study on these breeds helps in the development of suitable seed handling techniques which will facilitate the sericulturists to produce quality cocoons. Silkworm Seed Technology Laboratory, NSSO, CSB, Bangalore has developed suitable schedules for preservation of bivoltine silkworm eggs under Indian conditions and were evolved for pure as well as hybrid eggs by following these schedules, eggs could be preserved from 110 ~ 335 days without causing any weakness to the embryos of the mulberry silkworm, *B. mori* (Reddy, et al. 2004; Ravindra Singh et al., 2010; Rajanna et al., 2009; 2011).

Optimum temperature for chilling (Shirota, 2004) and suppression of diapause development at -5°C and 0°C during long-term preservation of diapause eggs of silkworm, *B. mori* have been studied (Shirota, 2005). Khatri et al. (2005) have studied preservation schedules for silkworm seed under north Indian condition. Several attempts have been made to develop long-term preservation schedule for diapause eggs in silkworm, *B. mori* (Matsuno & Shimizu, 1979; Machida, 2007; Machida et al., 2009; Iizuka et al., 2008). Recently, Banno et al. (2013) have developed a method for long-term preservation of silkworm strains using frozen ovaries.

Exploitation of SK_6 and SK_7 possessing quality silk coupled with hardiness character will not only improve the quality of silk but also will facilitate to obtain sustainable silkworm crops. Study on egg preservation schedule of these breeds would be an added advantage in order to obtain silkworm eggs as and when required.

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Table 1. Performance of bivoltine breed SK_6 during different hibernation schedules.

Preservation schedule	Fecundity (No.)	Hatching %	Effective Rate of Rearing (ERR)	Pupation (%)	Cocoon Weight (g)	Cocoon shell weight (g)	Cocoon shell %
4 months	536 ± 43	96.30 ± 2.03	9560 ± 128	96.88 ± 1.39	1.647 ± 0.03	0.284 ± 0.007	17.24 ± 0.33
6 months	574 ± 7	94.48 ± 1.38	9293 ± 185	91.70 ± 2.94	1.621 ± 0.04	0.277 ± 0.004	17.08 ± 0.33
8 months	568 ± 25	94.45 ± 0.79	9190 ± 496	93.59 ± 2.21	1.528 ± 0.13	0.244 ± 0.03	15.97 ± 1.01
10 months	519 ± 12	92.39 ± 1.61	9075 ± 245	93.86 ± 0.03	1.608 ± 0.03	0.282 ± 0.01	17.53 ± 0.64

Data mean ± SD of six replications

Table 2. Performance of bivoltine breed SK_7 during different hibernation schedules.

Preservation schedule	Fecundity (No.)	Hatching %	Effective Rate of Rearing (ERR)	Pupation (%)	Cocoon Weight (g)	Cocoon shell weight (g)	Cocoon shell %
4 months	573 ± 50	97.60 ± 1.15	9445 ± 182	95.99 ± 1.76	1.608 ± 0.03	0.278 ± 0.01	17.28 ± 0.33
6 months	566 ± 21	95.01 ± 2.46	9401 ± 459	94.27 ± 1.65	1.615 ± 0.06	0.269 ± 0.01	16.65 ± 0.72
8 months	554 ± 47	94.85 ± 2.90	8941 ± 740	89.70 ± 3.81	1.626 ± 0.20	0.277 ± 0.04	17.03 ± 0.75
10 months	531 ± 26	92.99 ± 2.04	9214 ± 215	94.97 ± 0.83	1.584 ± 0.10	0.279 ± 0.02	17.61 ± 0.35

Data mean ± SD of six replications

Table 3. Performance of bivoltine breeds SK_6 evaluated at different units of NSSO.

Unit	Season	Fecundity (No.)	Hatching %	Cocoon yield/100 dfls (kg)	Pupation (%)	Cocoon Weight (g)	Cocoon shell weight (g)	Cocoon shell %
P3, Majra	Mar, 12	560	95.80	73.000	96.00	1.800	0.377	20.94
P3, Mysore	Mar, 12	541	93.30	70.600	90.70	1.460	0.263	18.01
-do-	Jun, 12	420	95.80	55.000	92.10	1.519	0.261	17.18
-do-	Aug, 12	522	95.50	73.000	90.30	1.595	0.285	17.87
-do-	Oct, 12	493	95.90	71.200	89.50	1.678	0.307	18.30
-do-	Dec, 12	469	96.10	60.000	94.50	1.505	0.282	18.74
-do-	May, 13	504	93.70	68.000	90.50	1.761	0.320	18.17
-do-	Aug, 13	563	96.70	75.000	90.90	1.486	0.257	17.27
P2, Gavimata	May, 12	493	95.20	70.500	96.20	1.584	0.274	17.30
-do-	May, 13	500	97.00	56.300	90.00	1.520	0.287	18.88
P2, Nagamangla	Feb, 13	495	94.90	60.920	95.00	1.575	0.280	17.78
-do-	Jul, 13	475	90.11	50.000	96.00	1.438	0.232	16.13
P1, Madakasira	Jul, 13	477	95.00	55.000	91.06	1.401	0.249	17.77
Mean ± SD		**501 ±39**	**95.00 ±1.80**	**64.502 ±8.54**	**92.52 ±2.59**	**1.563 ±0.12**	**0.283 ±0.03**	**18.03 ±1.13**

Table 4. Performance of bivoltine breeds SK_7 evaluated at different units of NSSO.

Unit	Season	Fecun-dity (No.)	Hatching %	Cocoon yield/100 dfls (kg)	Pupation (%)	Cocoon weight (g)	Cocoon shell weight (g)	Cocoon shell %
P3, Majra	Mar, 12	550	94.50	71.840	95.00	1.795	0.375	20.89
P3, Mysore	Mar, 12	530	96.95	68.800	90.10	1.433	0.279	19.47
-do-	Jun, 12	451	95.00	56.000	91.20	1.437	0.278	19.35
-do-	Aug, 12	460	96.90	58.670	91.70	1.599	0.299	18.70
-do-	Oct, 12	528	95.10	71.200	90.70	1.655	0.300	18.13
-do-	Dec, 12	463	95.50	52.500	94.70	1.356	0.266	19.62
-do-	May, 13	473	94.10	54.000	81.40	1.538	0.296	19.25
-do-	Aug, 13	548	96.10	71.000	90.40	1.404	0.241	17.17
P2, Gavimata	May, 12	516	94.90	65.500	96.40	1.675	0.337	20.12
-do-	May, 13	506	98.30	67.170	90.00	1.530	0.274	17.91
P2, Nagamangla	Feb, 13	519	96.80	70.820	98.00	1.592	0.288	18.09
-do-	Jul, 13	470	94.89	53.860	97.00	1.440	0.235	16.32
P1 Madakasira	Jul, 13	451	94.00	51.000	91.27	1.353	0.239	17.66
Mean ± SD		**497 ±37**	**95.62 ±1.29**	**62.489 ±8.22**	**92.14 ±1.30**	**1.524 ±0.13**	**0.285 ±0.03**	**18.68 ±1.26**

1 2 3 4

Plate I. Larval and cocoon photographs of bivoltine breed SK_6 and SK_7: 1. Larvae of SK_6 2. Larvae of SK_7, 3. Cocoons of SK_6 and 4. Cocoons of SK_7.