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Effects of Sex, Generation and Genetic Group on Economic Traits in Three Iranian Commercial Silkworm Pure Lines

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Abstract: Considering the lake of sufficient information in connection with the three commercial line of silkworm 32, 104, 110 of Islamic Republic of Iran, the objective of research is to investigate the effect of sex, generation, line on economic cocoon traits in these 3 commercial lines. Economic cocoon traits of 3 lines 32, 104, 110 by utilizing 11259 records obtain from four generation in Iran Silkworm Research Center (ISRC) was assessed. The fixed effect of sex, generation, line on traits studied were significant ($p<0.01$). The commercial lines regarding cocoon traits were also significant which demonstrated the various genetic diversities of commercial lines of silkworm. The total average of the cocoon weight was measured at 1.667±0.0045. The averages of Cocoon Weight trait (CW) in line 32, 104, 110 were 1.734±0.0084, 1.6997±0.0047 and 1.5654±0.0066, respectively. The effect of line was very significant ($p<0.001$). The effect of the generation was significant too ($p<0.001$) and the average of 1st generation was higher than other generations and after that there were 3rd, 2nd and 4th generations. The effect of sex was very significant and the average of CW in females and males were 1.85±0.005 and 1.48±0.003 g, respectively. Total mean of Cocoon Shell Weight (CSW) was 0.3618±0.0009 and average of this trait in line 32, 104 and 110 were 0.3902±0.0016, 0.3675±0.0013 and 0.3268±0.0019 g. Effect of all fixed effects were significant on cocoon shell weight. Total average of Cocoon Shell Percentage (CSP) was 21.89±0.044. Average of this trait in line 32, 104 and 110 were 22.736±0.789, 21.8416±0.752 and 21.0677±0.694%. All of the fixed effects were significant on this trait. Average of 1st generation for this trait was 23.794±0.184 and the average of 2nd, 3rd and 4th generations were measured at 21.723±0.079, 21.936±0.081 and 21.628±0.072, respectively. In addition the value of this trait was higher in male than female.

Key words: Silkworm, economic traits, cocoon, generation, sex, shell weight

INTRODUCTION

The production of cocoon silkworms and raw silk depend on a variety of factor such as the genetic capacity of commercial varieties, the quality of silkworm eggs, pets and disease, the quality of mulberry leaves weather method of culture, management, silk drawing operation (Moghadam, 2004). One of the objectives of genetic modifying is to improve the average of traits by increasing the genetic potential of the commercial lines used. Considering the current crises which exist in the sericulture, one of the major objectives is to increase productivity in commercial hybrids silkworm which results in an increase in prefect for producers of silkworm eggs, producer of cocoon and of silk fiber producers. Save this industry from extinction in this direction, genetic modification can play a sign cant role in achieving this objective. Therefore by analyzing the current silk egg system and policies we need to base any genetic modification goals which must be achieved on massive industrial policies and increase the profit of the system and reduce costs (Wiener, 1994). The main objective of animal breeding is to increase productivity and the quality of the products for consumers through design genetic engineering. There are a variety of factors which effect fluctuation in livestock production and forecasting time line production including nutrition, management sanitation, various physiological elements, medicine and genetic modification of the livestock. One factor which especially important for future generation is genetics and genetic modification but genetic modification is not based on isolation of livestock from various environmental aspects. The first step of animal breeding is accept to resources to farm livestock which need to be identified accursedly on the other hand additional feeding improved management and sanitation all need to be considered

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which of course impressive cost. This cost should be on going until we see an increase in animal production capacity. Improve genetics also can not be achieved without addition cost.

However, with just one investment increase productivity in this field will also be guaranteed what this means is the profit gained from a specific genetic selection at any point of time will be accumulative and sustainable while providing food medication well always need to be repeated. The degree of complexity of an animal breeding program mainly depends on the method used as well as the type of traits which need to be modified. In any animal breeding program we should also considered if the traits are multi traits (Wiener, 1994).

Selection objective should be chosen in the way that the income update from a single livestock is maximized: for any important economic trait has economic coefficient which is relative since it varies by price. Second, needs to be done its minimize cost for each unit of production to determine a selection objective we need to determine that a breed has the highest degree liability then choose the best breeding strategy based on traits of the livestock. In addition, there must be a variation of traits to guaranty improvement over time.

In other words it is essential that there be differences in animal and their traits and at least a proportion of these traits need to be hereditary (Simm, 1998). The varieties of silkworm in Iran account for a proportion of genetic resources, these creatures which have years and generation through natural and artificial selection under the conditions of this country have become resistant to various environment limitations and disease. To used utilized this resource in animal breeding we must have comprehensive knowledge of economic characteristics. Identifying and evaluating genetic resources of the silkworm in this country and potential is vital for scientific research in the future users.

Effective performance from the high potential of these resources is a task which must be overcome during the next several years to generate sustainable resources and economical ability. Due to lack of enough information about three Islamic Republic of Iran commercial lines of silkworm 32, 104 and 110, the purpose of this study was surveying the effect of sex, generation and line on economic traits of these 3 lines.

MATERIALS AND METHODS

Geographic location and climate of research conducted data used in this study were collected from the Iran Silkworm Research Center which is the original trustee in sericulture researches in Iran. This center is located in Rasht district Pasikhan. This region has a mean temperature of 17°C, annual rainfall 1450 mm, latitude and longitude 49°36', 34°16' and -6.9 altitudes from sea level.

Rearing management of lines: In order to make proper coordination in embryos growth, silkworm egg to embryos rotation stage (day 6-7) exposed to natural daylight and darkness at night and after being up at this stage to change the color stage of the egg they have exposure 18 h light and 6 h darkness. Then which completion of changing the color of the egg (>90%) complete darkness for 3 days given and on the morning of the day 14 with the supply of light, the eggs were hatching. Silkworm rearing techniques of humidity, temperature, light, young and mature worm rearing, cocoon spinning, preparation of silkworm egg maintenance of silkworm egg and acidification shock for eggs were conducted following the standard procedure of ESCAP.

Rearing was in the young worm stage (1st, 2nd and 3rd larval age) and mature worm (4th and 5th larval age) in standard terms. At the end of each larval period, cocoon weight and cocoon shell weight was recorded and all of these activities were repeated. First, it was established base population for each pure line from 3P population.

For each pure line, it is selected 40 male and 40 female cocoons which had superior cocoon traits and were randomly mated. In the end of the rearing duration and cocoon production and after determining of the individual sexuality in order to pedigree construction 25 male and 25 female cocoon recorded in the each family based on cocoon weight, cocoon shell weight and cocoon shell percentage. Stage of rearing and producing raw data in 2nd (2P) and 3rd (P) generation were conducted as same as the 1st generation.

Lines and commercial traits: The present study has been performed on 3 line 32, 104 and 110 economic traits studied in this research were Cocoon Weight (CW), Cocoon Shell Weight (CSW) and Cocoon Shell Percentage (CSP). To measure cocoon weight traits, cocoons individually were weighting with digital scale with 0.001 g accuracy to measure cocoon shell weight trait, first each cocoon cut with razor blades, pupa and cocoon shell inside were removed and cocoon were sex determining. Then weight of cocoon shell using a digital scale with 0.001 accuracy weighed. Sex-determination using the pupa phenotype genital symptoms was done. To measure the traits of cocoon shell percentage the following equation was used [$CSW/CW\times100$].

Data preparation and processing: Estimation of genetic and environmental parameters for the desired traits, the data obtained form four generation or rearing periods for each line. In first or base generation 40 selected individuals were method. Every line in every generation. Eight families were take. This was repeated each year. At the end of cocoon spinning in each full sib families, 25 males and 25 female cocoons were individually recorded for cocoon traits.

For each traits and each line, data used for estimation of genetic parameters of population obtained from formula derived by multiplying the number of generation x number of traits x number of individuals in the trait generation for each in that in total 11598 records were obtained and number of individual records for each traits was 3866. However, due to poor environment conditions very few (less than a family) records of larvae in rearing age destroyed and it is not possible to take the records, as a result the information received from the Iran Silkworm Research Center, some larvae of lines 104 and 110 population did not have records that to avoid creating an error were excluded.

Information includes data on pedigree, records on prediction traits (cocoon weight, cocoon sell weight and cocoon sell percentage) line number, sex and generation number. Data was classified using Excel software and using SPSS 17 software with completely randomize design to compare the mean and variance analysis were performed. For statistical analysis, Generalized Liner Models (GLM) procedure was used.

RESULTS

Average of traits for fixed traits: Each of the traits studied by the respective models were analyzed that average fixed effect s model s separately their various levels are shown in Table 1.

Average of cocoon weight: Mean cocoon weight was 1.667±0.0045. Significant fixed effect on the average of the trait was evaluated accordingly average of cocoon weight trait in line 32, 104 and 110 were 1.734±0.0084, 1.6997±0.0047 and 1.5654±0.0066 g, respectively. Effect of line for cocoon weight was so significant ($p<0.001$). According to previous researches among silkworm breeding lines, significant difference in average of the traits can be seen. Also, the effect of generating was significant average of 1st generation or base population was higher that the rest of the population and 3rd, 2nd, 4th generation were place, respectively. Also the effect of sex was very significant ($p<0.001$) for this trait and average of females were 1.85±0.005 g and in male were 1.48±0.003 g. Generally cocoon weight in female is higher than male.

Table 1: Average comparisons for fixed effects in studied traits

	Traits		
Elements	CW (g)	CSW (g)	CSP (%)
Descriptive statistics			
Total average	1.667±0.0045	0.3618±0.0009	21.89±0.044
Minimum	0.89	0.18	11.90
Maximum	2.58	0.55	41.60
Line			
32	1.734±0.0084^{a}	0.3902±0.0016^{a}	22.7361±0.789^{a}
104	1.6997±0.0047^{b}	0.3675±0.0013^{b}	21.841±0.752^{b}
110	1.5654±0.0066^{c}	0.3268±0.0019^{c}	21.067±0.694^{c}
Generation			
1	1.8061±0.0169^{a}	0.4241±0.0022^{a}	23.7943±0.184^{a}
2	1.7146±0.0067^{c}	0.3682±0.0011^{c}	21.7231±0.0799^{c}
3	1.7580±0.0088^{b}	0.3825±0.0018^{b}	21.9366±0.0814^{b}
4	1.4987±0.0063^{d}	0.3218±0.0012^{d}	21.6280±0.0724^{d}
Sex			
Female	1.8514±0.0053	0.3689±0.0013	19.9153±0.0388^{b}
Male	1.4802±0.0039^{b}	0.3545±0.0012^{b}	23.8913±0.0472^{a}

In each column for line, generation and sex, if exist same letters, respective averages do not have significant differences ($p<0.01$)

Average of cocoon shell weight: Total average of CSW was 0.3618±0.0009. Average of cocoon shell weight in lines 32, 104 and 110 were 0.3902±0.0016, 0.3675±0.0013 and 0.3268±0.0019, respectively. Fixed effects on the CSW were calculated and effect of line, generation and gender was significant for this trait.

Average of cocoon shell percentage: Total mean for CSP was 21.89±0.044% and average of this trait in lines 32, 104 and 110 was 22.736±0.789, 21.8416±0.752 and 21.0677±0.694%. All of the fixed effects were significant on this trait. However, there is very little deferent between the mean of trait in 2nd, 3rd and 4th generations. In fact 1st generation or base population which have the less animals makes significant difference in this fixed effect.

Mean of 1st generation was 23.794±0.184 and 2nd, 3rd and 4th generations were 21.723±0.079, 21.936±0.081 and 21.628±0.072%, respectively. The value of this trait in males was higher than female. Considering the method of calculating the CSP from CW and CSW also the fact that CSW does not have a significant difference in sex and the most difference is in CW can easy signify this problem.

Average of trait and fixed effect in each line: In each line average and fix of gene and sex were calculated separately.

Average of trait in line 32: Averages of CW, CSW and CSP in this line were 1.734±0.008 and 0.3902±0.0016 g and 22.736±0.078%, respectively which were higher than other lines. The effect of gene and sex in all traits were significant. However, in trait CSP between the 2nd and 3rd generation there was no significant difference. Also

Table 2: Average comparison of traits for fixed effects in line 32

	Traits		
Elements	CW (g)	CSW (g)	CSP (%)
Generation			
1	1.8423±0.02874[b]	0.4487±0.00281[a]	24.7456±0.34407[a]
2	1.7216±0.01267[c]	0.3888±0.00200[c]	22.8875±0.14465[b]
3	1.9213±0.01449[a]	0.4334±0.00225[b]	22.8449±0.13289[b]
4	1.5376±0.01138[d]	0.3368±0.00204[d]	22.0739±0.13207[c]
Sex			
Female	1.9443±0.00961[a]	0.4024±0.00223[a]	20.7298±0.07353[b]
Male	1.5237±0.00718[b]	0.3781±0.00226[b]	24.7423±0.08332[a]

In each column for generation and sex, if exist same letters, respective averages do not have significant differences (p<0.01)

Table 3: Average comparison of traits for fixed effects in line 104

	Traits		
Elements	CW (g)	CSW (g)	CSP (%)
Generation			
1	1.8598±0.02773[a]	0.4361±0.00291[a]	23.7552±0.286442[a]
2	1.7507±0.01119[b]	0.3685±0.00178[c]	21.2887±0.127540[b]
3	1.7779±0.01359[b]	0.3866±0.00235[b]	21.9706±0.143940[b]
4	1.5204±0.01085[c]	0.3311±0.00209[d]	21.9382±0.121790[b]
Sex			
Female	1.8756±0.00860[a]	0.3717±0.00197[a]	19.8330±0.058670[b]
Male	1.5174±0.00662[b]	0.3630±0.00194[b]	23.9234±0.075490[a]

In each column for generation and sex, if exist same letters, respective averages do not have significant differences (p<0.01)

Table 4: Average comparison of traits for fixed effects in line 110

	Traits		
Elements	CW (g)	CSW (g)	CSP (%)
Generation			
1	1.7162±0.02507[a]	0.3874±0.00221[a]	22.8821±0.29214[a]
2	1.6693±0.01095[a]	0.3471±0.00168[b]	21.0204±0.12474[b]
3	1.5553±0.01121[b]	0.3220±0.00190[c]	20.8983±0.12701[b]
4	1.4405±0.00979[c]	0.2986±0.00170[d]	20.9054±0.11267[b]
Sex			
Female	1.7314±0.00735[a]	0.3317±0.00164[a]	19.1600±0.05190[b]
Male	1.3989±0.00560[b]	0.3218±0.00171[b]	22.9815±0.06975[a]

In each column for generation and sex, if exist same letters, respective averages do not have significant differences (p<0.01)

for the CW 3rd generation mean is higher than the 1st generation female were also higher average in CW and CSW (Table 2).

Average of traits in line 104: Averages of CW, CSW and CSP in this line were 1.699±0.007 and 0.3675±0.001 g and 21.841±0.075%, respectively. In this line the highest mean of CW and CSW traits was in the 1st generation and after that it was in 3rd, 2nd and 4th generation. CSP had the high average in 1st generation and then the 3rd, 4th and 2nd generations are. Also the average of CW and CSW in females were highest then the male and in CSP average of males were highest (Table 3).

Average of traits in line 110: Average of studied traits (CW, CSW, CSP) were 1.565±0.006 and 0.3268±0.001 g and 21.067±0.069%. Mean of CW in this line from 1st-4th generation were 1.7162±0.02507, 1.6693±0.01095, 1.5553±0.01121 and 1.4405±0.00979, respectively. As is clear mean of the 1st generation is the highest and then there are 2nd, 3rd and 4th generations. Same trend also exist for CSW but for CSP there are 2nd, 4th and 3rd, respectively after 1st generation. Effect of sex and generation were significant in all traits (Table 4).

DISCUSSION

As a first step in preparing an animal breeding program, it is necessary to identify the genetic characteristic of base lines and review of economically important traits. Economically important traits of silkworm are quantitative and affected by many genes. The economic trait average of silkworms in different generations varies which might be due to environmental factor or changes in genetic capacity or a combination of these two elements. The conclusion of this research demonstrate that the differences in the averages of all lines regarding the economic traits of the cocoon were significant (p<0.01) which directly indicate the differences and the genetic commercial lines 32, 104 and 110. Therefore, utilizing these lines which have a higher genetic capacity in breeding program is a vital importance. In a research, it was reported that the differences in line 31, 51, 101, 32, 102 and 202 were significant in cocoon weight, cocoon shell weight, pupa weight, larval duration and cocoon shell percentage (Esfandarani *et al*., 2001). In another research differences in means of economic traits, CW, CSW and CSP in studied lines (110, 107, 101433, Xinhang, Koming1 and Y) were significant (Ghanipour *et al*., 2007).

In this research the average of CW in lines 32 and 104 were higher respectively and as seen in all lines females have higher CW than males. Economically speaking, the value of the female cocoon is much higher therefore, the features and traits of the cocoon is mostly influence by sex. CW trait is polygene and its controlling genes influenced asexual chromosomes (ESCAP, 1993). Also in this research the average of these traits and various generations were significant (p<0.01) depending on season, year and environmental factors. Averages obtained for CSP showed significant effects of line, generation and sex on this trait. Production of silk and silk gland growth depends on environmental and feeding conditions of larvae. Under favorable conditions farming and environment (spring) since mulberry leaves are higher quality the mount of leaf which has consumed larva is lower and also because of the higher ability of the mulberry leaves to digest, the amount of defection produced is low. However, in fall the exact opposite happens, meaning that the production of cocoon shell drop dramatically and as a result the average of the CSW in the spring was reported higher than the fall. Before that it was reported that cocoon of the female and male have different means (Moghadam, 2004). Seidavi (2010) likewise showed that sex have significant effect only on additive genetic of CW ($p<0.05$) and CSP ($p<0.01$). The results of average from CSP show that unlike CW and CSW this trait is higher in male than female. This is due to relatively low weight in male pupa which makes the higher percentage of cocoon shell in male than female cocoons.

CONCLUSION

In this research fixed effects (generation and sex) have significant effect on CW, CSW, CSP. CSP measured as a weight ration. Considering the chaos and multiple impact of this trait on studied models, the low heritability and low or negative correlation with other economic traits of silkworm suggest that should be emphasis more on other traits like CW and CSW in researches related to silkworm breeding for selection using selection index. Also considering that the environmental factors have high effect on production traits, controlling the nutrition, environment and management conditions is necessary to achieve acceptable results. Additionally, considering the characteristics of female and male cocoons suggest the possibility to create a separate parental lines for further surveys.

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