



**SCREENING OF REGION AND SEASON SPECIFIC BIVOLTINE SILKWORM
(*BOMBYX MORI* LINN.) HYBRID BREEDS OF WEST BENGAL IN SPRING AND
SUMMER SEASON OF UTTAR PRADESH CLIMATIC CONDITION**

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ABSTRACT : An attempt has been made to evaluate the seasonal response of Ten bivoltine silkworm hybrid breeds *i.e.* P₅ x KB, P₅ x KPG-B, NB₄D₂ x NB₁₈, P₅ x NB₁₈, KPG-B x NB₇ for spring KPG-B x NB₁₈, NB₁₈ x P₅, NB₁₈ x NB₇, SH₆ x NB₁₈ and KA x NB₁₈ for summer season were selected from different seasons of West Bengal by survey (questioner method) from different part of West Bengal on the basis of climatic factors (Temperature and Humidity) and check their economic traits in the U.P climatic conditions. The selected breeds were reared in triplicates, data was collected for the nine performance parameters viz. hatching %, yield / 10000 larvae by number, by weight, survival percentage, cocoon weight, shell weight, shell percentage, total larval duration, filament length and reelability percentage. On the basis of results achieved, it is analyzed that P₅ x NB₁₈, KA x NB₁₈ performed better in spring and summer seasons of Uttar Pradesh in respect of other breeds.

Key words: Silkworm, Bivoltine, Climatic condition

INTRODUCTION

Improvement of silkworm breeds *Bombyx mori* is of great importance to Increase silk production in any tropical silk producing country like India. Adequate steps had been taken for breeding bivoltine silkworm and a number of improved breeds were developed which were successfully exploited in the field during favorable rearing seasons [1-18].

It has also been established fact that, adaptation of silkworm *Bombyx mori* L. under tropical conditions is highly influenced by the robustness of the breed, quality of mulberry leaf and atmospheric conditions [19-24]. The seasonal performances of bivoltine breeds also depend upon the technology of rearing of silkworm under tropical conditions [25-27]. It is also established fact that, for exploiting maximum benefit from above mentioned rearing technology, use for high yielding varieties of mulberry & superior bivoltine silkworm breeds and favourable conditions plays vital role in success of cocoon crops [28- 36]. The success of cocoon crop mainly depends upon three major factors *viz.* quality of laying, quality of leaves and proper rearing method adopted by the former [37-39]. Sericulture researcher in the past had emphasized that there is need for improvement of silk production by evolving the silkworm breeds, which are season specific. In India, attempts were made to identify superior silkworm breeds suitable for summer and autumn rearing [40-48] as well as their seasonal performance in different seasons [49-53]. A number of improved breeds were developed, which are successfully exploited in the field during favorable rearing seasons [54-63]. Keeping these points in view author has taken up this experiment to identify the superior bivoltine silkworm breeds for different rearing seasons of Uttar Pradesh farmers.

MATERIALS AND METHODS

This study was conducted at Babasaheb Bhimrao Ambedkar University, Lucknow. Ten bivoltine silkworm hybrid breeds *i.e.* P₅ x KB, P₅ x KPG-B, NB₄D₂ x NB₁₈, P₅ x NB₁₈, KPG-B x NB₇ for spring KPG-B x NB₁₈, NB₁₈ x P₅, NB₁₈ x NB₇, SH₆ x NB₁₈ and KA x NB₁₈ for summer season were selected from different seasons of West Bengal by using tabular method [64-90]. Three replica with 400 larvae of selected breeds were maintained for control and field conditions separately.

Data was collected for the nine performance parameters viz. hatching %, yield / 10000 larvae by number, by weight, survival percentage, cocoon weight, shell weight, shell percentage, total larval duration, filament length and reelability percentage. Data were subjected to statistical analysis for deriving the results. Experiment was conducted in different rearing seasons of two subsequent years i.e. 2002 and 2003.

RESULTS

The result recorded for ten bivoltine hybrid breeds viz., P₅ x KB, P₅ x KPG-B, NB₄D₂ x NB₁₈, P₅ x NB₁₈, KPG-B x NB₇ for spring KPG-B x NB₁₈, NB₁₈ x P₅, NB₁₈ x NB₇, SH₆ x NB₁₈ and KA x NB₁₈ for summer seasons are summarised in Tables 1-2.

SPRING SEASON

On the basis of results obtained, the value of nine economic characters such as hatching %, yield / 10000 larvae by number, by weight, survival rate, cocoon weight, shell weight, cocoon shell %, total larval duration, filament length and reelability percentage for different rearing seasons pertaining to each breed as shown in Tables -1.

Table –1 Performance of different bivoltine hybrid breeds in spring season of Uttar Pradesh

	Breed	HA. %	Yield/ 400 larvae		S.Rate	C.W	S.W (cg)	SR%	T.L.D	F.L.(m)	Reel. %
			By No.	By wt. (kg)							
Control	P ₅ x KB	94.50 ± 0.02	315 ± 1.86	0.47 ± 0.16	78.12 ± 0.89	1.53 ± 0.02	33.37 ± 0.01	21.80 ± 0.01	580.00 ± 12.78	900.55 ± 18.91	84.01 ± 2.12
	P ₅ x KPG-B	95.08 ± 0.01	316 ± 2.45	0.46 ± 0.13	79.50 ± 0.79	1.56 ± 0.03	33.21 ± 0.01	21.29 ± 0.02	578.12 ± 14.56	870.37 ± 22.82	88.12 ± 2.31
	NB ₄ D ₂ x NB ₁₈	95.55 ± 0.01	314 ± 3.12	0.49 ± 0.18	80.00 ± 1.42	1.54 ± 0.02	34.09 ± 0.01	22.14 ± 0.01	590.08 ± 11.80	850.72 ± 23.56	90.90 ± 2.80
	P ₅ x NB ₁₈	97.00 ± 0.01	318 ± 1.58	0.51 ± 0.09	80.66 ± 0.24	1.58 ± 0.01	35.96 ± 0.00	22.76 ± 0.01	566.00 ± 7.50	980.90 ± 9.90	91.52 ± 1.92
	KPG-B x NB ₇	95.25 ± 0.02	309 ± 1.78	0.50 ± 0.52	76.50 ± 0.92	1.57 ± 0.02	33.80 ± 0.02	21.51 ± 0.03	585.50 ± 13.23	950.80 ± 14.12	91.00 ± 2.62
Lucknow 2002	P ₅ x KB	91.00 ± 0.02	228 ± 2.81	0.38 ± 0.22	62.04 ± 1.68	1.47 ± 0.10	27.20 ± 0.09	18.50 ± 0.03	573.33 ± 13.68	780.50 ± 23.21	71.25 ± 2.50
	P ₅ x KPG-B	90.00 ± 0.04	224 ± 3.28	0.39 ± 0.28	65.15 ± 1.79	1.48 ± 0.12	28.56 ± 0.11	19.31 ± 0.05	612.00 ± 14.25	790.32 ± 24.12	72.40 ± 3.12
	NB ₄ D ₂ x NB ₁₈	91.25 ± 0.05	231 ± 3.29	0.40 ± 0.48	62.00 ± 1.75	1.46 ± 0.13	29.00 ± 0.15	19.84 ± 0.08	618.50 ± 20.11	840.50 ± 23.00	75.58 ± 3.66
	P ₅ x NB ₁₈	95.00 ± 0.11	235 ± 3.02	0.41 ± 0.59	68.91 ± 2.38	1.51 ± 0.20	33.86 ± 0.19	22.40 ± 0.14	560.00 ± 22.45	900.00 ± 22.12	82.00 ± 2.23
	KPG-B x NB ₇	91.50 ± 0.04	230 ± 3.12	0.39 ± 0.38	67.50 ± 2.16	1.49 ± 0.18	29.50 ± 0.21	19.80 ± 0.12	596.00 ± 14.86	742.78 ± 24.00	80.45 ± 2.70
Lucknow 2003	P ₅ x KB	94.00 ± 0.02	276 ± 2.67	0.40 ± 0.28	71.50 ± 1.42	1.52 ± 0.04	31.34 ± 0.01	20.62 ± 0.01	619.50 ± 12.78	810.25 ± 22.98	80.28 ± 2.80
	P ₅ x KPG-B	93.25 ± 0.02	267 ± 3.23	0.41 ± 0.32	69.25 ± 2.23	1.53 ± 0.05	28.78 ± 0.02	18.82 ± 0.02	612.18 ± 16.52	811.75 ± 31.32	79.48 ± 3.45
	NB ₄ D ₂ x NB ₁₈	93.00 ± 0.03	268 ± 3.17	0.42 ± 0.23	72.00 ± 1.91	1.52 ± 0.06	33.32 ± 0.02	21.90 ± 0.02	616.33 ± 22.89	891.50 ± 28.66	82.00 ± 3.98
	P ₅ x NB ₁₈	95.00 ± 0.01	279 ± 1.58	0.43 ± 0.12	75.00 ± 1.58	1.61 ± 0.01	35.30 ± 0.01	22.49 ± 0.01	611.00 ± 15.46	940.50 ± 14.16	88.42 ± 2.11
	KPG-B x NB ₇	92.00 ± 0.03	270 ± 1.76	0.42 ± 0.38	71.00 ± 1.68	1.55 ± 0.03	32.20 ± 0.03	20.78 ± 0.02	620.12 ± 18.52	788.50 ± 17.59	81.00 ± 3.79

H.A.% = Hatching Percentage, S.Rate = Survival Rate C.W. = Cocoon Weight S.W. = Shell Weight S.R.% = Shell Ratio Percentage
T.L.D. = Total Larval Duration, F.L = Filament Length Reel. % = Reelability Percentage

Hatching Percentage

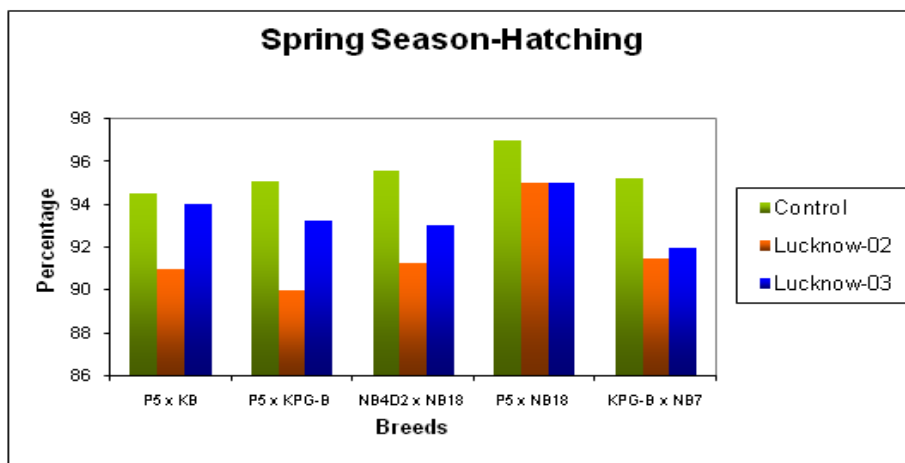
In spring season under controlled conditions recorded highest hatching % recorded was 97.00 in P₅ x NB₁₈ followed by 95.55 in NB₄D₂ x NB₁₈, 95.25 in KPG-B x NB₇, 95.08 P₅ x KPG-B, 94.50 in P₅ x KB. In first year under field conditions highest hatching % recorded was 95.00 in P₅ x NB₁₈ followed by 91.00 in P₅ x KB, 90.00 in P₅ x KPG-B, 91.25 in NB₄D₂ x NB₁₈ and 91.50 in KPG-B x NB₇. In second year under field conditions highest hatching % recorded was 95.00 in P₅ x NB₁₈ followed by 94.00 in P₅ x KB, 93.25 in P₅ x KPG-B, 93.00 in NB₄D₂ x NB₁₈ and 92.00 in KPG-B x NB₇ as shown in table-1 and graph-1.

Effective Rate Of Rearing

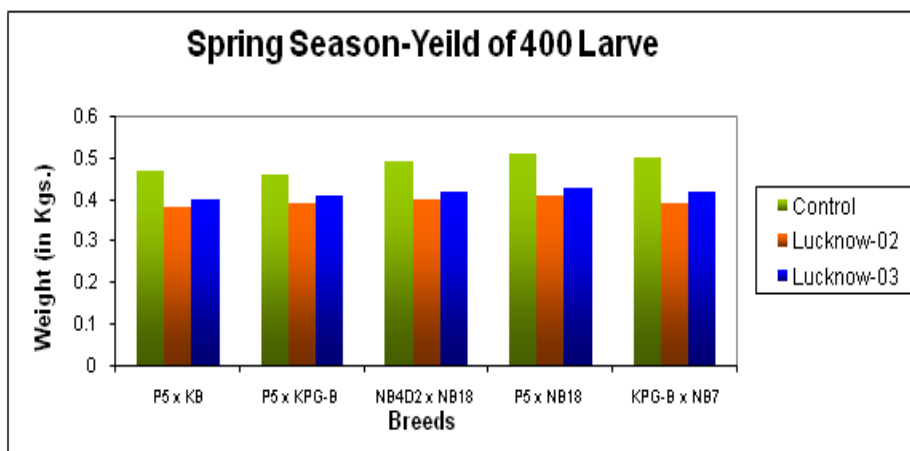
Under controlled conditions larva by number recorded was 318 in P₅ x NB₁₈ followed by 316 in P₅ x KPG-B), 315 in P₅ x KB, 314 in NB₄D₂ x NB₁₈ and 309 in KPG-B x NB₇. In first year under field conditions highest larva by number recorded was 235 in P₅ x NB₁₈ followed by 228 in P₅ x KB, 230 in KPG-B x NB₇, 231 in NB₄D₂ x NB₁₈ and 224 P₅ x KPG-B.

In second year under field conditions highest larva by number recorded was 279 in $P_5 \times NB_{18}$ followed by 276 in $P_5 \times KB$, 270 in $KPG-B \times NB_7$, 268 in $NB_4D_2 \times NB_{18}$ and 267 in $P_5 \times KPG-B$. The observation in controlled conditions larva by weight (kg.) was 0.51 in $P_5 \times NB_{18}$ followed by 0.50 in $KPG-B \times NB_7$, 0.49 in $NB_4D_2 \times NB_{18}$, 0.47 in $P_5 \times KB$ and 0.46 in $P_5 \times KPG-B$. In first year under field conditions highest cocoon yield by weight recorded was 0.41 in $P_5 \times NB_{18}$ followed by 0.40 in $NB_4D_2 \times NB_{18}$, 0.39 in $KPG-B \times NB_7$, 0.39 in $P_5 \times KPG-B$ and 0.38 in $P_5 \times KB$. In second year under field conditions highest cocoon yield by weight recorded was 0.43 in $P_5 \times NB_{18}$ followed by 0.42 in $NB_4D_2 \times NB_{18}$, 0.42 in $KPG-B \times NB_7$, 0.41 in $P_5 \times KPG-B$ and 0.40 in $P_5 \times KB$ as shown in table-1 and graph-2.

Graph-1 Performance of breeds on the basis of hatching percentage



Graph-2 Performance of breeds on the basis of yield



Survival Percentage

The observed survival % recorded under controlled conditions was 80.66 in $P_5 \times NB_{18}$ followed by 80.00 in $NB_4D_2 \times NB_{18}$, 79.50 in $P_5 \times KPG-B$, 78.12 in $P_5 \times KB$ and 76.50 in $KPG-B \times NB_7$. In first year under field conditions highest survival % recorded was 68.91 in $P_5 \times NB_{18}$ followed by 62.00 in $NB_4D_2 \times NB_{18}$, 67.50 in $KPG-B \times NB_7$, 65.15 in $P_5 \times KPG-B$ and 62.04 in $P_5 \times KB$. In second year under field conditions highest survival % recorded was 75.00 in $P_5 \times NB_{18}$ followed by 72.00 in $NB_4D_2 \times NB_{18}$, 71.00 in $KPG-B \times NB_7$, 71.50 in $P_5 \times KB$ and 69.25 in $P_5 \times KPG-B$ as shown in table-1.

Single Cocoon Weight

In spring season under controlled conditions, highest cocoon weight (g) recorded was 1.58 in P₅ x NB₁₈ followed by 1.57 in KPG-B x NB₇, 1.56 in P₅ x KPG-B, 1.54 in NB₄D₂ x NB₁₈ and 1.53 in P₅ x KB. In first year under field conditions highest cocoon weight recorded was 1.51 in P₅ x NB₁₈ followed by, 1.49 in KPG-B x NB₇, 1.48 in P₅ x KPG-B, 1.47 in P₅ x KB and 1.46 in NB₄D₂ x NB₁₈. In second year under field conditions highest cocoon weight recorded was 1.61 in P₅ x NB₁₈ followed by 1.55 in KPG-B x NB₇, 1.53 in P₅ x KPG-B and 1.52 in NB₄D₂ x NB₁₈ & P₅ x KB as shown in table-1.

Single Shell Weight

The observed shell weight (cg) recorded under controlled conditions was 35.96 in P₅ x NB₁₈ followed by 34.09 in NB₄D₂ x NB₁₈, 33.80 in KPG-B x NB₇, 33.37 in P₅ x KB and 33.21 in P₅ x KPG-B. In first year under field conditions highest shell weight (cg) recorded was 33.86 in P₅ x NB₁₈ followed by 29.00 in NB₄D₂ x NB₁₈, 29.50 in KPG-B x NB₇, 28.56 in P₅ x KPG-B and 27.20 in P₅ x KB. In second year under field conditions highest shell weight recorded was 35.30 in P₅ x NB₁₈ followed by 33.32 in NB₄D₂ x NB₁₈, 32.20 in KPG-B x NB₇, 31.34 in P₅ x KB and 28.78 in P₅ x KPG-B as shown in table-1.

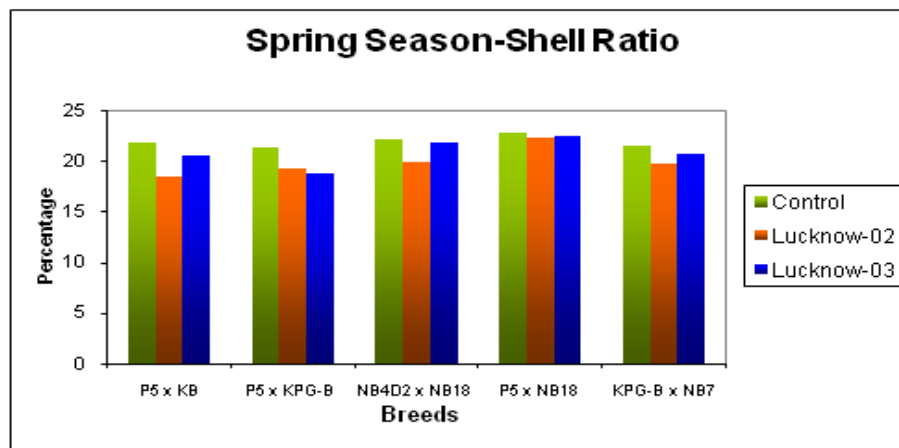
Shell Ratio Percentage

The shell ratio % recorded under controlled conditions was 22.76 in P₅ x NB₁₈ followed by 22.14 in NB₄D₂ x NB₁₈, 21.80 in P₅ x KB, 21.29 in P₅ x KPG-B and 21.15 in KPG-B x NB₇. In first year under field conditions highest shell ratio % recorded was 22.40 in P₅ x NB₁₈ followed by 19.84 in NB₄D₂ x NB₁₈, 19.80 in KPG-B x NB₇, 19.31 in P₅ x KPG-B and 18.50 in P₅ x KB. In second year under field conditions highest shell ratio % recorded was 22.49 in P₅ x NB₁₈ followed by 21.90 in NB₄D₂ x NB₁₈, 20.78 in KPG-B x NB₇, 20.62 in P₅ x KB and 18.82 in P₅ x KPG-B as shown in table-1 and graph-1.

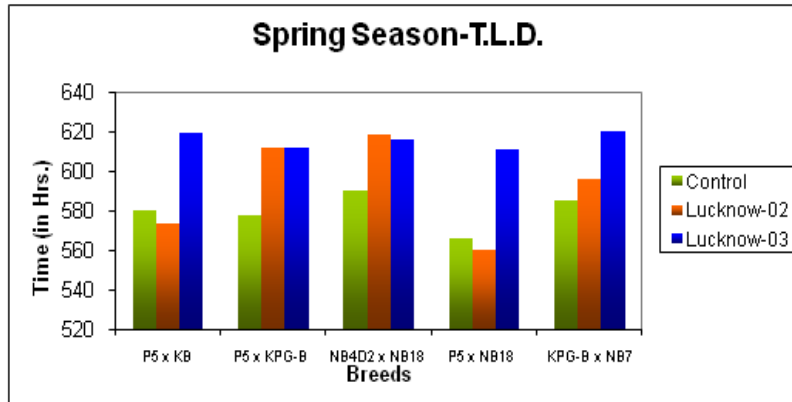
Total Larval Duration

The observed total larval duration (hrs) under controlled conditions was 566.00 in P₅ x NB₁₈ followed by 578.12 in P₅ x KPG-B, 580.50 in P₅ x KB, 585.50 in KPG-B x NB₇ and 590.08 in NB₄D₂ x NB₁₈. In first year under field conditions total larval duration recorded was 560.00 in P₅ x NB₁₈ followed by 618.50 in NB₄D₂ x NB₁₈, 596.00 in KPG-B x NB₇, 612.00 in P₅ x KPG-B and 573.33 in P₅ x KB. In second year under field conditions total larval duration % recorded was 611.00 in P₅ x NB₁₈ followed by 612.50 in P₅ x KPG-B, 616.33 in NB₄D₂ x NB₁₈, 619.50 in P₅ x KB and 620.12 in KPG-B x NB₇ as shown in table-1 and graph-4.

Graph-3 Performance of breeds on the basis of shell ratio percentage



Graph-4 Performance of breeds on the basis of total larval



Filament Length

The filament length (meter) recorded under controlled conditions was 980.90 in P₅ x NB₁₈ followed by 950.80 in KPG-B x NB₇, 900.55 in P₅ x KB, 870.37 P₅ x KPG-B and 850.72 in NB₄D₂ x NB₁₈. In first year under field conditions filament length recorded was 900.00 in P₅ x NB₁₈ followed by 840.50 in NB₄D₂ x NB₁₈, 742.78 in KPG-B x NB₇, 790.32 in P₅ x KPG-B and 780.50 in P₅ x KB. In second year under field conditions highest filament length recorded was 940.50 in P₅ x NB₁₈ followed by 891.50 in NB₄D₂ x NB₁₈, 811.75 in P₅ x KPG-B, 810.25 in P₅ x KB and 788.50 in KPG-B x NB₇ as shown in table-1.

Reelability Percentage

The reelability % recorded under controlled conditions was 91.52 in P₅ x NB₁₈ followed by 91.00 in KPG-B x NB₇, 90.90 in NB₄D₂ x NB₁₈, 88.12 in P₅ x KPG-B and 84.01 in P₅ x KB. In first year under field conditions reelability % recorded was 82.00 in P₅ x NB₁₈ followed by 75.58 in NB₄D₂ x NB₁₈, 80.45 in KPG-B x NB₇, 72.40 in P₅ x KPG-B and 71.25 in P₅ x KB. In second year under field conditions highest reelability % recorded was 88.42 in P₅ x NB₁₈ followed by 82.00 in NB₄D₂ x NB₁₈, 81.00 in KPG-B x NB₇, 79.48 in P₅ x KPG-B and 80.28 in P₅ x KB as shown in table-1.

SUMMER SEASON

On the basis of results obtained, the value of nine economic characters such as hatching %, yield / 10000 larvae by number, by weight, survival rate, cocoon weight, shell weight, cocoon shell %, total larval duration, filament length and reelability percentage for summer season pertaining to each breed shown in Table- 2.

Table -2 Performance of different bivoltine hybrid breeds in summer season of Uttar Pradesh

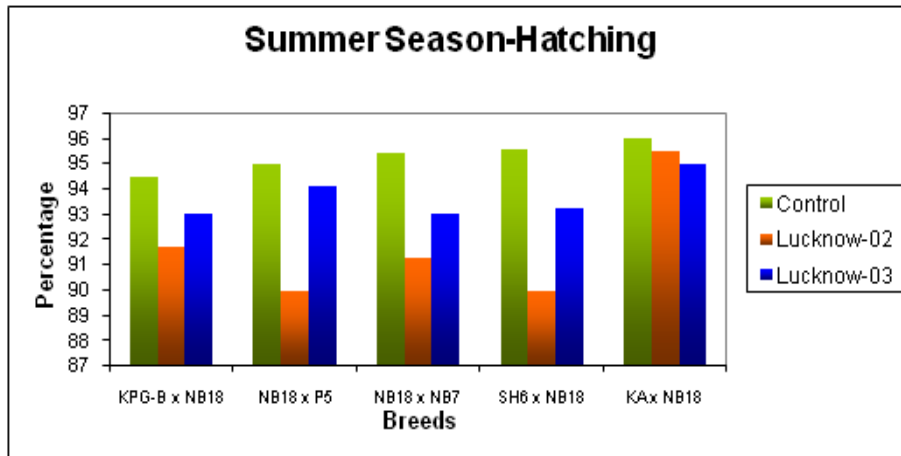
Control	Breed	HA. %	Yield/ 400 larvae		S.Rate	C.W	S.W (cg)	SR%	T.L.D	F.L.(m)	Reel. %
			By No.	By wt. (kg)							
Control	KPG-B x NB18	94.50 ± 0.02	313 ± 1.58	0.52 ± 0.11	83.56 ± 0.91	1.57 ± 0.02	33.04 ± 0.01	21.09 ± 0.01	580.00 ± 9.54	910.50 ± 12.34	84.01 ± 2.72
	NB18 x P5	95.00 ± 0.01	314 ± 2.34	0.50 ± 0.12	82.45 ± 0.98	1.56 ± 0.03	33.80 ± 0.01	21.20 ± 0.02	578.12 ± 10.14	890.40 ± 23.45	86.78 ± 2.02
	NB18 x NB7	95.45 ± 0.01	311 ± 3.34	0.53 ± 0.13	81.23 ± 1.24	1.58 ± 0.02	33.00 ± 0.01	21.31 ± 0.01	590.08 ± 13.34	870.45 ± 22.78	87.45 ± 2.77
	SH6 x NB18	95.60 ± 0.01	309 ± 1.58	0.55 ± 0.09	84.52 ± 0.34	1.59 ± 0.01	33.15 ± 0.00	21.41 ± 0.01	576.66 ± 6.58	900.00 ± 10.78	88.25 ± 2.34
	KA x NB18	96.00 ± 0.02	320 ± 1.68	0.56 ± 0.52	86.50 ± 0.82	1.61 ± 0.02	34.00 ± 0.02	21.70 ± 0.03	560.50 ± 12.80	930.90 ± 16.58	90.00 ± 2.87
Lucknow 2002	KPG-B x NB18	91.75 ± 0.02	242 ± 2.90	0.39 ± 0.21	72.04 ± 1.62	1.46 ± 0.12	27.20 ± 0.02	18.65 ± 0.02	573.33 ± 13.78	750.00 ± 23.25	74.25 ± 2.51
	NB18 x P5	90.00 ± 0.04	246 ± 3.14	0.43 ± 0.25	71.15 ± 1.78	1.48 ± 0.15	28.56 ± 0.10	19.31 ± 0.03	612.42 ± 14.56	790.32 ± 24.50	75.40 ± 3.14
	NB18 x NB7	91.25 ± 0.05	240 ± 3.22	0.43 ± 0.45	72.00 ± 1.72	1.46 ± 0.19	28.00 ± 0.09	19.17 ± 0.06	618.50 ± 20.23	850.50 ± 23.92	78.58 ± 3.78
	SH6 x NB18	90.00 ± 0.11	245 ± 3.98	0.42 ± 0.58	74.25 ± 2.34	1.39 ± 0.21	26.16 ± 0.15	18.80 ± 0.11	625.12 ± 24.00	740.56 ± 24.58	74.00 ± 4.23
	KA x NB18	95.50 ± 0.04	250 ± 3.02	0.45 ± 0.32	76.50 ± 2.12	1.50 ± 0.19	29.50 ± 0.08	19.70 ± 0.09	596.00 ± 14.56	852.78 ± 24.00	82.45 ± 2.79
Lucknow 2003	KPG-B x NB18	93.00 ± 0.02	256 ± 2.34	0.42 ± 0.22	76.50 ± 1.58	1.49 ± 0.04	30.12 ± 0.01	20.14 ± 0.01	625.33 ± 13.34	820.00 ± 22.78	84.28 ± 3.98
	NB18 x P5	94.12 ± 0.02	260 ± 3.34	0.40 ± 0.23	78.12 ± 2.34	1.51 ± 0.05	28.35 ± 0.02	19.79 ± 0.02	612.18 ± 15.58	798.00 ± 23.34	78.56 ± 4.12
	NB18 x NB7	93.00 ± 0.03	261 ± 3.78	0.41 ± 0.34	77.00 ± 1.98	1.50 ± 0.06	30.40 ± 0.02	21.00 ± 0.22	616.33 ± 22.69	810.50 ± 30.54	81.50 ± 3.48
	SH6 x NB18	93.25 ± 0.01	259 ± 1.58	0.43 ± 0.11	78.25 ± 1.58	1.48 ± 0.01	31.41 ± 0.01	21.11 ± 0.01	611.00 ± 11.58	852.80 ± 15.37	82.20 ± 2.42
	KA x NB18	95.00 ± 0.03	269 ± 1.98	0.48 ± 0.42	80.00 ± 1.89	1.52 ± 0.03	32.72 ± 0.03	21.21 ± 0.02	610.00 ± 15.50	890.70 ± 20.23	87.53 ± 3.81

H.A.% = Hatching Percentage S.Rate = Survival Rate C.W. = Cocoon Weight S.W. = Shell Weight S.R.% = Shell Ratio Percentage
 T.L.D. = Total Larval Duration F.L. = Filament Length Reel. % = Reelability Percentage

Hatching Percentage

In summer season under controlled conditions highest hatching % recorded was 96.00 in KA x NB₁₈ followed by 95.60 in SH₆ x NB₁₈, 95.45 in NB₁₈ x NB₇, 95.00 in NB₁₈ x P₅ and 94.50 KPG-B x NB₁₈. In first year under field conditions hatching % recorded was 95.50 in KA x NB₁₈, followed by 90.00 in NB₁₈ x P₅ & SH₆ x NB₁₈, 91.25 in NB₁₈ x NB₇ and 91.75% in KPG-B x NB₁₈. In second year under field conditions hatching % recorded was 95.00 in KA x NB₁₈ followed by 94.12 in NB₁₈ x P₅, 93.23 in SH₆ x NB₁₈ and 93% in NB₁₈ x NB₇ & KPG-B x NB₁₈ as shown in table-2 and graph-5.

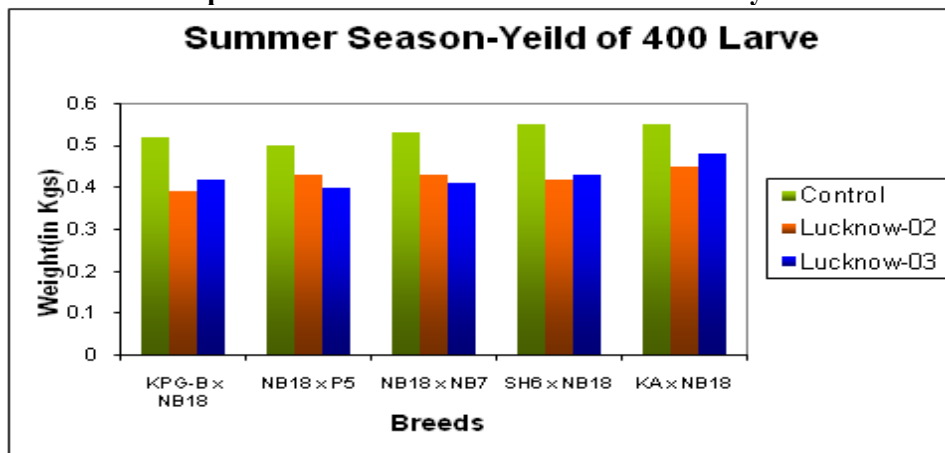
Graph-5 Performance of breeds on the basis of hatching percentage



Effective Rate of Rearing

Under controlled conditions larva by number recorded was 320 in KA x NB₁₈ followed by 314 in NB₁₈ x P₅, 313 in KPG-B x NB₁₈, 311 in NB₁₈ x NB₇ and 309 in SH₆ x NB₁₈. In first year under field conditions larva by number recorded was 250 in KA x NB₁₈ followed by 240 in NB₁₈ x NB₇, 246 in NB₁₈ x P₅, 245 in SH₆ x NB₁₈ and 242 in KPG-B x NB₁₈. In second year under field condition larva by number recorded was 269 in KA x NB₁₈ followed by 261 in NB₁₈ x NB₇, 260 in NB₁₈ x P₅, 259 in SH₆ x NB₁₈ and 256 in KPG-B x NB₁₈. The observation in controlled conditions larva by weight (kg.) was 0.56 in KA x NB₁₈ followed by 0.55 in SH₆ x NB₁₈, 0.53 in NB₁₈ x NB₇, 0.52 in KPG-B x NB₁₈ and 0.50 in NB₁₈ x P₅. In first year under field condition cocoon yield by weight recorded was 0.45 in KA x NB₁₈ followed by 0.42 in SH₆ x NB₁₈, 0.39 in KPG-B x NB₁₈, 0.43 in NB₁₈ x NB₇ & NB₁₈ x P₅. In second year under field condition larva by weight recorded was 0.48 in KA x NB₁₈ followed by 0.43 in SH₆ x NB₁₈, 0.42 in KPG-B x NB₁₈, 0.41 in NB₁₈ x NB₇ and 0.40 in NB₁₈ x P₅ as shown in table-2 and graph-6.

Graph-6 Performance of breeds on the basis of yield



Survival Percentage

The observed survival % recorded under controlled conditions was 86.50 in KA x NB₁₈ followed by 84.52 in SH₆ x NB₁₈, 83.56 in KPG-B x NB₁₈, 82.45 in NB₁₈ x P₅ and 81.23 in NB₁₈ x NB₇. In first year under field condition highest survival % recorded was 76.50 in KA x NB₁₈, followed by 74.25 in SH₆ x NB₁₈, 72.04 in KPG-B x NB₁₈, 72.00 in NB₁₈ x NB₇ and 71.15 in NB₁₈ x P₅. In second year under field condition highest survival % recorded was 80.00 in KA x NB₁₈ followed by 78.25 in SH₆ x NB₁₈, 77.00 in NB₁₈ x NB₇, 78.12 in NB₁₈ x P₅ and 76.50 in KPG-B x NB₁₈.

Single Cocoon Weight

In summer season under controlled conditions, highest cocoon weight (g) recorded was 1.61 in KA x NB₁₈ followed by 1.59 in SH₆ x NB₁₈, 1.58 in NB₁₈ x NB₇, 1.57 in KPG-B x NB₁₈ and 1.56 in NB₁₈ x P₅. In second year under field condition highest cocoon weight recorded was 1.52 in KA x NB₁₈ followed by 1.51 in NB₁₈ x P₅, 1.50 in NB₁₈ x NB₇, 1.49 in KPG-B x NB₁₈ and 1.48 in SH₆ x NB₁₈. In first year under field condition highest cocoon weight recorded was 1.50 in KA x NB₁₈ followed by 1.48 in NB₁₈ x P₅, 1.46 in NB₁₈ x NB₇ & KPG-B x NB₁₈ and 1.39 in SH₆ x NB₁₈.

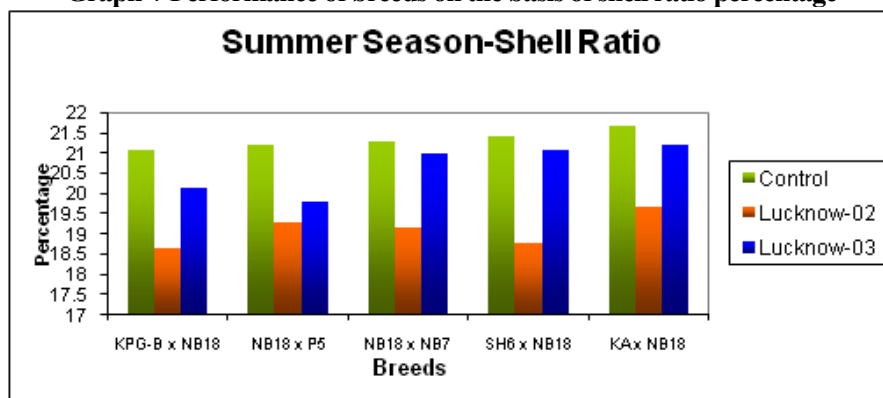
Shell Weight

The observed shell weight (cg) recorded under controlled conditions was 34.00 in KA x NB₁₈ followed by 33.80 in NB₁₈ x P₅, 33.15 in SH₆ x NB₁₈, 33.00 in NB₁₈ x NB₇ and 33.04 in KPG-B x NB₁₈. In first year under field condition highest shell weight recorded was 29.50 in KA x NB₁₈ followed by 28.56 in NB₁₈ x P₅, 28.00 in NB₁₈ x NB₇, 27.20 in KPG-B x NB₁₈ and 26.16 in SH₆ x NB₁₈. In second year under field condition highest shell weight recorded was 32.72 in KA x NB₁₈ followed by 31.41 in SH₆ x NB₁₈, 30.40 in NB₁₈ x NB₇, 28.35 in NB₁₈ x P₅ and 30.12 in KPG-B x NB₁₈.

Shell Ratio Percentage

The highest shell ratio % recorded under controlled conditions was 21.70 in KA x NB₁₈ followed by 21.41 in SH₆ x NB₁₈, 21.31 in NB₁₈ x NB₇, 21.20 in NB₁₈ x P₅, 21.09 in KPG-B x NB₁₈. In first year under field condition highest shell ratio % recorded was 19.70 in KA x NB₁₈ followed by 18.80 in SH₆ x NB₁₈, 19.17 in NB₁₈ x NB₇, 19.31 in NB₁₈ x P₅ and 18.65 in KPG-B x NB₁₈. In second year under field condition highest shell ratio % recorded was 21.21 in KA x NB₁₈ followed by 21.11 in SH₆ x NB₁₈, 21.00 in NB₁₈ x NB₇, 19.79 in NB₁₈ x P₅ and 20.14 in KPG-B x NB₁₈ as shown in table-2 and graph-7.

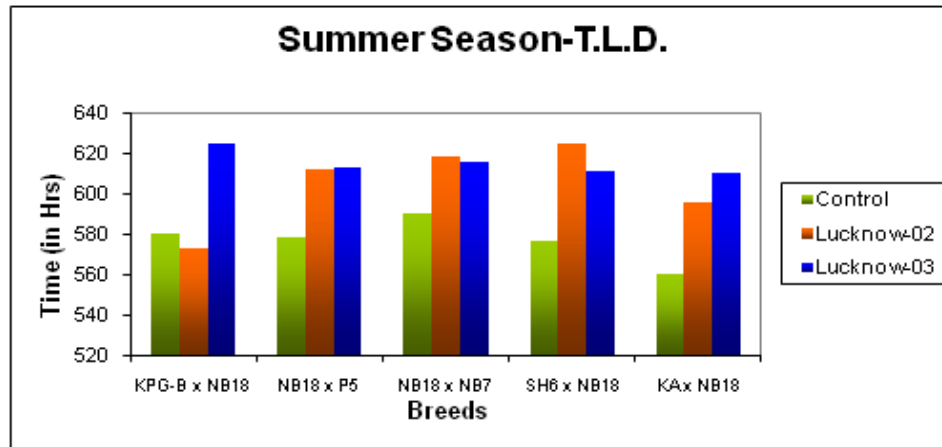
Graph-7 Performance of breeds on the basis of shell ratio percentage



Total Larval Duration

The observed total larval duration (hrs) under controlled conditions was 560.50 in KA x NB₁₈ followed by 576.66 in SH₆ x NB₁₈, 590.08 in NB₁₈ x NB₇, 578.12 in NB₁₈ x P₅ and 580.00 in KPG-B x NB₁₈. In first year under field condition total larval duration recorded was 596.00 in KA x NB₁₈ followed by 625.12 in SH₆ x NB₁₈, 618.50 in NB₁₈ x NB₇, 612.42 in NB₁₈ x P₅ and 573.33 in KPG-B x NB₁₈. In second year under field condition total larval duration recorded was 610.00 in KA x NB₁₈ followed by 611.00 in SH₆ x NB₁₈, 616.33 in NB₁₈ x NB₇, 612.18 in NB₁₈ x P₅ and 625.33 in KPG-B x NB₁₈ as shown in table-2 and graph-8.

Graph-8 Performance of breeds on the basis of total larval duration



Filament Length

The filament length (meter) recorded under controlled conditions was 930.90 in KA x NB₁₈ followed by 900.00 in SH₆ x NB₁₈, 870.45 in NB₁₈ x NB₇, 890.40 in NB₁₈ x P₅ and 910.50 KPG-B x NB₁₈. In first year under field condition filament length recorded was 852.78 in KA x NB₁₈ followed by 740.56 in SH₆ x NB₁₈, 850.50 in NB₁₈ x NB₇, 790.32 in NB₁₈ x P₅ and 750.00 in KPG-B x NB₁₈. In second year under field condition filament length recorded was 890.70 in KA x NB₁₈ followed by 852.80 in SH₆ x NB₁₈, 810.50 in NB₁₈ x NB₇, 798.00 in NB₁₈ x P₅ and 820.00 in KPG-B x NB₁₈ as shown in table-2.

Reelability Percentage

Under controlled conditions the reelability % recorded was 90.00 in KA x NB₁₈ followed by 88.25 in SH₆ x NB₁₈, 87.45 in NB₁₈ x NB₇, 86.78 in NB₁₈ x P₅ and 84.28 in KPG-B x NB₁₈. In first year under field condition reelability % recorded was 82.45 in KA x NB₁₈ followed by 74.00S in SH₆ x NB₁₈, 78.58 in NB₁₈ x NB₇, 75.40 in NB₁₈ x P₅ and 74.25 in KPG-B x NB₁₈. In second year under field condition reelability % recorded were 87.53 in KA x NB₁₈ followed by 82.20 in SH₆ x NB₁₈, 81.50 in NB₁₈ x NB₇, 78.56 in NB₁₈ x P₅ and 84.28 in KPG-B x NB₁₈.

All these observations show that in monsoon, autumn, spring and summer season SH₆ x KA, KA x NB₄D₂, P₅ x NB₁₈ and KA x NB₁₈ shows its superiority among other breeds in Uttar Pradesh climatic conditions.

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Discussion

China being a tropical country has succeeded in evolving silkworm breeds suitable for spring, summer and autumn rearings [91-98]. In Japan also, silkworm breeds suitable for spring, summer and autumn season evolved and are commercially exploited [99-105].

Due to varied climatic conditions in India, different breeds evolved are reared in different seasons. In West Bengal, Nistari is being reared during summer and rainy season, while, Nistari x Bivoltine and KPG5 x P5 are reared in hilly and selected plain areas during autumn and spring.

In Karnataka, PM x Bivoltine (NB4D2, NB18) is reared in all the season in irrigated areas. However, bivoltine KA x NB4D2 is being reared during September to February. In rainfed areas, PM x Bivoltine is reared in all the seasons. In Uttaranchal, SH6 x NB4D2 and C108.C110 x J112.J122 are reared in plains, Nistari/Diazo are utilized for summer season and bivoltine hybrids during spring season [106-107]. Besides these, silkworm breeds suitable for tropical climate in India have also been evolved [108-110].

In present study some of the characters like yield; by number and by weight, survival rate, cocoon weight, shell weight, shell ratio, total larval duration, filament length and reelability % of four more bivoltine hybrids i.e. SH₆ x KA, KA x NB_{4D2}, P₅ x NB₁₈ & KA x NB₁₈ have screened out best for monsoon, autumn, spring and summer season respectively for U.P climatic condition based on their performance in laboratory and field conditions.

0.43 kg cocoon yield, 75% survival rate, 22.49% shell ratio, 940.50 meter filament length and 611.00 hours was recorded for P₅ x NB₁₈ during spring season. 0.48 kg cocoon yield, 80.00% survival rate, 21.21% shell ratio, 890.70 meter filament length and 610 hours of larval duration was recorded for KA x NB₁₈ during summer season. From the obtained result it was found in our study that the performance of cocoon traits varied depending on the season and breed. Our results were similar to the finding of [111-113]. These bivoltine P₅ x NB₁₈ & KA x NB₁₈ hybrid shows superiority in cocoon and post cocoon parameters over selected breeds in spring and summer seasons of Uttar Pradesh as shown in table (1-2) and graphs (1-8).

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