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Full Length Research Paper

Evaluation of the genetic potential of six native strains of silkworm, *Bombyx mori* L.

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The aim of this study was to evaluate six native strains of silkworm, *Bombyx mori* L., available in Iran based on different quantitative traits. In this experiment, the studied six native strains are Lemon Khorasan; Lemon Haratee, White Haratee, Yellow Haratee, Pink Khorasan and Baghdadi. From the obtained results, it is shown that the amount of percentage of hatchability in the six studied local varieties was between 84.93 and 98.87%. Among the studied local varieties, the highest level of percentage of hatchability belonged to Pink Khorasan (98.87%), and White Haratei variety (84.93%) remained at a lower level than other varieties (P<0.05). The amount of average of cocoon weight in the six studied local varieties was between 14.70 and 20.35%. Among the studied local varieties, the highest level of average of cocoon weight belonged to White Haratee and Yellow Haratee (14.70), and Lemon Haratee variety (20.35) remained at a lower level than other varieties (P<0.05). Also, the highest level of cocoon shell percentage belonged to Pink Khorasan (13.36%), and Lemon Haratee variety (19.11%) remained at a lower level than other varieties (P<0.05).

Key words: *Bombyx mori*, local race, cocoon, fertility, larvae duration.

INTRODUCTION

Silkworm, *Bombyx mori* is an important economic insect, since it is the producer of silk. It is entirely dependent on humans for its reproduction and does not occur naturally in the wild (Barber, 1992).

Germplasm of silkworm has changed considerably, via selection, during successive generations; and in a way of becoming domestic, it has achieved the present variety in modern species for the purposes of the existing characters, as a result of these changes. The domesticated silkworm includes more than 400 well described mutations that are differed in morphological physiological and biochemical characters that are mapped in more than 200 loci comprising 28 linkage groups or chromosomes (Cristina et al., 2007). The major objectives of silkworm breeding are improving fecundity, healthiness of larvae, quantity of cocoon and silk production, disease resistance, etc. (Barber, 1992). High genetic variability has been found in domestic lines of silkworms, though this is less than that found among wild silkmoths (about 83%). This suggests a single event of domestication, and that it happened over a short period, with a large number of wild worms being collected for domestication (Xia et al., 2009).

Genetic potentials of silkworm strains were investigated in various countries. Rayar et al. (1988) studied the performance of silkworm with about five important economic traits, and they mentioned that strain Saniish-18×NB18 had the highest performance. Also, Rao et al. (1997) investigated some properties of several silkworm varieties and found that a few lines have more performance than other pure lines. Ranatunga et al. (1990) studied the genetic structure and function of several new varieties of silkworm in Sri Lanka and found that variety 14 had the highest shell cocoon weight and cocoon shell percentage, while variety 40 had the highest cocoon weight. However, similar studies were conducted by Reza et al. (1993).

There are six local silkworm races in Iran Silkworm Research Center (ISRC) and there are enough data regarding some of their productive characteristics. Performance of these silkworm native groups has not

Abbreviations: ISRC, Iran Silkworm Research Center; **ANOVA,** analysis of variance.

been investigated and compared; as such, there is no precise information about their production performance and there is no information regarding the significant or non-significant differences between performance and production features in these native groups. Therefore, the aims of this research were to estimate the important performance indexes with regard to different quantitative and qualitative traits of these six native groups.

MATERIALS AND METHODS

Rearing of the six native strains, namely: Lemon Khorasan, Lemon Haratee, White Haratee, Yellow Haratee, Pink Khorasan and Baghdadi, was conducted during the spring of 2010 with three replications and each replication contained 250 larvae.

This experiment was performed to study the productive and economical traits of these native silkworms. Silkworm egg of six strains was taken from Iran Silkworm Research Center (ISRC). Rearing was conducted to standard, following rearing technology. Favorable conditions were applied for larva rearing such as 25 to 28°C and 75 to 85% relative humidity. After egg hatching, every group was bred separately under standard situations (ESCAP, 1993). Rearing, in young silkworm duration, was performed by chopped leaves and paraffin paper coverage and in the adult duration it was performed with leaves and branches. Rice straw was used as a cocoon making structure for cocoon spinning in each replication, separately. After cocoon spinning development (7 days after cocoon spinning started), obtained cocoons were gathered and sorted based on form, thickness, clarity, etc., to the four classes which include good, middle, double and low cocoons. The calculated ratio was done for each class of cocoon replication separately. Furthermore, it was investigated on the healthiness or disease of the total obtained pupae, and the ratio of each class cocoon disease was calculated for each replication, separately. The cocoon weight was recorded for good and double cocoons. All records were conducted on the 8^{th} day of cocoon spinning. Nonetheless, recorded traits were compared between the six studied native groups.

Recorded traits for this study were the number of produced eggs, number of healthy eggs, number of unfertilized and dead eggs, number of dead hatched eggs, percentage of hatchability, good cocoon number, good cocoon weight, good cocoon percentage, good cocoon mortality, middle cocoon number, middle cocoon percentage, middle cocoon mortality, low cocoon number, low cocoon percentage, low cocoon mortality, double cocoon number, double cocoon weight, double cocoon percentage, double cocoon mortality, total mortality, female cocoon weight, female cocoon shell weight, female cocoon shell percentage, male cocoon weight, male cocoon shell weight, male cocoon shell percentage, average of cocoon weight, sum of cocoon weight for male and female, average of shell cocoon weight, sum of shell cocoon weight and cocoon shell percentage. These parameters were measured using standard protocols (ESCAP, 1993). Furthermore, the data above 70 or below 30%, undergone inverse sine transformation ($Z=\text{Arcsin } P_{ij}^{1/2}$) and the data between 0 and 1, undergone square transformation ($P^{1/2}$). The data were subjected to analysis of variance (ANOVA) to determine if the differences found between treatments were significant. For analysis of variance, Tukey's studentized range (HSD) test in a complete randomized design was used at $\alpha=0.05$.

RESULTS AND DISCUSSION

The results obtained in this study are summarized in Table 1.

Number of produced eggs

From the obtained results, it is shown that the amount of the number of produced eggs in the six studied local varieties is between 319.66 and 424.91. Among the studied local varieties, the highest level of the number of produced eggs belonged to Pink Khorasan (424.91), and the Yellow Haratee variety (319.66) remained at a lower level. However, other varieties were between these two groups. Meanwhile, the statistical differences between the studied varieties for this trait were not significant ($P>0.05$).

Number of healthy eggs

From the obtained results, it is shown that the amount of the number of healthy eggs in the six studied local varieties is between 263.87 and 387.78. Among the studied local varieties, the highest level of the number of healthy eggs belonged to Pink Khorasan (387.78), and Lemon Khorasan variety (263.87) remained at a lower level. However, other varieties were between these two groups. Meanwhile, the statistical differences between the studied varieties for this trait were significant ($P<0.05$).

Number of unfertilized and dead eggs

From the obtained results, it is shown that the amount of the number of unfertilized and dead eggs in the six studied local varieties is between 7.33 and 32.10. Among the studied local varieties, the highest level of the number of unfertilized and dead eggs belonged to Yellow Haratee (32.10), and Baghdadi variety (7.33) remained at a lower level. However, other varieties were between these two groups. Meanwhile, the statistical differences between the studied varieties for this trait were not significant ($P>0.05$).

Number of dead hatched eggs

From the obtained results, it is shown that the amount of the number of dead hatched eggs in the six studied local varieties is between 5.01 and 63.00. Among the studied local varieties, the highest level of the number of dead hatched eggs belonged to White Haratee (63.00), and Pink Khorasan variety (5.01) remained at a lower level. However, other varieties were between these two groups. Meanwhile, the statistical differences between the studied varieties for this trait were not significant ($P>0.05$).

Percentage of hatchability

From the obtained results, it is shown that the amount of percentage of hatchability in the six studied local varieties

Table 1. Mean comparison (±SEM) of the productive parameters in the six studied local silkworm varieties*.

Parameter	Unit	Variety					
		Lemon Khorasan	Lemon Haratee	White Haratee	Yellow Haratee	Pink Khorasan	Baghdadi
Number of produced eggs	-	357.18±47.93^{a}	347.00±15.17^{a}	380.00±88.70^{a}	319.66±28.91^{a}	424.91±7.92^{a}	392.00±25.63^{a}
Number of the health eggs	-	263.87±36.38^{b}	300.66±16.75^{ab}	302.00±48.04^{ab}	273.00±23.54^{b}	387.78±19.96^{a}	334.00±37.63^{ab}
Number of the unfertilized and dead eggs	-	13.04±5.77^{a}	29.00±15.30^{a}	15.00±7.37^{a}	30.66±10.83^{a}	32.10±11.54^{a}	7.33±4.33^{a}
Number of the dead hatched eggs	-	48.66±23.96^{a}	17.33±8.35^{a}	63.00±35.92^{a}	16.00±3.78^{a}	5.01±0.57^{a}	50.66±14.31^{a}
Percentage of hatchability	%	87.79±5.26^{ab}	94.43±2.82^{ab}	84.93±5.63^{b}	94.43±1.22^{ab}	98.87±0.35^{a}	86.20±4.82^{ab}
Good cocoon number	-	51.17±5.19^{d}	153.00±26.50^{ab}	97.33±7.21^{cd}	159.33±7.21^{ab}	106.85±16.45^{bc}	175.33±25.20^{a}
Good cocoon weight	g	64.09±5.55^{c}	210.00±36.21^{a}	134.17±5.30^{b}	196.86±15.91^{ab}	156.47±25.00^{ab}	224.83±19.30^{a}
Good cocoon percentage	%	76.90±1.49^{a}	70.60±3.32^{a}	68.53±4.41^{a}	73.10±38.68^{a}	72.84±5.49^{a}	75.66±3.08^{a}
Good cocoon mortality	%	12.34±2.88^{ab}	0.96±0.48^{b}	6.66±5.49^{ab}	0.73±0.38^{b}	15.80±7.75^{a}	6.73±2.88^{ab}
Middle cocoon number	-	12.04±2.88^{b}	4.46±2.21^{ab}	33.33±8.98^{ab}	52.33±12.66^{a}	39.13±15.01^{ab}	46.00±9.86^{a}
Middle cocoon percentage	%	17.15±2.25^{a}	21.36±2.61^{a}	22.20±3.55^{a}	23.43±4.92^{a}	22.12±4.82^{a}	20.33±1.07^{a}
Middle cocoon mortality	%	2.75±0.54^{a}	1.30±1.10^{a}	2.26±.086^{a}	2.16±1.51^{a}	1.35±0.77^{a}	1.93±1.23^{a}
Low cocoon number	-	3.01±0.57^{a}	4.00±2.00^{a}	6.66±1.33^{a}	4.33±0.33^{a}	5.01±1.15^{a}	4.00±2.26^{a}
Low cocoon percentage	%	4.41±0.34^{a}	2.21±1.09^{b}	4.53±0.52^{a}	1.96±0.08^{b}	3.21±0.05^{ab}	1.56±0.84^{b}
Low cocoon mortality	%	2.45±1.41^{ab}	1.43±0.54^{b}	4.33±0.46^{a}	1.73±0.20^{b}	2.60±0.28^{ab}	1.53±0.81^{b}
Double cocoon number	-	1.00±0.57^{b}	12.66±2.18^{a}	7.00±1.52^{ab}	3.00±2.05^{b}	4.01±1.73^{b}	6.66±3.48^{ab}
Double cocoon weight	g	2.14±1.23^{a}	35.12±5.90^{b}	18.61±6.39^{b}	9.46±6.63^{b}	11.01±5.29^{b}	15.42±6.84^{b}
Double cocoon percentage	%	1.90±1.09^{c}	5.86±0.23^{a}	47.33±0.69^{ab}	1.46±1.04^{c}	2.15±0.66^{bc}	2.43±1.03^{bc}
Double cocoon mortality	%	0.00±0.00^{b}	0.60±0.45^{a}	2.73±0.39^{b}	0.16±0.16^{b}	0.50±0.28^{b}	1.00±0.64^{b}
Total mortality	%	17.55±4.85^{a}	4.30±0.51^{a}	15.96±5.55^{a}	4.80±1.58^{a}	20.26±6.98^{a}	11.20±5.06^{a}
Female cocoon weight	g	1.39±0.01^{b}	1.62±0.01^{a}	1.67±0.14^{a}	1.56±0.07^{ab}	1.69±0.02^{a}	1.55±0.09^{ab}
Female cocoon shell weight	g	0.16±0.01^{d}	0.20±0.00^{cd}	0.26±0.02^{ab}	0.22±0.01^{bc}	0.30±0.01^{ab}	0.25±0.01^{ab}
Female cocoon shell percentage	%	11.43±1.06^{d}	12.34±0.17^{cd}	15.66±0.16^{b}	14.36±0.31^{bc}	18.09±1.34^{a}	16.54±0.27$^{ab`}$
Male cocoon weight	g	1.16±0.02^{b}	1.27±0.24^{ab}	1.30±0.11^{ab}	1.29±0.02^{ab}	1.37±0.00^{a}	1.22±0.06^{b}
Male cocoon shell weight	g	0.22±0.01^{b}	0.18±0.00^{c}	0.25±0.02^{ab}	0.22±0.00^{b}	0.27±0.01^{b}	0.24±0.01^{ab}
Male cocoon shell percentage	%	19.78±1.73^{a}	14.70±0.13^{b}	19.60±0.62^{a}	17.61±0.66^{a}	20.35±1.13^{a}	19.60±0.45^{a}
Average of cocoon weight	g	1.28±0.01^{b}	1.44±0.01^{ab}	1.49±0.07^{a}	1.43±0.05^{ab}	1.53±0.01^{a}	1.39±0.08^{ab}
Sum of cocoon weight for male and female	g	2.56±0.05^{b}	2.89±0.05^{ab}	2.98±0.14^{a}	2.86±0.10^{ab}	3.05±0.02^{a}	2.78±0.16^{ab}
Average of shell cocoon weight	g	0.19±0.00^{cd}	0.16±0.03^{d}	0.25±0.01^{ab}	0.22±0.01^{bc}	0.29±0.03^{a}	0.24±0.01^{abc}
Sum of shell cocoon weight	g	0.38±0.00^{cd}	0.32±0.06^{d}	0.51±0.02^{ab}	0.45±0.02^{bc}	0.58±0.03^{a}	0.49±0.05^{abc}
Cocoon shell percentage	%	15.20±0.20^{c}	13.36±0.12^{d}	17.37±0.61^{ab}	15.83±0.26^{bc}	19.11±12.42^{a}	17.93±0.60^{a}

is between 84.93 and 98.87%. Among the studied local varieties, the highest level of percentage of hatchability belonged to Pink Khorasan (98.87%), and White Haratei variety (84.93%) remained at a lower level. However, other varieties were between these two groups. Meanwhile, the statistical

differences between the studied varieties for this trait were significant (P<0.05).

Good cocoon number

From the obtained results, it is shown that the amount of good cocoon number in the six studied local varieties is between 51.17 and 175.33. Among the studied local varieties, the highest level of good cocoon number belonged to Baghdadi (175.33), and Lemon Khorasan variety (51.17) remained at a lower level. However, other varieties were between these two groups. Meanwhile, the statistical differences between the studied varieties for this trait were significant (P<0.05).

Good cocoon weight

From the obtained results, it is shown that the amount of good cocoon weight in the six studied local varieties is between 64.09 and 224.83 g. Among the studied local varieties, the highest level of good cocoon weight belonged to Baghdadi (224.83 g), and Lemon Khorasan variety (64.09 g) remained at a lower level. However, other varieties were between these two groups. Meanwhile, the statistical differences between the studied varieties for this trait were significant (P<0.05).

Good cocoon percentage

From the obtained results, it is shown that the amount of good cocoon percentage in the six studied local varieties is between 68.53 and 76.90%. Among the studied local varieties, the highest level of good cocoon percentage belonged to Lemon Khorasan (76.90%), and White Haratee variety (68.53%) remained at a lower level. However, other varieties were between these two groups. Meanwhile, the statistical differences between the studied varieties for this trait were not significant (P>0.05).

Good cocoon mortality

From the obtained results, it is shown that the amount of good cocoon mortality in the six studied local varieties is between 0.73 and 12.34%. Among the studied local varieties, the highest level of good cocoon mortality belonged to Lemon Khorasan (12.34%), and Lemon Haratee variety (0.73%) remained at a lower level. However, other varieties were between these two groups. Meanwhile, the statistical differences between the studied varieties for this trait were not significant (P>0.05).

Middle cocoon number

From the obtained results, it is shown that the amount of middle cocoon number in the six studied local varieties is between 4.46 and 52.33. Among the studied local varieties, the highest level of the middle cocoon number belonged to Yellow Haratee (52.33), and Lemon Haratee variety (4.46) remained at a lower level. However, other varieties were between these two groups. Meanwhile, the statistical differences between the studied varieties for this trait were significant (P<0.05).

Middle cocoon mortality

From the obtained results, it is shown that the amount of middle cocoon mortality in the six studied local varieties is between 2.00 and 2.75. Among the studied local varieties, the highest level of the middle cocoon mortality belonged to White Haratee and Yellow Haratee (8.52 mg/dl), and Lemon Haratee variety (2.00 mg/dl) remained at a lower level. However, other varieties were between these two groups. Meanwhile, the statistical differences between the studied varieties for this trait were not significant (P>0.05).

Middle cocoon percentage

From the obtained results, it is shown that the amount of middle cocoon percentage in the six studied local varieties is between 17.15 and 23.43%. Among the studied local varieties, the highest level of middle cocoon percentage belonged to Yellow Khorasan (17.15%), and Lemon Haratee variety (23.43%) remained at a lower level. However, other varieties were between these two groups. Meanwhile, the statistical differences between the studied varieties for this trait were not significant (P>0.05).

Low cocoon number

From the obtained results, it is shown that the amount of low cocoon percentage in the six studied local varieties is between 3.01 and 6.66. Among the studied local varieties, the highest level of low cocoon percentage belonged to White Haratee (6.66), and Lemon Khorasan variety (3.01) remained at a lower level. However, other varieties were between these two groups. Meanwhile, the statistical differences between the studied varieties for this trait were not significant (P>0.05).

Low cocoon percentage

From the obtained results, it is shown that the amount of low cocoon mortality in the six studied local varieties is between 1.56 and 4.53%. Among the studied local varieties, the highest level of low cocoon mortality

belonged to White Haratee (4.53%), and Baghdadi variety (1.56%) remained at a lower level. However, other varieties were between these two groups. Meanwhile, the statistical differences between the studied varieties for this trait were significant (P<0.05).

Low cocoon mortality

From the obtained results, it is shown that the amount of low cocoon mortality in the six studied local varieties is between 1.43 and 4.53%. Among the studied local varieties, the highest level of low cocoon mortality belonged to Lemon Haratee (4.53%), and Baghdadi variety (1.43%) remained at a lower level. However, other varieties were between these two groups. Meanwhile, the statistical differences between the studied varieties for this trait were not significant (P<0.05).

Double cocoon number

From the obtained results, it is shown that the amount of double cocoon number in the six studied local varieties is between 1.00 and 12.66. Among the studied local varieties, the highest level of double cocoon number belonged to Lemon Haratee (12.66), and Lemon Khorasan variety (1.00) remained at a lower level. However, other varieties were between these two groups. Meanwhile, the statistical differences between the studied varieties for this trait were significant (P<0.05).

Double cocoon weight

From the obtained results, it is shown that the amount of double cocoon weight in the six studied local varieties is between 2.14 and 35.12 g. Among the studied local varieties, the highest level of double cocoon weight belonged to Lemon Haratee (12.66 g), and Lemon Khorasan variety (2.14 g) remained at a lower level. However, other varieties were between these two groups. Meanwhile, the statistical differences between the studied varieties for this trait were significant (P<0.05).

Double cocoon percentage

From the obtained results, it is shown that the amount of double cocoon percentage in the six studied local varieties is between 1.46 and 47.33%. Among the studied local varieties, the highest level of double cocoon percentage belonged to White Haratee (47.33%), and Yellow Haratee variety (1.46%) remained at a lower level. However, other varieties were between these two groups. Meanwhile, the statistical differences between the studied varieties for this trait were significant (P<0.05).

Double cocoon mortality

From the obtained results, it is shown that the amount of double cocoon mortality in the six studied local varieties were between 0.00 and 2.73%. Among the studied local varieties, the highest level of double cocoon mortality belonged to White Haratee (2.73%), and Lemon Khorasan variety (0.00%) remained at a lower level. However, other varieties were between these two groups. Meanwhile, the statistical differences between the studied varieties for this trait were significant (P<0.05).

Total mortality

From the obtained results, it is shown that the amount of total mortality in the six studied local varieties is between 4.30 and 17.55%. Among the studied local varieties, the highest level of total mortality belonged to Lemon Khorasan (17.55%), and White Haratee variety (4.30%) remained at a lower level. However, other varieties were between these two groups. Meanwhile, the statistical differences between the studied varieties for this trait were not significant (P>0.05).

Female cocoon weight

From the obtained results, it is shown that the amount of female cocoon weight in the six studied local varieties is between 1.39 and 1.67%. Among the studied local varieties, the highest level of female cocoon weight belonged to White Haratee (1.67%), and Lemon Khorasan variety (1.39%) remained at a lower level. However, other varieties were between these two groups. Meanwhile, the statistical differences between the studied varieties for this trait were significant (P<0.05).

Female cocoon shell weight

From the obtained results, it is shown that the amount of female cocoon shell weight in the six studied local varieties is between 0.16 and 0.30 g. Among the studied local varieties, the highest level of female cocoon shell weight belonged to Pink Khorasan (0.16 g), and Lemon Khorasan variety (0.16 g) remained at a lower level. However, other varieties were between these two groups. Meanwhile, the statistical differences between the studied varieties for this trait were significant (P<0.05).

Female cocoon shell percentage

From the obtained results, it is shown that the amount of female cocoon shell percentage in the six studied local varieties is between 11.43 and 18.09%. Among the studied local varieties, the highest level of female cocoon

shell percentage belonged to Pink Khorasan (18.09%), and Lemon Khorasan variety (11.43%) remained at a lower level. However, other varieties were between these two groups. Meanwhile, the statistical differences between the studied varieties for this trait were significant (P<0.05).

Male cocoon weight

From the obtained results, it is shown that the amount of male cocoon weight in six studied local varieties were between 1.16 and 1.37 g. Among the studied local varieties, the highest level of male cocoon weight belonged to Pink Khorasan (1.16 g), and Lemon Khorasan variety (1.37 g) remained at a lower level. However, other varieties were between these two groups. Meanwhile, the statistical differences between the studied varieties for this trait were significant (P<0.05).

Male cocoon shell weight

From the obtained results, it is shown that the amount of male cocoon shell weight in the six studied local varieties is between 0.18 and 0.27 g. Among the studied local varieties, the highest level of male cocoon shell weight belonged to Pink Khorasan (0.18 g), and Lemon Haratee variety (0.27 g) remained at a lower level. However, other varieties were between these two groups. Meanwhile, the statistical differences between the studied varieties for this trait were significant (P<0.05).

Male cocoon shell percentage

From the obtained results, it is shown that the amount of male cocoon shell percentage in the six studied local varieties is between 14.70 and 20.35%. Among the studied local varieties, the highest level of male cocoon shell percentage belonged to Pink Khorasan (20.35%), and Lemon Haratee variety (14.70%) remained at a lower level. However, other varieties were between these two groups. Meanwhile, the statistical differences between the studied varieties for this trait were significant (P<0.05).

Average of cocoon weight

From the obtained results, it is shown that the amount of average of cocoon weight in the six studied local varieties is between 14.70 and 20.35. Among the studied local varieties, the highest level of average of cocoon weight belonged to White Haratee and Yellow Haratee (14.70), and Lemon Haratee variety (20.35) remained at a lower level. However, other varieties were between these two groups. Meanwhile, the statistical differences between the studied varieties for this trait were significant (P<0.05).

Sum of cocoon weight for male and female

From the obtained results, it is shown that the amount of the sum of cocoon weight for male and female in the six studied local varieties is between 2.56 and 3.05 g. Among the studied local varieties, the highest level of sum of cocoon weight for male and female belonged to Pink Khorasan (3.05 g), and Lemon Khorasan variety (2.56 g) remained at a lower level. However, other varieties were between these two groups. Meanwhile, the statistical differences between the studied varieties for this trait were significant (P<0.05).

Average of shell cocoon weight

From the obtained results, it is shown that the amount of average of shell cocoon weight in the six studied local varieties is between 0.16 and 0.29 g. Among the studied local varieties, the highest level of average of shell cocoon weight belonged to Yellow Haratee (0.29 g), and Lemon Haratee variety (0.16 g) remained at a lower level. However, other varieties were between these two groups. Meanwhile, the statistical differences between the studied varieties for this trait were significant (P<0.05).

Sum of shell cocoon weight

From the obtained results, it is shown that the amount of sum of shell cocoon weight in the six studied local varieties is between 0.32 and 0.58 g. Among the studied local varieties, the highest level of sum of shell cocoon weight belonged to Pink Khorasan (0.32 g), and Lemon Haratee variety (0.58 g) remained at a lower level. However, other varieties were between these two groups. Meanwhile, the statistical differences between the studied varieties for this trait were significant (P<0.05).

Cocoon shell percentage

From the obtained results, it is shown that the amount of cocoon shell percentage in the six studied local varieties is between 13.36 and 19.11%. Among the studied local varieties, the highest level of cocoon shell percentage belonged to Pink Khorasan (13.36%), and Lemon Haratee variety (19.11%) remained at a lower level. However, other varieties were between these two groups. Meanwhile, the statistical differences between the studied varieties for this trait were significant (P<0.05).

Most of the quantitative traits of commercial importance in silkworm are under complicated polygenic control via

the influence of the environment (Rao et al., 2006; Salehi et al., 2010b). For synthesizing the potential polyvoltine cross breeds, usually, the high yielding traits of bivoltine varieties and fitness traits of strains are hybridized, as a proper selection of potential and homozygous parents is very important (Rao et al., 2006; Salehi et al., 2010b).

There are similar results with our study. Previously, Rangaiah et al. (1995), in another study, examined fertility, larval growth, larval weight, cocoon weight and cocoon shell percentage in 18 varieties of silkworm and reported significant differences among the 18 studied varieties. Meanwhile, Rao et al. (1997) studied some properties of several silkworm varieties and their obtained results showed that one variety had the most performance than other studied varieties. Also, Ashoka et al. (1993) investigated 32 silkworm varieties based on 13 traits and found that several of these varieties had the most performance among the studied varieties. However, similar studies are conducted by Seidavi (2011).

The breeding system of silkworm parental lines is based on using standard conditions of breeding and then visual selection of persons based on external phenotype. This system does not accomplish recording and selection based on any record whatsoever; it is expected that recording of pure parental lines and selection of best individuals is based on the highest individual records. Correctness of selection is used as a criterion of relation intensity between the actual reformative values and their anticipated amount, and it depends on numerous factors such as: heritability of characteristics and the method of assessment. The kind of assessment depends on the individual records used, or the relative record used together with the individual records, which have an effect on assessment correctness. The estimated error in genius parameters, and the phenotype and difference between the actual genius and phenotype parameters of the society with their estimated amounts have an effect on genius development. In this case, the genius produced development is less than the amount expected.

The obtained results relate to previous findings, and they support many previous reports regarding performance differences of various silkworm strains. The obtained data show that there are highly significant differences among the genotypes for all the studied characters.

Varietal differences for the studied traits in *Bombyx mori* have been reported by Ahsan and Rahman (2000). Nonetheless, similar results on varietal diversity have also been substantiated by the findings of Reza and Rahman (1996), Ahsan et al. (1999), Mirhosseini et al. (2010), Salehi et al. (2010a), Vaez et al. (2011) and Ahsan and Rahman (2008).

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