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PERFORMANCE OF BIVOLTINE HYBRID SILKWORM (*BOMBYX MORI* LINN) BREEDS OF WEST BENGAL IN DIFFERENT SEASONS OF UTTAR PRADESH ON THE BASIS OF FEED EFFICIENCY PARAMETERS

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ABSTRACT: The present study has been conducted at Babasaheb Bhimrao Ambedkar University, Lucknow. Twenty bivoltine silkworm hybrid breeds *i.e.* SF_{19} x KA, NB_{18} x KA, NB_7 x KPG-B, SH_6 x KA, NB_4D_2 x KA for monsoon KA x NB_4D_2, NB_7 x NB_{18}, NB_4D_2 x SH_6, KA x KB, NB18 x NB_4D_2 for autumn P_5 x KB, P_5 x KPG-B, NB_4D_2 x NB_{18}, P_5 x NB_{18}, KPG-B x NB_7 for spring KPG-B x NB_{18}, NB_{18} x P_5, NB_{18} x NB_7, SH_6 x NB_{18} and KA x NB_{18} for summer season were reared. These breeds 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 maintained for control and field conditions separately to draw comparisons between feed utilization by different hybrids. The feed utilization study was confined to fifth larval instar as 80-85% of total leaf consumption was in this instar and same quantum of fresh mulberry leaves under each treatments was offered to silkworm four times a day taking almost care to maintain the leaf moisture content to maximum possible. The healthy larvae were counted daily in each replicate and unequal and unhealthy / dead larvae were removed. The litter was collected carefully on subsequent days of feeding at 10 am. The excreta and left over leaf in the litter were manually separated and oven dried to a constant weight. Data analyzed for nutritional indices like V Instar Ingesta / 10000 Larvae, Leaf Cocoon Conversion Rate, Leaf Silk Conversion Rate, V Instar Ingesta / 10000 Larvae and Cocoon Yield 10000 Larvae. Our result showed that the breeds SH_6 x KA, KA x NB_4D_2, P_5 x NB_{18}, KA x NB_{18} showed better perform in conversion of ingested food into cocoon and silk among other selected breeds in monsoon, autumn, spring and summer season respectively for Uttar Pradesh climatic conditions.

Key words: Silkworm, Bivoltine, Climatic condition, feed efficiency, silk conversion etc.

INRODUCTION

Under tropical conditions, the breeds of silkworm *Bombyx mori* L. differ in their nutritional requirements, body growth and cocoon parameters, the feed consumption has a direct impact on larval weight, cocoon weight, amount of silk produced and number of eggs laid [1-8]. Food consumption and utilization in the silkworm, *Bombyx mori* L. has been studied by Hiratsuka is still valid, though there has been a change in some of the values with the introduction of commercial breeds later [9-28]. Differences in food consumption and utilization efficiencies have been noticed among silkworm races quite early [29-30]. It has also been established by few researchers that the nutritional efficiencies vary among silkworm breeds. There could be variation with in species depending on the eco-climatic conditions. An individual which utilizes the food to maximum extent for a self gain should be considered more efficient than others [29].

The efficiency of converting the ingested and digested food into body, cocoon and cocoon shell varies the silkworm breeds under the influence of mulberry varieties and seasons [31-35]. Nutritional quality of mulberry leaf has greater importance on regulation over the quantum of ingesta, digesta and digestibility of food among silkworms [36]. The quantum of ingesta and digesta has direct relation with growth and silk production in silkworms [37].

Quantity of leaf consumed influences the digestibility and conversion efficiencies of food ingested and digested, directly or indirectly in temperate silkworm *Bombyx mori* L. [38-41]. The breed efficiency as a tool to convert mulberry silk under varying ecological conditions, the leaf - silk conversion rate of the silkworm is a comprehensive physiological character and is an important economic index in cocoon production [42- 47]. The present study was undertaken in order to analyse in detail the food ingestion and digestion in bivoltine hybrids breeds for identification of best breed for better prospect and expansion of Sericulture industry in Uttar Pradesh.

MATERIALS AND METHODS

The present study has been conducted at Babasaheb Bhimrao Ambedkar University, Lucknow. Twenty bivoltine silkworm hybrid breeds *i.e.* SF_{19} x KA, NB_{18} x KA, NB_7 x KPG-B, SH_6 x KA, NB_4D_2 x KA for monsoon KA x NB_4D_2, NB_7 x NB_{18}, NB_4D_2 x SH_6, KA x KB, NB18 x NB_4D_2 for autumn P_5 x KB, P_5 x KPG-B, NB_4D_2 x NB_{18}, P_5 x NB_{18}, KPG-B x NB_7 for spring KPG-B x NB_{18}, NB_{18} x P_5, NB_{18} x NB_7, SH_6 x NB_{18} and KA x NB_{18} for summer season were reared, on fresh mulberry leaves as per [48-50]. In each season, three replicas of 400 larvae of selected breeds were maintained for control and field conditions separately to draw comparisons between feed utilization by different hybrids. The feed utilization study was confined to fifth larval instar as 80-85% of total leaf consumption was in this instar and same quantum of fresh mulberry leaves under each treatments was offered to silkworm four times a day taking almost care to maintain the leaf moisture content to maximum possible content as [51-68]. The healthy larvae were counted daily in each replicate and unequal and unhealthy / dead larvae were removed. The litter was collected carefully on subsequent days of feeding at 10 am. The excreta and left over leaf in the litter were manually separated and oven dried to a constant weight. Data analyzed for nutritional indices like V Instar Ingesta / 10000 Larvae, Leaf Cocoon Conversion Rate, Leaf Silk Conversion Rate, V Instar Ingesta / 10000 Larvae and Cocoon Yield 10000 Larvae.

Result

Variability in feed efficiency in bivoltine silkworm hybrids across monsoon season under controlled and field conditions are presented in Table-1. Feed efficiency measurement regarding mean values of V instar ingesta / 10,000 larvae (Kg), Percentage of leaf cocoon conversion rate, Percentage of leaf silk conversion rate, I-V instar ingesta/ 10,000 larvae and Yield/10,000 larvae were done as shown in the table-1 and table-2.

MONSOON SEASON

On the basis of results obtained, the value of five economic characters such as V instar ingesta / 10,000 larvae (Kg), Percentage of leaf cocoon conversion rate, Percentage of leaf silk conversion rate, I-V instar ingesta/ 10,000 larvae (Kg) and Yield/10,000 larvae pertaining to each breed shown in Table-1

V instar ingesta / 10,000 larvae (Kg)

In monsoon season under controlled conditions, highest V instar ingesta / 10,000 larvae (Kg) recorded was 146.78 in NB_{18} x KA followed by 142.56 in NB_7 x KPG-B, 141.25 in SF_{19} x KA, 140.66 in NB_4D_2 x KA, 137.59 in SH_6 x KA. In first year under field conditions highest V instar ingesta / 10,000 larvae (Kg) recorded was 146.89 in NB_7 x KPG-B followed by 145.56 in NB_{18} x KA, SF_{19} x KA 142.23 in NB_4D_2 x KA and 139.99 in SH_6 x KA. During second year under field conditions highest V instar ingesta / 10,000 larvae recorded was 147.23 in NB_{18} x KA followed by 144.58 in NB_7 x KPG-B, 144.25 in SF_{19} x KA, 142.50 in NB_4D_2 x KA and 139.00 in SH_6 x KA as shown in table-1

Table 1. Feed Efficiency Parameters of Silkworm breeds during Monsoon and Autumn Seasons

Monsoon Season						
	Breed	V Instar Ingesta / 10000 L (kg)	L.C.C.R %	L.S.C.R.%	I-V Instar Ingesta / 10000 L(kg)	Yield/10000 L (kg)
Control	SF_{19} x KA	141.25	9.45	2.41	170.50	13.00
	NB_{18} x KA	146.78	9.86	2.47	165.12	12.50
	NB_7 x KPG-B	142.56	9.56	2.40	162.00	13.25
	SH_6 x KA	137.59	10.64	2.48	169.24	14.50
	NB_4D_2 x KA	140.66	9.82	2.46	170.56	14.00
Lucknow 2002	SF_{19} x KA	145.12	7.08	2.35	176.24	9.50
	NB_{18} x KA	145.56	7.20	2.36	177.79	9.75
	NB_7 x KPG-B	146.89	7.00	2.34	179.53	9.50
	SH_6 x KA	139.99	7.28	2.41	173.01	10.20
	NB_4D_2 x KA	142.23	7.21	2.39	175.40	9.75
Lucknow 2003	SF_{19} x KA	144.25	7.10	2.31	174.23	10.25
	NB_{18} x KA	147.23	7.23	2.33	178.89	10.00
	NB_7 x KPG-B	144.58	7.12	2.30	180.52	10.50
	SH_6 x KA	139.00	7.60	2.40	171.00	10.50
	NB_4D_2 x KA	142.50	7.50	2.36	176.51	10.25
Autumn Season						
	Breed	V Instar Ingesta / 10000 L (kg)	L.C.C.R %	L.S.C.R.%	I-V Instar Ingesta / 10000 L(kg)	Yield / 10000 L (kg)
Control	KA x NB_4D_2	135.50	10.71	2.61	169.5	14.52
	NB_7 x NB_{18}	138.12	9.66	2.50	174.56	11.50
	NB_4D_2 x SH_6	137.45	9.89	2.56	173.81	12.75
	KA x KB	142.58	9.11	2.54	175.50	12.50
	NB_{18} x NB_4D_2	139.60	9.90	2.58	172.32	13.25
Lucknow 2002	KA x NB_4D_2	141.01	8.68	2.14	175.11	11.40
	NB_7 x NB_{18}	146.92	7.90	2.10	178.91	10.80
	NB_4D_2 x SH_6	144.78	8.50	2.11	177.82	11.20
	KA x KB	148.85	7.51	2.09	180.90	10.60
	NB_{18} x NB_4D_2	142.66	8.00	2.12	178.00	11.10
Lucknow	KA x NB_4D_2	140.00	8.71	2.42	174.50	12.20
	NB_7 x NB_{18}	142.56	7.98	2.40	177.12	10.50
	NB_4D_2 x SH_6	141.86	8.57	2.41	176.24	10.75
	KA x KB	146.45	7.58	2.39	178.23	10.25
	NB_{18} x NB_4D_2	143.54	8.62	2.40	175.25	11.20

L.C.C.R. Percentage

In monsoon season under controlled conditions, highest Percentage of leaf cocoon conversion rate recorded was 10.64 in SH_6 x KA followed by 9.86 in NB_{18} x KA, 9.82 in NB_4D_2 x KA, 9.56 in NB_7 x KPG-B, 9.45 in SF_{19} x KA. In first year under field conditions highest percentage of leaf cocoon conversion rate recorded was 7.28 in SH_6 x KA followed by 7.20 in NB_{18} x KA, 7.21 in NB_4D_2 x KA, 7.08 in SF_{19} x KA and 7.00 in NB_7 x KPG-B. In second year under field conditions highest Percentage of leaf cocoon conversion rate recorded was 7.60 in SH_6 x KA followed by 7.50 in NB_4D_2 x KA, 7.23 in NB_{18} x KA, 7.12 in NB_7 x KPG-B, and 7.01 in SF_{19} x KA as shown in table-1 and graph-1.

Table 2. Feed Efficiency Parameters of Silkworm breeds during Spring and Summer Seasons

	Breed	V Instar Ingesta / 10000 L (kg)	L.C.C.R %	L.S.C.R.%	I-V Instar Ingesta / 10000 L(kg)	Yield / 10000 L (kg)
Spring Season						
Control	P_5 x KB	110.21	10.85	2.89	150.00	11.80
	P_5 x KPG-B	111.45	10.45	2.91	148.12	11.56
	NB_4D_2 x NB_{18}	106.50	11.56	3.10	146.80	12.30
	P_5 x NB_{18}	105.64	12.34	3.40	145.62	12.92
	KPG-B x NB_7	108.11	10.94	2.86	148.23	12.58
Lucknow 2002	P_5 x KB	120.13	7.88	2.41	172.52	9.58
	P_5 x KPG-B	121.82	7.59	2.46	173.56	9.90
	NB_4D_2 x NB_{18}	116.45	8.56	2.50	170.50	10.18
	P_5 x NB_{18}	115.24	8.99	2.65	169.01	10.36
	KPG-B x NB_7	118.54	8.11	2.52	173.25	9.88
Lucknow	P_5 x KB	169.89	7.98	1.98	188.23	10.10
	P_5 x KPG-B	172.56	7.56	1.99	190.00	10.30
	NB_4D_2 x NB_{18}	171.53	8.09	2.00	187.00	10.55
	P_5 x NB_{18}	170.12	8.38	2.07	186.85	10.85
	KPG-B x NB_7	168.54	7.92	1.88	188.00	10.59
Summer Season						
	Breed	V Instar Ingesta / 10000 L (kg)	L.C.C.R %	L.S.C.R.%	I-V Instar Ingesta / 10000 L(kg)	Yield / 10000 L (kg)
Control	KPG-B x NB_{18}	119.41	11.00	2.50	146.50	13.21
	NB_{18} x P_5	118.35	10.80	2.45	145.00	12.65
	NB_{18} x NB_7	115.98	11.56	2.60	147.16	13.35
	SH_6 x NB_{18}	116.12	11.98	2.70	144.90	13.85
	KA x NB_{18}	115.60	12.15	2.94	144.27	14.05
Lucknow 2002	KPG-B x NB_{18}	128.53	7.89	2.10	155.88	10.00
	NB_{18} x P_5	129.60	7.82	2.12	152.66	10.70
	NB_{18} x NB_7	124.50	8.00	2.21	153.12	10.80
	SH_6 x NB_{18}	122.54	8.06	2.24	150.45	10.65
	KA x NB_{18}	120.34	8.14	2.26	149.46	11.30
Lucknow	KPG-B x NB_{18}	172.50	8.41	2.40	258.80	10.60
	NB_{18} x P_5	174.34	8.85	2.42	270.00	10.25
	NB_{18} x NB_7	168.12	8.92	2.55	255.55	10.38
	SH_6 x NB_{18}	167.92	8.94	2.66	250.80	10.85
	KA x NB_{18}	166.65	9.00	2.77	249.15	12.20

L.S.C.R. Percentage

In monsoon season under controlled conditions the highest Percentage of leaf silk conversion rate recorded was 2.48 in SH_6 x KA followed by 2.47 in NB_{18} x KA, 2.46 in NB_4D_2 x KA, 2.41 in SF_{19} x KA, 2.40 in NB_7 x KPG-B. In first year under field conditions highest percentage of leaf silk conversion rate recorded was 2.41 in SH_6 x KA followed by 2.39 in NB_4D_2 x KA, 2.36 in NB_{18} x KA, 2.35 in SF_{19} x KA, and 2.34 in NB_7 x KPG-B. During second year under field conditions percentage of leaf silk conversion rate recorded was 2.40 in SH_6 x KA followed by 2.36 in NB_4D_2 x KA, 2.33 in NB_{18} x KA, 2.31 in SF_{19} x KA and 2.30 in NB_7 x KPG-B as shown in table-1 and graph-2.

Table-1: - Graph-1 Performance of breeds on the basis of Leaf cocoon conversion ratio

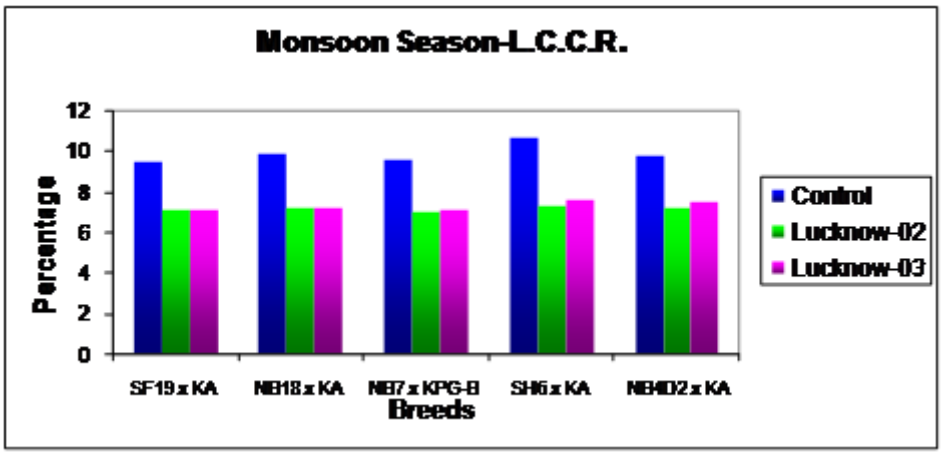
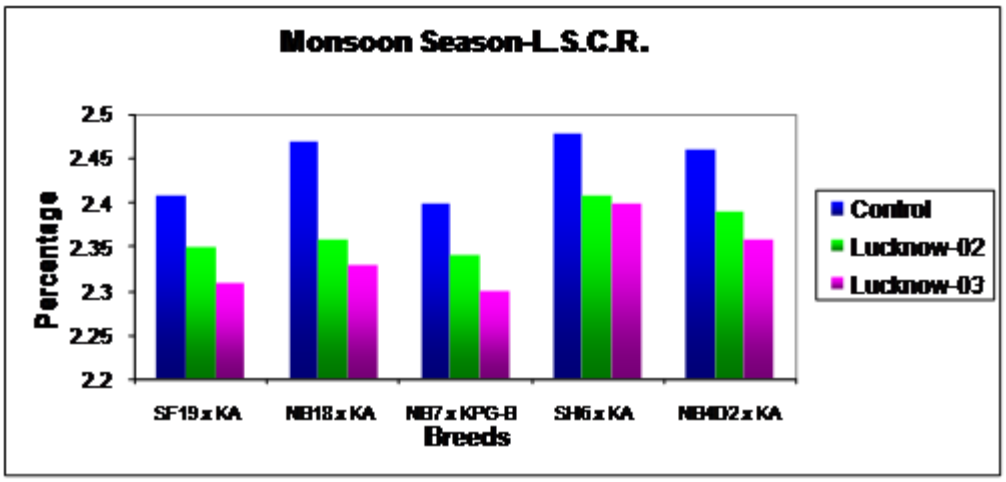


Table-1: - Graph-2 Performance of breeds on the basis of Leaf silk conversion ratio



I-V instar ingesta/ 10,000 larvae (Kg)

In monsoon season under controlled conditions the highest I-V instar ingesta/ 10,000 larvae (Kg) recorded was 170.56 in NB_4D_2 x KA followed by 170.50 in SF19 x KA, 169.24 in SH_6 x KA, 165.12 in NB_{18} x KA and 162.00 in NB_7 x KPG-B. In first year under field conditions highest I-V instar ingesta/ 10,000 larvae recorded was 179.53 in NB_7 x KPG-B followed by 176.24 in SF_{19} x KA, NB_{18} x KA & 175.40 in NB_4D_2 x KA and 173.01 in SH_6 x KA. In second year under field conditions highest I-V instar ingesta/ 10,000 larvae recorded was 180.52 in NB_7 x KPG-B followed by 178.89 in NB_{18} x KA, 176.51 in NB_4D_2 x KA, 174.23 in SF_{19} x KA and 171.00 in SH_6 x KA as shown in table-1.

Yield/10,000 larvae (Kg)

In monsoon season under controlled conditions the highest Yield/10,000 larvae (Kg) recorded was 14.50 in SH_6 x KA followed by 14.00 in NB_4D_2 x KA, 13.25 in NB_7 x KPG-B, 13.00 in SF_{19} x KA and 12.50 in NB_{18} x KA. In first year under field conditions highest Yield/10,000 larvae recorded was 10.20 in SH_6 x KA followed by 9.75 in NB_{18} x KA & NB_4D_2 x KA, 9.50 in NB_7 x KPG-B & SF_{19} x KA. During second year under field conditions highest Yield/10,000 larvae recorded was 10.50 in SH_6 x KA & NB_7 x KPG-B followed by 10.25 in NB_4D_2 x KA and SF_{19} x KA and 10.00 in NB_{18} x KA as shown in table-1.

AUTUMN SEASON

V instar ingesta / 10,000 larvae (Kg)

In autumn season under controlled conditions the highest V instar ingesta / 10,000 larvae (Kg) recorded was 142.58 in KA x KB followed by 139.60 in NB_{18} x NB_4D_2, 138.12 in NB_7 x NB_{18}, 137.45 in NB_4D_2 x SH_6 and 135.50 in KA x NB_4D_2. In first year under field conditions highest V instar ingesta / 10,000 larvae recorded was 148.85 in KA x KB followed by 146.92 in NB_7 x NB_{18}, 144.78 in NB_4D_2 x SH_6, 142.66 in NB_{18} x NB_4D_2 and 141.01 in KA x NB_4D_2. During second year under field conditions highest V instar ingesta / 10,000 larvae recorded was 146.45 in KA x KB followed by 143.54 in NB_{18} x NB_4D_2, 142.56 in NB_7 x NB_{18}, 141.86 in NB_4D_2 x SH_6 and 140.00 in KA x NB_4D_2 as shown in table-1.

L.C.C.R. Percentage

In autumn season under controlled conditions the highest Percentage of leaf cocoon conversion rate recorded was 10.71 in KA x NB_4D_2 followed by 9.90 in NB_{18} x NB_4D_2, 9.89 in NB_4D_2 x SH_6, 9.66 in NB_7 x NB_{18} and 9.11 in KA x KB. In first year under field conditions highest Percentage of leaf cocoon conversion rate recorded was 8.68 in KA x NB_4D_2 followed by 8.50 in NB_4D_2 x SH_6, 8.00 in NB_{18} x NB_4D_2, 7.90 in NB_7 x NB_{18} and 7.51 in KA x KB. During second year field conditions highest Percentage of leaf cocoon conversion rate recorded was 8.71 in KA x NB_4D_2 followed by 8.62 in NB_{18} x NB_4D_2, 7.98 in NB_7 x NB_{18}, 8.57 in NB_4D_2 x SH_6 and 7.58 in KA x KB as shown in table-1 and graph-3.

Table-1: - Graph-3 Performance of breeds on the basis of Leaf cocoon conversion ratio

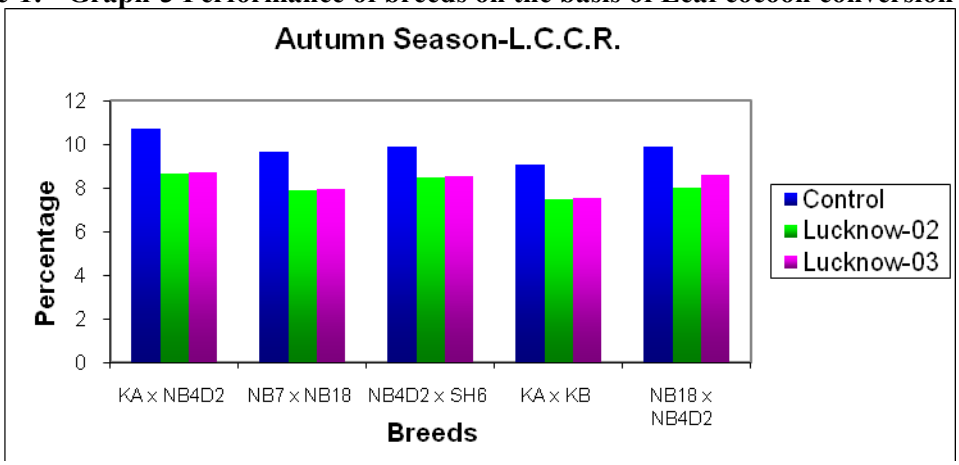
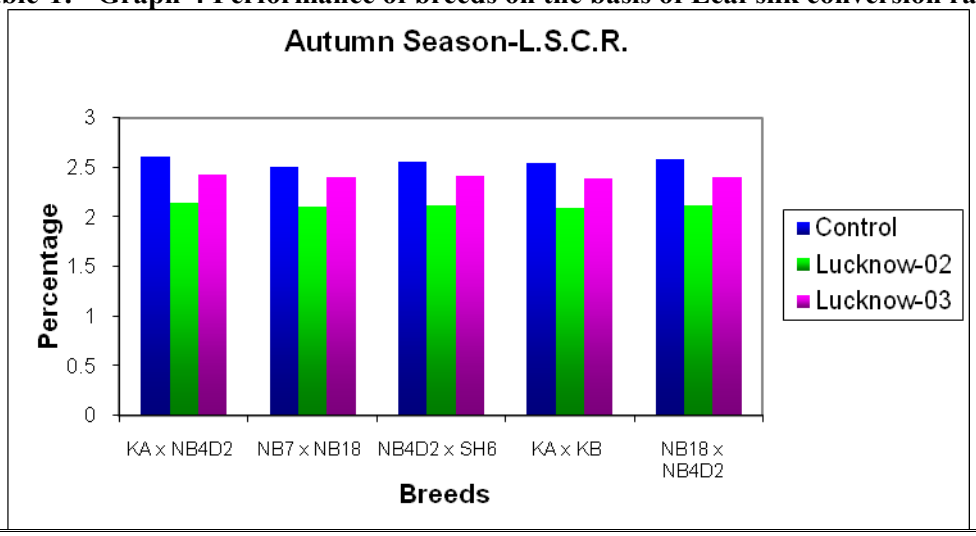


Table-1: - Graph-4 Performance of breeds on the basis of Leaf silk conversion ratio



L.S.C.R. Percentage

In autumn season under controlled conditions, highest Percentage of leaf silk conversion rate recorded was 2.61 in KA x NB_4D_2 followed by 2.58 in NB_{18} x NB_4D_2, 2.56 in NB_4D_2 x SH_6, 2.54 in KA x KB, 2.50 in NB_7 x NB_{18}. In first year under field conditions highest Percentage of leaf silk conversion rate recorded was 2.14 in KA x NB_4D_2 followed by 2.12 in NB_{18} x NB_4D_2, 2.11 in NB_4D_2 x SH_6, 2.10 in NB_7 x NB_{18} and 2.09 in KA x KB. During second year under field conditions Percentage of leaf silk conversion rate recorded was 2.42 in KA x NB_4D_2 followed by 2.41 in NB_4D_2 x SH_6, 2.40 in NB_7 x NB_{18} & NB_{18} x NB_4D_2 and 2.39 in KA x KB as shown in table-1 and graph-4.

I-V instar ingesta/ 10,000 larvae (Kg)

In autumn season under controlled conditions, highest I-V instar ingesta/ 10,000 larvae (Kg) recorded was 175.50 in KA x KB followed by 174.56 in NB_7 x NB_{18}, 173.81 in NB_4D_2 x SH_6, 172.32 in NB_{18} x NB_4D_2 and 169.5 in KA x NB_4D_2. In first year under field conditions, highest I-V instar ingesta/ 10,000 larvae recorded was 180.90 in KA x KB followed by 178.91 in NB_7 x NB_{18}, 178.00 in NB_{18} x NB_4D_2, 177.82 in NB_4D_2 x SH_6 and 175.11 in KA x NB_4D_2.In second year under field conditions highest I-V instar ingesta/ 10,000 larvae (Kg) recorded was 178.23 in KA x KB followed by 177.12 in NB_7 x NB_{18}, 176.24 in NB_4D_2 x SH_6, 175.23 in NB_{18} x NB_4D_2 and 174.50 in KA x NB_4D_2 as shown in table-1.

Yield/10,000 larvae (Kg)

In autumn season, controlled conditions, highest Yield/10,000 larvae (Kg) recorded was 14.42 in KA x NB_4D_2 followed by 13.25 in NB_{18} x NB_4D_2, 12.75 in NB_4D_2 x SH_6, 12.50 in KA x KB and 11.50 in NB_7 x NB_{18}. In first year under field conditions highest Yield/10,000 larvae recorded was 11.40 in KA x NB_4D_2 followed by 11.20 in NB_4D_2 x SH_6, 11.10 in NB_{18} x NB_4D_2, 10.80 in NB_7 x NB_{18} and 10.60 in KA x KB. During second year under field conditions highest Yield/10,000 larvae recorded was 12.20 in KA x NB_4D_2 followed by 11.20 in NB_{18} x NB_4D_2, 10.75 in NB_4D_2 x SH_6, 10.50 in NB_7 x NB_{18} and 10.25 in KA x KB as shown in table-1.

SPRING SEASON

V instar ingesta / 10,000 larvae (Kg)

In spring season under controlled conditions the highest V instar ingesta / 10,000 larvae (Kg) recorded was 111.45 in P_5 x KPG-B followed by 110.21 in P_5 x KB, 108.11 in KPG-B x NB_7, 106.50 in NB_4D_2 x NB_{18} and 105.64 in P_5 x NB_{18}. In first year under field conditions highest V instar ingesta / 10,000 larvae recorded was 121.82 in P_5 x KPG-B followed by 120.13 in P_5 x KB, 118.54 in KPG-B x NB_7, 116.45 in NB_4D_2 x NB_{18} and 115.24 in P_5 x NB_{18}. During second year under field conditions highest V instar ingesta / 10,000 larvae recorded was 172.56 in P_5 x KPG-B followed by 171.53 in NB_4D_2 x NB_{18}, 170.12 in P_5 x NB_{18}, 169.89 in P_5 x KB and 168.54 in KPG-B x NB_7.

L.C.C.R. Percentage

In spring season under controlled conditions the highest Percentage of leaf cocoon conversion rate recorded was 12.34 in P_5 x NB_{18} followed by 11.56 in NB_4D_2 x NB_{18}, 10.94 in KPG-B x NB_7, 10.85 in P_5 x KB and 10.45 in P_5 x KPG-B. In first year under field conditions highest Percentage of leaf cocoon conversion rate recorded was 8.99 in P_5 x NB_{18}, 7.88 in P_5 x KB followed by 8.56 in NB_4D_2 x NB_{18}, 8.11 in KPG-B x NB_7 and 7.59 in P_5 x KPG-B. During second year under field conditions highest Percentage of leaf cocoon conversion rate recorded was 8.33 in P_5 x NB_{18} followed by 8.09 in NB_4D_2 x NB_{18}, 7.98 in P_5 x KB, 7.56 in P_5 x KPG-B and 7.92 in KPG-B x NB_7 as shown in table-2 and graph-1.

Table-2: - Graph-1 Performance of breeds on the basis of Leaf cocoon conversion ratio

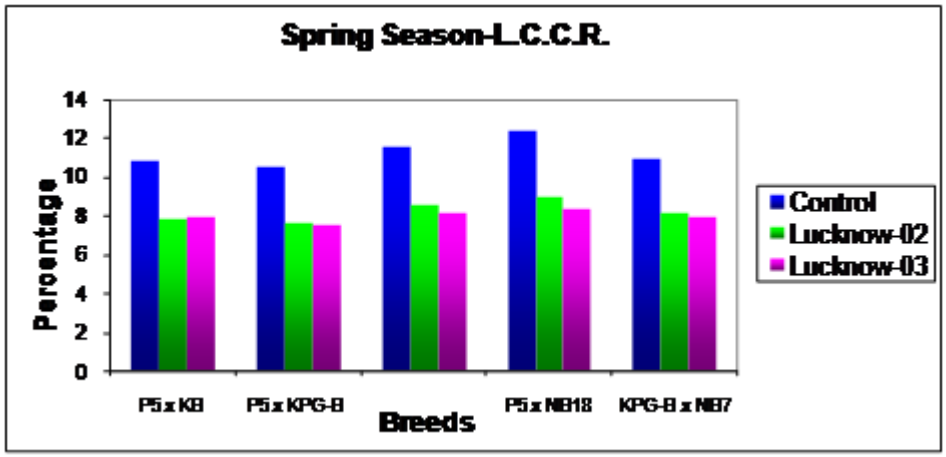
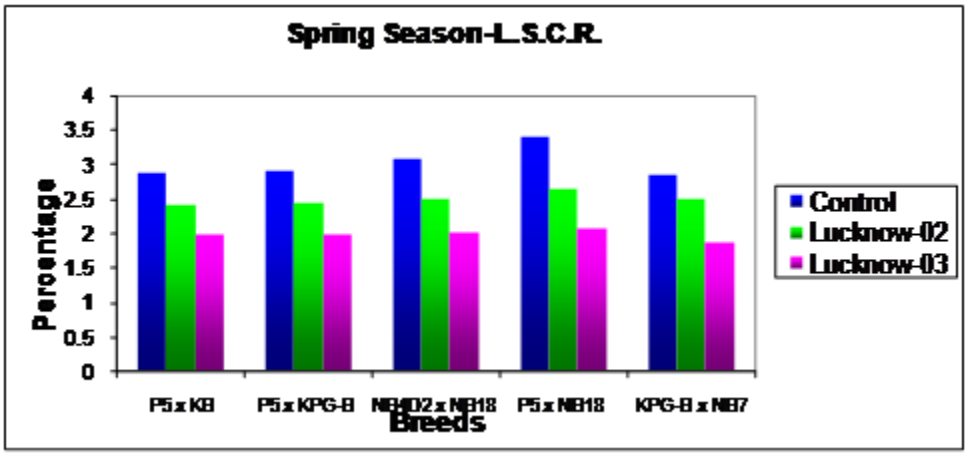


Table-2: - Graph-2 Performance of breeds on the basis of Leaf silk conversion ratio



L.S.C.R. Percentage

In spring season under controlled conditions the highest Percentage of leaf silk conversion rate recorded was 3.40 in P_5 x NB_{18} followed by 3.10 in NB_4D_2 x NB_{18}, 2.91 in P_5 x KPG-B, 2.89 in P_5 x KB and 2.86 in KPG-B x NB_7. In first year under field conditions highest Percentage of leaf silk conversion rate recorded was 2.65 in P_5 x NB_{18} followed by 2.52 in KPG-B x NB_7, 2.50 in NB_4D_2 x NB_{18}, 2.46 in P_5 x KPG-B, and 2.41 in P_5 x KB. During second year under field conditions Percentage of leaf silk conversion rate recorded was 2.07 in P_5 x NB_{18} followed by 2.00 in NB_4D_2 x NB_{18}, 1.99 in P_5 x KPG-B, 1.98 in P_5 x KB and 1.88 in KPG-B x NB_7 as shown in table-2 and graph-2.

I-V instar ingesta/ 10,000 larvae (Kg)

In spring season under controlled conditions the highest I-V instar ingesta/ 10,000 larvae (Kg) recorded was 150.00 in P_5 x KB followed by 148.23 in KPG-B x NB_7, 148.12 in P5 x KPG-B, 146.80 in NB_4D_2 x NB_{18}, and 145.62 in P_5 x NB_{18}. In first year under field conditions highest I-V instar ingesta/ 10,000 larvae recorded was 173.56 in P_5 x KPG-B followed by 173.25 in KPG-B x NB_7, 172.52 in P_5 x KB, 170.50 in NB_4D_2 x NB_{18} and 169.01 in P_5 x NB_{18}. During second year under field conditions highest I-V instar ingesta/ 10,000 larvae (Kg) recorded was 190.00 in P_5 x KPG-B followed by 188.23 in P_5 x KB, 188.00 in KPG-B x NB_7, 187.00 in NB_4D_2 x NB_{18} and 186.85 in P_5 x NB_{18}.

Yield/10,000 larvae (Kg)

In spring season under controlled conditions the highest Yield/10,000 larvae recorded was 12.92 in P_5 x NB_{18} followed by 12.58 in KPG-B x NB_7, 12.30 in NB_4D_2 x NB_{18}, 11.80 in P_5 x KB and 11.56 in P_5 x KPG-B. In first year under field conditions highest Yield/10,000 larvae (Kg) recorded was 10.36 in P_5 x NB_{18} followed by 10.18 in NB_4D_2 x NB_{18}, 9.90 in P_5 x KPG-B, 9.88 in KPG-B x NB_7 and 9.58 in P_5 x KB. In second year under field conditions highest Yield/10,000 larvae recorded was 10.85 in P_5 x NB_{18} followed by 10.59 in KPG-B x NB_7, 10.55 in NB_4D_2 x NB_{18}, 10.30 in P_5 x KPG-B, and 10.10 in P_5 x KB.

SUMMER SEASON

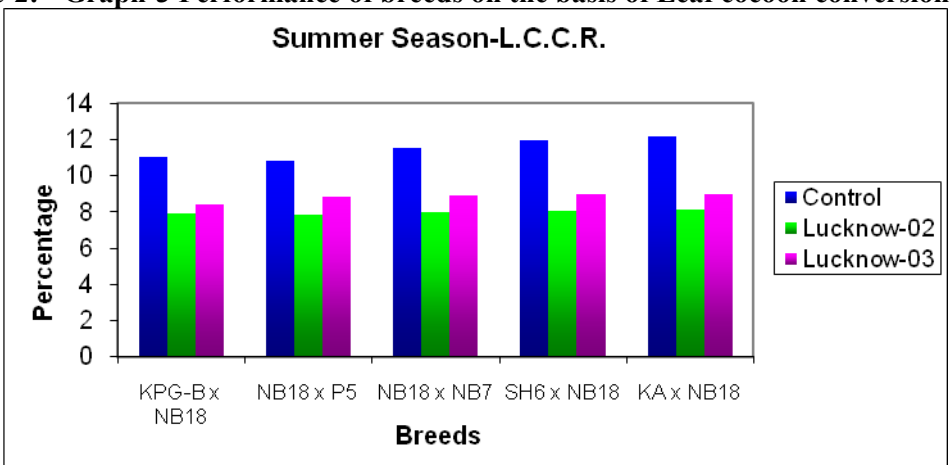
V instar ingesta / 10,000 larvae (Kg)

In summer season under controlled conditions the highest V instar ingesta / 10,000 larvae recorded was 119.41 in KPG-B x NB_{18} followed by 118.35 in NB_{18} x P_5, 116.12 in SH_6 x NB_{18}, 115.98 in NB_{18} x NB_7, and 115.60 in KA x NB_{18}. In first year under field conditions highest V instar ingesta / 10,000 larvae (Kg) recorded was 129.60 in NB_{18} x P_5 followed by 128.53 in KPG-B x NB_{18}, 124.50 in NB_{18} x NB_7, 122.54 in SH_6 x NB_{18} and 120.34 in KA x NB_{18}. During second year under field conditions highest V instar ingesta / 10,000 larvae (Kg) recorded was 174.34 in NB_{18} x P_5 followed by 172.50 in KPG-B x NB_{18}, 167.92 in SH_6 x NB_{18}, 168.12 in NB_{18} x NB_7, and 166.65 in KA x NB_{18}.

L.C.C.R. Percentage

In summer season under controlled conditions the highest Percentage of leaf cocoon conversion rate recorded was 12.15 in KA x NB_{18} followed by 11.98 in SH_6 x NB_{18}, 11.00 in KPG-B x NB_{18}, 11.56 in NB_{18} x NB_7 and 10.80 in NB_{18} x P_5. In first year under field conditions highest Percentage of leaf cocoon conversion rate recorded was 8.14 in KA x NB_{18} followed by 8.06 in SH_6 x NB_{18}, 8.00 in NB_{18} x NB_7, 7.82 in NB_{18} x P_5 and 7.89 in KPG-B x NB_{18}.In second year under field conditions highest Percentage of leaf cocoon conversion rate recorded was 9.00 in KA x NB_{18} followed by 8.94 in SH_6 x NB_{18}, 8.92 in NB_{18} x NB_7, 8.85 in NB_{18} x P_5, and 8.41 in KPG-B x NB_{18} as shown in table-2 and graph-3.

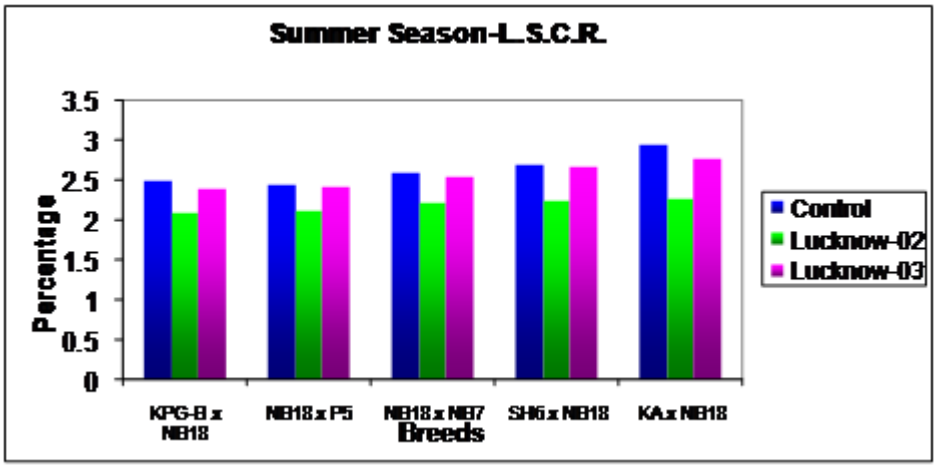
Table-2: - Graph-3 Performance of breeds on the basis of Leaf cocoon conversion ratio



L.S.C.R. Percentage

In summer season under controlled conditions the highest Percentage of leaf silk conversion rate recorded was 2.94 in KA x NB_{18} followed by 2.70 in SH_6 x NB_{18}, 2.60 in NB_{18} x NB_7, 2.50 in KPG-B x NB_{18} and 2.45 in NB_{18} x P_5. In first year under field conditions highest Percentage of leaf silk conversion rate recorded was 2.26 in KA x NB_{18} followed by 2.24 in SH_6 x NB_{18}, 2.21 in NB_{18} x NB_7, 2.12 in NB_{18} x P_5, and 2.10 in KPG-B x NB_{18}. During second year under field conditions Percentage of leaf silk conversion rate recorded was 2.77 in KA x NB_{18} followed by 2.66 in SH_6 x NB_{18}, 2.55 in NB_{18} x NB_7, 2.42 in NB_{18} x P_5 and 2.40 in KPG-B x NB_{18} as shown in table-2 and graph-4.

Table-2: - Graph-4 Performance of breeds on the basis of Leaf silk conversion ratio



I-V instar ingesta/ 10,000 larvae (Kg)

In summer season under controlled conditions the highest I-V instar ingesta/ 10,000 larvae (Kg) recorded was 147.16 in NB_{18} x NB_7 followed by 146.50 in KPG-B x NB_{18}, 145.00 in NB_{18} x P_5, 144.90 in SH_6 x NB_{18} and 144.27 in KA x NB_{18}. In first year under field conditions highest I-V instar ingesta/ 10,000 larvae recorded was 155.88 in KPG-B x NB_{18} followed by 153.12 in NB_{18} x NB_7, 152.66 in NB_{18} x P_5, 150.45 in SH_6 x NB_{18} and 149.46 in KA x NB_{18}. During second year under field conditions highest I-V instar ingesta/ 10,000 larvae recorded was 270.00 in NB_{18} x P_5 followed by 258.80 in KPG-B x NB_{18}, 255.55 in NB_{18} x NB_7, 250.80 in SH_6 x NB_{18} and 249.15 in KA x NB_{18}.

Yield/10,000 larvae (Kg)

In summer season under controlled conditions the highest Yield/10,000 larvae (Kg) recorded was 14.05 in KA x NB_{18}, followed by 13.85 in SH_6 x NB_{18}, 13.35 in NB_{18} x NB_7, 13.21 in KPG-B x NB_{18} and 12.65 in NB_{18} x P_5. In second year under field conditions highest Yield/10,000 larvae recorded was 12.20 in KA x NB_{18} followed by 10.85 in SH_6 x NB_{18}, 10.60 in KPG-B x NB_{18}, 10.38 in NB_{18} x NB_7 and 10.25 in NB_{18} x P_5. During first year under field conditions highest Yield/10,000 larvae recorded was 11.30 in KA x NB_{18}, followed by 10.80 in NB_{18} x NB_7, 10.70 in NB_{18} x P_5, 10.65 in SH_6 x NB_{18} and 10.00 in KPG-B x NB_{18}.

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DISCUSSION

The conversion efficiency of leaf to silk has been considered as an important economic index in China [52] in evolving new breeds. A larva, which utilizes the food to the maximum extent for self-gain is considered to be more efficient [26]. The positive correlation between the food ingested, digested, larval weight, larval duration and cocoon and shell weight obtained in recent study [64-65], also stresses the importance of evalution of bioenergetics parameters in identifying more productive silkworm races. The lower consumption and higher conversion of food into cocoon shell would be of more commercial value.

Feed efficiency parameters *Viz*. V instar ingesta / 10,000 larvae (Kg), Leaf cocoon conversion ratio (LCCR%) and leaf silk conversion ratio (LSCR%) were recorded under control and field conditions for different breeds as shown in Table (1 &2).

The present study points out that SH_6 x KA, KA x NB_4D_2, KA x NB_{18} & P_5 x NB_{18} were more efficient in converting the ingested food to cocoon and shell among other selected breeds. 139.00 kg V instar ingesta/ 10,000 larvae, converted 7.6 % in cocoon yield and 2.40 % silk in SH_6 x KA during the monsoon season. 140.00 kg V instar ingesta/ 10,000 larvae, converted 8.71 % in cocoon yield and 2.42 % silk in KA x NB_4D_2 during autumn season. 170.12 kg V instar ingesta/ 10,000 larvae, converted 8.38 % in cocoon yield and 2.07 % silk in P_5 x NB_{18} during spring season. 166.65 kg V instar ingesta/ 10,000 larvae, converted 9.00 % in cocoon yield and 2.77 % silk in KA x NB_{18} during the summer season. Our findings show that these inter-hybrid differences in food utilization capacity which varied from breed to breed indifferent seasons, this was also reported by many scientists [61-63, 69-80].

There are many contributing factors, which determine the digestibility and conversion efficiency of a breed. They varied in eco-physiological condition and morphological deviations are among major factors [26, 29, 66, 81]. Similarly in our study it was found that different breeds have shown varied digestibility and conversion efficiency due to different climatic variation across each season % of leaf cocoon conversion rate was recorded by 7.60 in SH_6 x KA followed by 7.50 in NB_4D_2 x KA, 7.23 in NB_{18} x KA, 7.12 in NB_7 x KPG-B, and 7.01 in SF_{19} x KA. Leaf silk conversion rate was recorded by 2.40 in SH_6 x KA followed by 2.36 in NB_4D_2 x KA, 2.33 in NB_{18} x KA, 2.31 in SF_{19} x KA and 2.30 in NB_7 x KPG-B leaf cocoon conversion rate was recorded by 8.71 in KA x NB_4D_2 followed by 8.62 in NB_{18} x NB_4D_2, 7.98 in NB_7 x NB_{18}, 8.57 in NB_4D_2 x SH_6 and 7.58 in KA x KB leaf silk conversion rate was recorded 2.42 in KA x NB_4D_2 followed by 2.41 in NB_4D_2 x SH_6, 2.40 in NB_7 x NB_{18} & NB_{18} x NB_4D_2 and 2.39 in KA x KB leaf cocoon conversion rate was recorded 8.33 in P_5 x NB_{18} followed by 8.09 in NB_4D_2 x NB_{18}, 7.98 in P_5 x KB, 7.56 in P_5 x KPG-B and 7.92 in KPG-B x NB_7 leaf silk conversion rate was recorded 2.07 in P_5 x NB_{18} followed by 2.00 in NB_4D_2 x NB_{18}, 1.99 in P_5 x KPG-B, 1.98 in P_5 x KB and 1.88 in KPG-B x NB_7 leaf cocoon conversion rate was recorded 9.00 in KA x NB_{18} followed by 8.94 in SH_6 x NB_{18}, 8.92 in NB_{18} x NB_7, 8.85 in NB_{18} x P_5, and 8.41 in KPG-B x NB_{18} Percentage of leaf silk conversion rate was recorded 2.77 in KA x NB_{18} followed by 2.66 in SH_6 x NB_{18}, 2.55 in NB_{18} x NB_7, 2.42 in NB_{18} x P_5 and 2.40 in KPG-B x NB_{18} as shown in table-1 and table-2. The conversion of ingested food to cocoon and shell [81, 82-84] are the ultimate indices to evaluate the production efficiency of a breed/hybrid in terms of the production of cocoon/ shell *vis-à-vis* the food consumed [21,22, 85-91]. Our findings have shown that the breeds SH_6 x KA, KA x NB_4D_2, P_5 x NB_{18}, KA x NB_{18} showed better perform in conversion of ingested food into cocoon and silk among other selected breeds in monsoon, autumn, spring and summer season respectively for Uttar Pradesh climatic conditions.

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