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EVALUATION OF SELECTED HOSUR BREEDS FOR BINOMICS, REARING PERFORMANCE AND ECONOMIC TRAITS OF SILKWORM, *BOMBYX MORI* L.

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ABSTRACT
The studies on disease free eggs of silkworm breeds *viz*., HOSUR 0019, HOSUR 0021, HOSUR 0246, HOSUR 276 and HOSUR 0178 were utilized. Observations on the different phenotypic and economic traits of silkworm, *Bombyx mori* L. were taken. The perusal of the data reveals that the fecundity was recorded from 382.00 (HOSUR 0276) to 460.67 (HOSUR 0246) and hatching percent ranged from 92.69 (HOSUR 0276) to 96.03 (HOSUR 0021). The larval weight varied in the range of 31.17 g to 35.52 g whereas, larval duration was observed in the range of 24.01 days to 26.22 days. The larval length recorded as on 6th day 7.62 cm (HOSUR 0021) to 7.98 cm (HOSUR 0178). Single cocoon weight 1.27 g to 1.54 g. The highest single cocoon weight was HOSUR 0178 (1.54 g), Single shell weight 0.22 g to 0.29 g. Maximum shell weight recorded in HOSUR 0246 and HOSUR 0178 (0.29 g), Shell percentage 16.61 per cent (HOSUR 0021) to 20.10 percent (HOSUR 0246). Maximum yield HOSUR 0178 (15.95 Kg/10000 larvae), was observed significantly superior compared to others. These findings will help the sericulturists in finding suitable breed for getting more economic returns from silkworm rearing. It is observed that HOSUR 0178 is having highest yield per 10, 000 larvae.

KEY WORDS: Fecundity, Larval duration, Larval length, Cocoon yield, Shell ratio, *Bombyx mori* L.

INTRODUCTION

Sericulture is the production of silk through rearing of silkworm. It is a farm based, labour intensive and commercially attractive economic activity falling under the cottage and small-scale sector. It provides income and employment to the rural poor especially, farmers with small land-holding and marginalized and weaker sections of the society. Most silk moths belong to two families of Lepidoptera, bombycidae and saturniidae, which secrete several varieties of silk fibres. They include domesticated silkworm (*Bombyx mori* L.) and the wild silkworms. Silk worm is the larvae of insects, which belongs to the order Lepidoptera experiencing complete metamorphosis. The mulberry silk worm *Bombyx mori* L. (Lepidoptera: Bombycidae) is a monophagous insect that feeds exclusively on mulberry foliage for its nutrition and produces the naturally protienous silk. Nutritional intake has direct impact on the overall genetic traits such as larval and cocoon weight, amount of silk production, pupation, and reproductive traits. Silkworms go through four stages of development- eggs, larva, pupa and adult. The silk worm larval life cycle is divided into five instars, separated by four molts. Four distinct stages of development completes one generation of the species. The total silk worm life cycle is completed in 56-62 days.

Among all the five instars first three instars are young larva, fourth and fifth instars larvae are grown larvae. Young and grown larvae of silk worms behave differently according to environmental conditions and type of feeding (leaf quality and quantity). Concerning leaf feeding, both quality and quantity are important and different for each instar.The silk gland is an organ specialized for the synthesis and secretion of silk proteins Venugopal Reddy *et al.* (2015). It is the major storage organ of the silk. This silk gland represents one of the most active proteins synthesizing system among the entire organ. Silk glands constitute approximately one quarter of the worms mass and produce liquid silk. This is composed of complex proteins. Specialized cells present at the posterior end of the silk glands devote 85% of their protein synthesis activity to silk production. Silk industry is a domestic based industry uniquely suited to the economy and social structure of developing countries because of its minimum investment requirements, high employment and foreign exchange earning potential. It is a holometabolous insect and produces silk of high commercial importance reported by Venugopal Reddy *et al.* (2015).

MATERIALS & METHODS

The experiments were carried out on five *B. mori* parental HOSUR breeds *viz*., HOSUR 0019, HOSUR 0021, HOSUR 0246, HOSUR 276 and HOSUR 0178 maintained at the RSRS, Jammu during spring, 2016 and were incubated for 9-12 days in a neat and clean, disinfected room at 80-85 % Humidity and 24-25ºC Temperature with 18 hrs light till pin head stage, at this stage black - boxing was done to ensure maximum hatching on exposure to bright light. The hatched larvae were reared separately under uniform laboratory conditions as described by Yokoyama (1963) and Krishnaswami (1978). During the entire period of research, same micro-climate and feeding conditions were ensured as per the larval stage. The experiment analysed for phenotypic charateristics of egg, larvae and cocoon patterns (Table 1) and biological studies of larvae includes feeding duration (Table 2), hatching percentage, larval weight (Table 5) and total

larval duration of different instars were studied, which reflects their variation among the breeds (Table 3) and cocoon characteristics of all breeds were recorded.

All the breeds were reared in three replications by following standard rearing techniques (Krishnaswami, 1978). Three hundred larvae were retained after 2nd moult in each replication. The data pertaining to the morphology/ phenotypic and biological parameters were recorded. During the entire period of research, same micro-climate and feeding conditions were ensured as per the larval stage.

At egg stage: egg shape, egg colour, hatching percentage and average fecundity per female moth were studied.

At larval stage: larval colour, markings, larval length and mean weight of 10 larvae on each day of V instar were studied and analyzed for different races.

The statistical analysis was done with the help of software SPSS and weight of larvae was measured with electronic balance.

At cocoon stage: cocoon shape, cocoon colour, cocoon grain and economic characters of cocoon were noted.

RESULTS & DISCUSSION

Phenotypic qualitative parameters:

Egg: All Hosur breeds which are selected are ellipsoidal in shape, grey in color and shell color was recorded as white in HOSUR 0021, HOSUR 0178 and HOSUR 0276 whereas HOSUR 0019 and HOSUR 0246 yellow in color (Table 1). Similar results were obtained by Anita *et al.* (2014).

Larvae: Color of newly hatched larvae was recorded as black and haemolymph color was transparent in all the breeds. The pattern of larvae was observed marked in HOSUR 0178 and others it was recorded as plain (Table 1). The results were agreement with work done by Anita *et al.* (2014).

Cocoon: All the Hosur breeds were distinctly white in color in HOSUR 0178, HOSUR 0246 and HOSUR 0276 whereas HOSUR 0019 and HOSUR 0021 observed as yellow color. The shape of cocoon was dumbbell and constricted (DC) in HOSUR 0019 and HOSUR 0021 and HOSUR 0178 and oval in HOSUR 0246 AND HOSUR 0276 respectively. The build and grain of among all the breeds was recorded hard and medium respectively (Table 1). Similar results were obtained by Anita *et al.* (2014).

TABLE 1. Phenotypic qualitative characteristics of egg, larvae and cocoon parameters of HOSUR breeds

Breeds	Egg			Larvae			Cocoon			
	Shape	Shell Colour	Egg colour	Colour of Newly Hatched	Haemolymph Colour	Larval pattern	Colour	Shape	Build	Grains
HOSUR-0019	E	Y	G	B	T	P	Y	DC	H	M
HOSUR-0021	E	W	G	B	T	P	Y	DC	H	M
HOSUR-0178	E	W	G	B	T	M	W	DC	H	M
HOSUR-0246	E	Y	G	B	T	P	W	O	H	M
HOSUR-0276	E	W	G	B	T	P	W	O	H	M

Note: E - Ellipsoid, W – White, Y – Yellow, G- Grey, SS - Sand Stone, B- Black, T- Transparent, O -Oval, M- Medium, DC - Dumbell Constricted, H – Hard, P – Plain, M- Marked

Biological parameters of larvae

Feeding duration

First instar: The active period of feeding among all the breeds was recorded three days five hours (Table 2).

Second instar: Two days fourteen hours were recorded as most active period of feeding among all the breeds (Table 2).

Third instar: The active feeding period was recorded among all breeds was three days sixteen hours (Table 2).

Fourth instar: The feeding period was observed among all breeds was four days five hours (Table 2).

Fifth instar: There is variation among breeds was recorded, eight days twenty two hours more active feeding period was recorded in HOSUR 0178 and less *i.e.* six days one hour observed in HOSUR 0021 respectively (Table 2).

The total average feeding duration among all the breeds was more in HOSUR 0178 *i.e.* twenty two days fifteen hours and less was recorded in HOSUR 0021 *i.e.* nineteen days seventeen hours respectively (Table 2).

Larval duration

First instar: The period among all the breeds was recorded as four days five hours respectively (Table 3).

Second instar: Three days fourteen hours were recorded as 2nd stage larval period among all the breeds (Table 3).

Third instar: Five days twenty hours were recorded as 3rd stage larval period among all the breeds (Table 3).

Fourth instar: The larval period was observed five days ten hours among all the breeds (Table 3).

Fifth instar: There is variation among breeds was recorded, eight days twenty two hours was recorded in HOSUR 0178 and less *i.e.* six days one hour observed in HOSUR 0021 respectively (Table 3).

The total average larval duration among all the breeds was more in HOSUR 0178 *i.e.* twenty six days twenty two hours and less was recorded in HOSUR 0021 *i.e.* twenty four days one hour respectively (Table 5) and it was ranges from 24.01 - 26.22days. The results were agreement with Krishnaswami (1978) reported that the larval duration was longer in race M-5 (24.17), but it was non agreement with results reported by Bothikar *et al.* (2014) the larvae reared on S -1635 recorded 19.66 days. Under ideal conditions it has been reported that the total larval duration is 25-30 days for selected JAM breeds (Raina, 2000). The results were justified with work done by Anita *et al.* (2014) reported similar results on JAM breeds, the larval duration which ranges between 23.22 - 26.16 days.

TABLE 2. Data showing feeding duration among different stages of HOSUR breeds during spring rearing (2016)

Race/Breed	Different stages (Days: h) (Mean±SD)					Total Avg. duration (Days: h)
	1st instar	2nd instar	3rd instar	4th instar	5th instar	
HOSUR-0019	3.05±0.00	2.14±0.00	3.16±0.00	4.05±0.05	7.10±0.57	19.51±0.59
HOSUR-0021	3.05±0.00	2.14±0.00	3.16±0.00	4.05±0.05	6.01±0.00	21.03±0.05
HOSUR-0178	3.05±0.00	2.14±0.00	3.16±0.00	4.05±0.05	8.22±0.51	22.15±0.56
HOSUR-0246	3.05±0.00	2.14±0.00	3.16±0.00	4.05±0.05	6.12±0.01	22.07±0.48
HOSUR-0276	3.05±0.00	2.14±0.00	3.16±0.00	4.05±0.05	7.17±0.51	22.10±0.53

TABLE 3. Data showing larval duration among different stages of HOSUR breeds during spring rearing 2016

Races/breeds	Different stages (Days : h) (Mean ±SD)					Total duration (Days : h)
	1st instar	2nd instar	3rd instar	4th instar	5th instar	
HOSUR-0019	4.05±0.00	3.14±0.00	4.44±0.48	5.10±0.05	6.34±0.57	24.34±0.57
HOSUR-0021	4.05±0.00	3.14±0.00	4.44±0.48	5.10±0.05	6.01±0.00	24.01±0.01
HOSUR-0178	4.05±0.00	3.14±0.00	4.44±0.48	5.10±0.05	6.70±0.51	24.70±0.51
HOSUR-0246	4.05±0.00	3.14±0.00	4.44±0.48	5.10±0.05	6.12±0.01	24.12±0.01
HOSUR-0276	4.05±0.00	3.14±0.00	4.44±0.48	5.10±0.05	6.41±0.51	24.41±0.51

TABLE 4. Showing length of fifth instar larvae of HOSUR breeds during spring (2016)

Breeds	Days (5th instar) (Mean±SD)					
	1	2	3	4	5	6
HOSUR-0019	4.30±0.12	5.00±0.16	6.10±0.25	6.50±0.16	7.06±0.21	7.70±0.16
HOSUR-0021	4.36±0.13	5.30±0.16	6.62±0.08	6.66±0.19	6.98±0.16	7.62±0.08
HOSUR-0178	4.28±0.08	5.44±0.29	6.52±0.19	7.06±0.21	7.66±0.11	7.98±0.16
HOSUR-0246	4.38±0.08	5.26±0.11	6.12±0.29	6.56±0.27	7.06±0.21	7.78±0.13
HOSUR-0276	4.32±0.13	5.70±0.12	6.56±0.11	7.14±0.15	7.54±0.11	7.88±0.15
C.D. @ 1%	-	0.23	0.26	0.26	0.22	0.18
SE. m±	0.05	0.08	0.09	0.09	0.07	0.06
C.V. (%)	2.61	3.36	3.16	2.96	2.29	1.79

Larval length

The length of 5th instar larvae was recorded from first day to sixth day results revealed that there is significant differences were observed among all the breeds except in first day (Table 4). During first day the larval length ranges from 4.30 (HOSUR 0019) to 4.38 cm (HOSUR 0246), 2nd day it was ranges from 5 cm (HOSUR 0019) to 5.70 cm ((HOSUR 0276), 3rd day ranges between 6.10 (HOSUR 0019) to 6.62 cm (HOSUR 0021), 4th day recorded as 6.50 cm (HOSUR 0019) to 7.14 cm (HOSUR 0276), 5th day it was ranges from 6.98 (HOSUR 0021) to 7.66 cm (HOSUR 0178) and 6th day recorded as 7.62 cm (HOSUR 0021) to 7.98 cm (HOSUR 0178) (Table 4). Similar results were recorded by 6.71 to 7.25 cm (Prabu *et al.*, 2011) and 6.12 to 7.05 cm (Balasundaram *et al.*, 2013). The data shows that there is increase in larval length from day 1 to day 6 of 5th instar. The length of silk worm depends on amount of food it consumes. Length of larvae increases until larvae reaches it's spinning state (6th day). When it reaches spinning stage the larvae reduce in size to one third of its normal length, it is the characteristic feature of a silk worm. This reduction in size increases pressure on silk glands to eject silk from the glands. Hence there is a sudden decrease in length on 6th day onwards. This decrease in length continues until pupal stage. The results also agreement with work done by Venugopal Reddy *et al.* (2015) revealed that the larval length varies from 5.00 to 7.43 cm.

Economic parameters:

The data pertaining to nine economic traits *viz*., hatching %, larval duration (h), larval weight (g), cocoon yield per 10,000 larvae by number, cocoon yield per 10,000 larvae by weight, pupation rate, cocoon weight, cocoon shell weight, and cocoon shell ratio of five breeds were presented in Table 5. The perusal of the data reveals that the fecundity was recorded from 382.00 (HOSUR 0276) to 460.67 (HOSUR 0246) which shows statistically significant among all the breeds and hatching per cent ranged from 92.69 (HOSUR 0276) to 96.03 (HOSUR 0021) and showing statistically significant among all the breeds where as larval duration shows statistically non significant among all the breeds and recorded to a maximum of 26.22 (HOSUR 0276) and minimum of 24.01 (HOSUR 0021) where as larval weight was recorded to a maximum of 35.52 g (HOSUR 0178) and minimum of 31.17 g (HOSUR 0019) showing statistically significant among all the breeds whereas pupation rate showing statistically non significant among all the breeds and it was recorded as highest 91 per cent (HOSUR 0019, HOSUR 0178) and less 89.33 per cent (HOSUR 0021). With regard to yield per 10,000 larvae by number, HOSUR 0178 was recorded the highest (9366.67) and lowest in HOSUR 0246 (9093.33). Yield per 10,000 larvae by weight (kg), ranged to the maximum of 15.95 kg in HOSUR 0178 and minimum of 9.97 kg in HOSUR 0021 showing statistically significant among all the breeds with regard both by number and weight basis.

TABLE 5. Economic parameters of HOSUR breeds reared during spring (2016)

Breeds	Fecundity by number	Hatching (%)	Larval duration (Days : h)	Larval weight (g)	Pupal weight (g)	Yield/ 10000 Larvae			Weight of cocoon with floss (g)	Weight of cocoon without floss (g)	Single cocoon weight (g)	Single shell weight (g)	Shell ratio (%)
						Pupation rate (%)	No.	Wt. (Kg)					
HOSUR 0019	389.00 (19.74)	95.65 (78.01)	24.34	31.17	11.06	91.00 (72.53)	9173.33 (95.78)	10.68	12.76	12.60	1.27	0.22	17.28 (24.55)
HOSUR 0021	389.00 (19.74)	96.03 (78.53)	24.01	33.40	11.38	89.33 (70.94)	8646.67 (92.97)	9.97	13.14	12.99	1.37	0.23	16.61 (24.03)
HOSUR 0246	460.67 (21.48)	95.73 (78.05)	24.70	34.51	12.57	90.00 (71.55)	9093.33 (95.36)	10.59	15.45	15.29	1.44	0.29	20.10 (26.62)
HOSUR 0276	382.00 (19.55)	92.69 (74.40)	24.12	34.44	11.31	90.33 (71.86)	9206.67 (95.95)	13.21	14.23	13.84	1.43	0.27	19.14 (25.93)
HOSUR 0178	428.00 (20.70)	93.17 (74.89)	24.41	35.52	12.20	91.00 (72.53)	9366.67 (96.78)	15.95	14.38	14.18	1.54	0.29	18.65 (25.57)
CD @ 1%	1.24	3.31	-	1.46	-	-	2.34	1.70	1.83	-	0.03	0.008	0.45
SE. m ±	0.39	1.03	0.23	0.46	0.37	0.59	0.73	0.53	0.57	0.59	0.01	0.002	0.14
C.V. (%)	3.34	2.34	1.69	2.35	5.53	1.43	1.33	7.66	7.06	7.45	1.30	1.61	0.98

The weight of cocoon found to the highest of 15.95 g in HOSUR 0178 and lowest of 12.76 g in HOSUR 0019 shows statistically significant among all the breeds. The cocoon weight ranged from the maximum of 1.54 g (HOSUR 0178) and minimum of 1.27 g (HOSUR 0019). The shell weight was maximum (0.29 g) in HOSUR 0178 and minimum in HOSUR 0019 (0.22 g) shows statistically significant among all the breeds with respect to both cocoon weight and shell weight. The shell ratio (%) shows statistically significant among all the breeds and was highest in HOSUR 0246 (20.10) and lowest in HOSUR 0021 (16.61) respectively.

The highest average fecundity per moth was 522 in Jam 2 and lowest was 355 in Jam 18 reported by Anita *et al.* (2014) these results were non agreement with our results. The lowest hatching percent (93.79 %) was obtained in Jam 11 race and the highest (94.17 %) was obtained in Jam 27 race, with a mean of 93.92 per cent in all studied races Anita *et al.* (2014). It was justified with our results, 92.69 (HOSUR 0276) to 96.03 (HOSUR 0021).

The larval weight was non agreement with results reported by Bothikar *et al.* (2014) *i.e.* 40.54 g which were reared on S - 1635 and other breeds which on par with silkworm reared on variety M - 5 and breeds having larval weight ranges between 31.17 g (HOSUR 0019) to 35.52 g (HOSUR 0178). Similar results were recorded by Pakhale *et al.* (2014), the larval weight was ranges from 33.77-40.67 g.

The larval duration was non agreement with results reported by Pakhale *et al.* (2014), the larval duration ranges from 21.04 - 22.28 days, our results shows that 24.01-26.22 days among the breeds.

The single cocoon weight was not justified with results reported by Bothikar *et al.* (2014) *i.e.*,1.86 g which were

reared on S - 1635 and Rayer (2006) and Chakravorty (2004) reported the highest single cocoon weight on variety V- 1 and also not justified with results reported by by Pakhale *et al.* (2014) single cocoon weight ranges from 1.76-1.86 g.

The single shell weight was non agreement with Bothikar *et al.* (2014) report the silkworms which reared on S-1635 but it was similar results with variety M - 5 reported by Bothikar *et al.* (2014). Rayer (2006) and Chakravorty (2004) reported the highest single shell weight on variety V- 1 and also not justified with results reported by by Pakhale *et al.* (2014) single cocoon weight ranges from 0.32 -0.36 g.

The cocoon shell percentage varies between 19.93 to 17.84 per cent reported by Bothikar *et al.* (2014) and it was agreement with our results the shell percentage varies between 16.61- 20.10 per cent. Rayer (2006) and Chakravorty (2004) reported the cocoon shell percentage.

Cocoon yield per 10,000 larvae brushed varied in the range of 18.66 kg to 16.59 kg reported by Bothikar *et al.* (2014) and it was non agreement with our results on S-1635 but similar results which reared on variety M - 5, the yield varies between 9.97- 15.95 kg. Similar results reported by Rayer (2006) and Chakravorty (2004) reported the cocoon shell percentage.

Varietal differences for studied traits in *B.mori* has been reported by Ahsan *et al*., 2000, Li *et al*., 2001; Furdui *et al*., 2010. Similar studies on varietal diversity have also been sustained by the findings of Reza *et al*.,1993, Mistri and Jayaswal, 1992; Ahsan *et al*.,1999; Umashankara and Subramanya, 2002; Nezhad *et al*., 2009; Nguku *et al*., 2007; Nguku *et al*., 2009; Zannata *et al*., 2009; Pal and Moorthy, 2011).

CONCLUSION

The obtained data showed that there are highly significant differences among the breeds for all the studied characters. There is a high positive correlation between economic parameters among all the breeds studied. The differences in obtained results are due to the variability and genotype characters for each individual of every breed.

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