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Estimation of response to selection in three silkworm commercial pure lines with oval cocoon

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ABSTRACT

To estimate and compare the response to selection of quantitative traits in the three commercial pure lines (32, 104 and 110) of silkworm, records and response to the choice of three successive generations were analyzed. According to existing records, for each of these three lines, a choice group was formed; its individuals have average cocoon weight higher than above-mentioned average in their colony. In each of these three lines, another similar colony was formed. Intercourse within the group over next three generations, without re-selection acts, took place and the economic characteristics of each choice were recorded, and respond to each trait, from the average difference in trait in selection and control groups over the previous generation, in every line separation, trait and group, over three consecutive generations were measured. Results from this study showed that selection in based colony based on the weight of cocoon, improved nine traits of these twenty-seven traits, simultaneously in all three commercial lines 32, 104, 110 of silkworm and comparison in the response to selection of three Lines also showed that the difference in response to the selection of these three lines, statistically, for the five traits, is meaningful ($p<0.05$). In line 32, the highest increase in trait selection resulted in cocoon weight of ten 10000 larvae (412.6 g), in line 104, for weight trait of the whole best cocoon weight (64.77 g), good (77.64 g) and in line 110 for the trait number of hatched larvae was (68.04 larvae). By comparing the response to the choice of above three lines, the trait of number of hatched eggs statistically have meaningful difference. Only in the trait of number of un-fertilized eggs simultaneously, we have observed reduction in all three lines 32, 104 and 110 (i.e. improvement of selection). Considering this, the most reduction of trait rate resulted in this study included in line 32, trait of the number of un-fertilized eggs (-9.33) in line 104, trait of the number of un-hatched eggs (-4.33) and in line 110, trait of the number of un-hatched eggs (-6.13).

Key words: Silkworm, Cocoon, Generation, Response to Selection

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INTRODUCTION

Silkworm is insect belong to Bombycid's family and Bombyx specie grown 10000s of years ago by human grown and some of its traits have changed or lost gradually regarding to natural conditions of environment and now have wild species traits [1]. The first step in any breeding program is the complete study of available species of silkworm and study of existing scientific resources. Using species of silkworm as genes source which were not in selected native varieties, especially in genes that lead to products with superior quality and quantity, are very useful. In all colonies, there is always superior in economic trait. It is necessary to be done targeted cross to gathered several desirable traits in a line or a different gene in order to obtain future selection.

Since the response rate to response in each generation is selection intensity function on each trait, heritability and genetic correlations of each trait with other traits, the genetic progress can be estimated as a criterion for planning for determining proper breeding strategy and selection in each line [2]. Therefore, the line selection system for breeding programs, design based on results of studies on the heritability of traits and rate of genetic traits and their correlation with each other, and selection in parent line for results carry out based on these cases [2].

This experiment carried out to give direction to the silkworm breeding programs, according to the response rate to estimated selection for quantitative traits in three lines of silkworm in this research, and with comparison of response to selection of quantitative traits in these lines, identity lines with high genetic capacity from estimated average among lines and their selection for nest intercourse and result performance improvement, study how to estimate answers in different traits in successive generations, estimation rate of response in selection in three business line of silkworm with oval cocoon, study of superior individuals as the next generation, how much improved performance in the downstream lines in next successive generations, and how much difference in response to selection between different economic traits.

MATERIALS AND METHODS

Data and Records of this study were received from Iran Silkworm Research Center (ISRC). Used data in this research, including individual records related to traits economic important traits in three trading 32, 104 and 110 Iran silkworm with information related to animal's number, Father number, mother number, generation number, family number and sex type (male and female) means; with pedigree information which after receiving them from Iran Silkworm Research Center (ISRC) were classified and saved in computer.

To implementing of this research project, according to records available pre-estimates related to individual three trading lines of 32, 104 and 110 Iran silkworm, and from Iran silkworm research center, for each of these three lines, a selected group, consisting average weight of high cocoon than average colony and a control group compose of individuals with similar average as base colony were studied. Data used to estimate and compare of responses to selection of desired traits, including eight families in 4 generations, 3 lines, 27 traits, 2 sex, and 25 individuals was (129,600). In this review, intercourse within a group during next generation, without reselection action was carried and economic characteristics of each choice and control group were recorded

and responding to selection of each trait from average difference of trait in choice and control groups over previous generation in separating each line, trait and group were measured.
Studied economic characteristics include the number of alive larvae, the number of alive pupae, the percentage of vitality pupae in total cocoons, the percentage of pupae in best cocoons, the weight of single best cocoons, the weight of ten 10000 larvae, larvae duration, the number of hatched larvae, the number of un-hatched eggs, the number of un-fertilized eggs, the percent of hatched eggs, the percent of un-fertilized eggs, the percent of un-hatched eggs, hatch percentage, and total produced eggs which in each line during three generation were measured separately. As it was told; this data was recorded and analyzed for calculating of response to selection of each traits.

Data was recorded and classified by Excel software. Then, with constant effects action (line, group, sex, trait, generation, season), the average of data based on randomly program using Duncan test by SAS software was calculated and analyzed and response to selection of above three lines were compared with each other.

RESULTS

Table 1. Comparison of studied lines for individual selection system efficiency in basic population and response to selection*

	32	**104**	**110**
Alive Larvae Number	30.67	23.08	39.91
Alive Pupae Number	20.00	23.67	34.74
Pupae Vitality Percentage	-2.378	0.824	-1.760
Pupae Vitality Percentage(Best Cocoon)	-1.168	0.633	-1.084
Pupae vitality Percentage (Middle Cocoon)	-6.167**b**	8.552**a**	0.023**ab**
Produced Cocoon Number	35.88	22.96	40.70
Best Cocoon Number	29.46	11.21	24.26
Middle Cocoon Number	9.083	11.167	13.000
Low Cocoon Number	0.667	-0.167	2.783
Double Cocoon Number	-3.333	0.750	0.652
Best Cocoon Percentage	11.517**a**	-3.130**b**	-1.497**b**
Middle Cocoon Percentage	7.417	3.598	0.937
Low Cocoon Percentage	-0.3396	-0.3158	0.8826
Double Cocoon Percentage	-1.571	-0.149	-0.321
Best Cocoon Weight	64.77	26.29	60.13
Double Cocoon weight	0.08	0.27	-13.15
Single Best Cocoon Weight	-0.8037	0.0054	0.5373
10000 Larvae Cocoon Weight	412.6	-153.8	-284.6
Larval Duration	0.5000	-0.9167	-0.3478
Hatched Larvae	68.04**a**	-3.21**b**	74.78**a**
Un-hatched eggs	7.000**a**	-4.333**ab**	-6.130**b**
Unfertilized eggs	-9.333	-1.333	-4.913
Hatched eggs percentage	1.043	0.712	2.631
Un-hatched eggs percentage	0.760	-0.938	-1.306
Unfertilized eggs percentage	-1.804	0.225	-1.326
Hatchability percentage	-0.715	0.940	1.390
Total produced eggs	65.71**a**	-8.88**b**	63.74**a**

**There is significant difference between the numbers that are shown with the different letter(s) in each row. Each row of data without any letter has not significant differences.*

The results of this research after select action in base community based on cocoon weight, for each line (three lines 32,104,110) separately and estimation of response to selection of studied traits (27 traits) during three generations in each line, and comparison response to selection of three lines with each other is represented in Table 1. It shall be noted that among 27 studied traits in this research, seven traits of low cocoon number, the percentage of low cocoons, larvae duration, the number of un-hatched eggs, the percentage of un-hatched eggs, the number of un-fertilized eggs and the percentage of un-fertilized eggs are part of sericulture industry and increasing in their rate mean un improvement and decreasing mean their improvement.

The comparison of performance of single selection system in base population and response to selection for trait of Alive Larvae Number

The results of this examination showed that selection in base population based on cocoon weight cause increasing alive larvae number in each three lines 32, 104,110. According to obtained results after selection action totally during three generation, the number of alive larvae in line 32 increased in amount of 30.670 larvae, and in line 104, in amount of 39.91 larvae respectively, and the rate of this trait in line 110 with 39.91 larvae were improved. But the comparison to response to selection of these three lines is not meaningful statistically ($p>0.05$).

The comparison of performance of single selection system in base population and response to selection for trait of Alive Pupae Number

The results of this examination showed that selection in base population based on cocoon weight cause increasing alive pupae number in each three lines 32, 104,110. According to obtained results after selection action totally during three generation, the number of alive pupae in line 32 increased in amount of 20.00 pupae, and in line 104, in amount of 23.67 pupae respectively, and the rate of this trait in line 110 with 34.74 pupae were improved. But the comparison to response to selection of these three lines is not meaningful statistically ($p>0.05$).

The comparison of performance of single selection system in base population and response to selection for trait of Pupae Vitality Percentage

The results of this examination showed that selection in base population based on cocoon weight observed increasing pupae vitality just in line 104 but decreased in line 32 and 110. Based on obtained results after selection action, the percentage of pupae vitality in line 104 increased in amount of 0.824, but in line 32 and 110 respectively,-2.378 and -1.760 percent was decreased. Although, this trait showed in one line increased and in next two lines decreased, but the comparison of response in theses three lines showed that the difference among response to these three lines, is not meaningful statistically ($p>0.05$).

The comparison of performance of single selection system in base population and response to selection for trait of Pupae Vitality Percentage (Best Cocoon)

The selection in base population based on pupae vitality percentage (best cocoon) during three generation in line 32 and 110 caused decreasing this trait in amount of -1.168% and -1.084 respectively but increased in line 104 in amount of 0.633%.after selection action and comparison of response in three line is not meaningful statistically ($p>0.05$).

The comparison of performance of single selection system in base population and response to selection for trait of Pupae Vitality Percentage (Middle Cocoon)

The selection in base population based on pupae vitality percentage (middle cocoon) during three generation in line 32 caused decreasing this trait in amount of -6.167% but increased in line 104 and 104 in amount of 8.552% and 0.023% respectively. After selection action and comparison of response in three line is meaningful statistically ($p<0.05$).

The comparison of performance of single selection system in base population and response to selection for trait of Produced Cocoon Number

Obtained results from this research showed that during three generations, the selection in base population based on cocoon weight caused increasing pupae vitality trait in middle cocoons in each three lines 32,104 and 110. Increasing this trait in line 32 equals 35.85 cocoon, in line 104 equals 22.96 and in line 110 equals 40.70 cocoon. With comparison carried out between responses to the selection of these three lines, no meaningful difference was observed ($p>0.05$).

The comparison of performance of single selection system in base population and response to selection for trait of Best Cocoon Number

Based on selection in base population based on cocoon weight during three generation in three lines 32,104,110 increased, with amount of 29.46, 11.21 and 24.26 respectively. With comparison carried out between responses to the selection of these three lines, no meaningful difference was observed ($p>0.05$).

The comparison of performance of single selection system in base population and response to selection for trait of Middle Cocoon Number

By the selection carried out based on base population, there was increased middle cocoon number for these three lines. Totally, during three selection generations, increasing rate for line 32 equals 9.083, for line 104, 11.167 and for line 110 equals 13.000. With comparison carried out between responses to the selection of these three lines, no meaningful difference was observed ($p>0.05$).

The comparison of performance of single selection system in base population and response to selection for trait of Low Cocoon Number

The selection in base population based on cocoon weight during three generation caused decreasing low cocoon number. `In line 104 in amount of 0.167 (improvement by selection) and increasing this trait observed in live 32 in amount of 0.667 and in line 110 in amount of 2.783 (un-improvement by selection). With comparison carried out between responses to the selection of these three lines, no meaningful difference was observed ($p>0.05$).

The comparison of performance of single selection system in base population and response to selection for trait of Double Cocoon Number

Based on cocoon weight, selection in base population caused decreasing trait of double cocoon number, totally during three generations in line 32 in amount of -3.333 but increasing in line 104 and 110 in amount of 0.750 and 0.652 respectively. With comparison carried out between responses to the selection of these three lines, no meaningful difference was observed ($p>0.05$).

The comparison of performance of single selection system in base population and response to selection for trait of Best Cocoon Percentage

By the selection carried out based on base population during three generation, the trait of best cocoon percentage increased in line 32 in amount of 11.517% but decreased this trait in line 104 in amount of -3.130% and in line 110 in amount of -1.497%. With different response to the trait of these three lines, meaningful difference was observed ($p<0.05$).

The comparison of performance of single selection system in base population and response to selection for trait of Middle Cocoon Percentage

During three generations selection, obtained results showed that in each three lines 32, 104 and 110, observed increasing trait of middle cocoon percentage. This showed that in line 32 was in amount of 7.417%, in line 104 in amount of 3.598% and in line 110 in amount of 0.937%. With different response to the trait of these three lines, no meaningful difference was observed ($p>0.05$).

The comparison of performance of single selection system in base population and response to selection for trait of Low Cocoon Percentage

The selection in base population based on cocoon weight during three generation in line 32 and 104 caused decreasing this trait in amount of -0.339% and -0.315% respectively (improvement by selection) but increased in line 110 in amount of 0.882% (un-improvement by selection). With comparison carried out between responses to the selection of these three lines, no meaningful difference was observed ($p>0.05$).

The comparison of performance of single selection system in base population and response to selection for trait of Double Cocoon Percentage

During three generations selection, obtained results showed that in each three lines 32, 104 and 110, observed decrease trait of double cocoon percentage. This showed that in line 32 was decreased in amount of -1.571%, in line 104 in amount of -0.149% and in line 110 in amount of -0.321%. With different response to the trait of these three lines, no meaningful difference was observed ($p>0.05$).

The comparison of performance of single selection system in base population and response to selection for trait of Best Cocoon Weight

During three generations selection, obtained results showed that in each three lines 32, 104 and 110, observed increase trait of best cocoon weight. This showed that in line 32 was increased in amount of 64.70gr, in line 104 in amount of 26.290gr and in line 110 in amount of 60.130gr. With different response to the trait of these three lines, no meaningful difference was observed ($p>0.05$).

The comparison of performance of single selection system in base population and response to selection for trait of Double Cocoon Weight

The selection in base population based on double cocoon weight during three generation in line 32 and 104 caused increased this trait in amount of 0.080gr and -0.270gr respectively but decreased in line 110 in amount of -13.150gr. With comparison carried out between responses to the selection of these three lines, no meaningful difference was observed ($p>0.05$).

The comparison of performance of single selection system in base population and response to selection for trait of Single Best Cocoon Weight

By the selection carried out based on base population during three generation, the trait of single best cocoon weight decreased only in line 32 in amount of -0.803gr but increased this trait in line 104 in amount of o.005gr and in line 110 in amount of 0.537gr. With different response to the trait of these three lines, no meaningful difference was observed ($p>0.05$).

The comparison of performance of single selection system in base population and response to selection for trait of 10000 Larvae Cocoon Weight

By the selection carried out based on base population during three generation, the trait of 10000 larvae cocoon weight increased in line 32 in amount of 412.600gr but decreased this trait in line 104 in amount of -153.800gr and in line 110 in amount of -284.600 gr. With different response to the trait of these three lines, no meaningful difference was observed ($p>0.05$).

The comparison of performance of single selection system in base population and response to selection for trait of Larvae Duration

The selection in base population based on larvae duration during three generation in line 104 and 110 caused decreasing this trait in amount of -0.916 and -0.347 hr respectively (improvement by selection) but increased in line 32 in amount of 0.500hr (un-improvement by selection). With comparison carried out between responses to the selection of these three lines, no meaningful difference was observed ($p>0.05$).

The comparison of performance of single selection system in base population and response to selection for trait of Hatched Larvae Number

By the selection carried out based on base population during three generation, the trait of hatched larvae number decreased in line 104 in amount of -3.210 larvae but increased this trait in line 32 and 110 in amount of 68.040 and 74.780 larvae respectively. With different response to the trait of these three lines, meaningful difference was observed ($p<0.05$).

The comparison of performance of single selection system in base population and response to selection for trait of Un-hatched Eggs Number

The selection in base population based on un-hatched eggs number during three generation in line 32 caused increasing this trait in amount of 7.000 eggs (un-improvement by selection) but decreased in line 104 and 110 in amount of -4.333 and -6.130 eggs respectively (improvement by selection). With comparison carried out between responses to the selection of these three lines, meaningful difference was observed ($p<0.05$).

The comparison of performance of single selection system in base population and response to selection for trait of un-fertilized eggs number

The selection in base population based on un-fertilized eggs number during three generation in line 32, 104 and 110 caused decreasing eggs (improvement by selection).according to obtained results after selection action, the un-fertilized eggs number decreased in line 32, 104 and 110 in amount of -9.333, -1.333 and -4.913 eggs respectively. With comparison carried out between responses to the selection of these three lines, no meaningful difference was observed ($p>0.05$).

The comparison of performance of single selection system in base population and response to selection for trait of Hatched Eggs Percentage

The selection in base population based on hatched eggs percentage during three generation in line 32, 104 and 110 caused increasing this trait in amount of 0.043%, 0.712% and 2.613% respectively. With comparison carried out between responses to the selection of these three lines, no meaningful difference was observed ($p>0.05$).

The comparison of performance of single selection system in base population and response to selection for trait of Un-hatched Eggs Percentage

The selection in base population based on un-hatched eggs percentage during three generation in line 32caused increasing this trait in amount of 0.760% (un-improvement by selection) and decrease in line 104 and 110 in amount of 0.938% and 0.306% respectively. It is noticed that decreasing this trait means improvement by selection is negative trait. With comparison carried out between responses to the selection of these three lines, no meaningful difference was observed ($p>0.05$).

The comparison of performance of single selection system in base population and response to selection for trait of Un-fertilized Eggs Percentage

The selection in base population based on un-fertilized eggs percentage during three generation in line 32and 110 caused decreasing eggs in amount of -1.804% and -1.326% respectively (improvement by selection) and increasing in line 104 in amount of 0.225% (un-improvement by selection). With comparison carried out between responses to the selection of these three lines, no meaningful difference was observed ($p>0.05$).

The comparison of performance of single selection system in base population and response to selection for trait of Hatchability Percentage

The selection in base population based on hatchability percentage during three generation in line 104 and 110 caused increasing this trait in amount of 0.940% and 1.390% respectively but decreased in line 32 in amount of -0.715%. With comparison carried out between responses to the selection of these three lines, no meaningful difference was observed ($p>0.05$).

The comparison of performance of single selection system in base population and response to selection for trait of Total Produced Eggs Number

The selection in base population based on total produced eggs number during three generation caused decreasing in line 104 only in amount of -0.88 eggs but increased in line 32 and 110 in amount of 65.71 and 63.74 eggs respectively. With comparison carried out between response to the selection of these three lines, meaningful difference was observed ($p<0.05$).

DISCUSSION

Although produced larvae eggs by commercial larvae eggs' suppliers have increased highly, but unfortunately, yet larvae suppliers and raw silkworm manufacturer face with larvae traits and united and uncoordinated cocoons.

Also, if it has been used of first generation population (F_1) for producing second generation (F_2) and distributing this kind of larvae egg, however, cost of larvae production decreased, this uncoordinated among offspring will become higher [3,4]. One war for solving partially this problem is different line crossing. This way called intercourse lines. Before intercourse within lines, with increasing generation number in each line, decreased variance between animal lines, but increased between lines. Then, intercourse was operated. It means in this way (intercourse line = line crossing), used from advantage of both increasing (Homozygote within a line, line differences). Animals with intense homolog, in most locus genetic positions are Homozygote cause that they produce gamete with lower variety. Within a Gamete with intensity homolog, genotype variance between animals is lowered. Therefore, produced gamete by this lines type over those which obtained from random population crossing is usually united. This unitary in centralized productive disciplines, which much more variety between populations may take account a fault, is very useful [5,6].

Breeding is way for generation optimization, having generations as parents next generation or having line is essential. Because main objective of silkworm is improving genetic sources due to useful economic characteristics, and this issue is practical. For breeding and various objectives in breeding, it is essential to conserve genetic source [7-9]. In practical situation, it is usually considered increasing more than one trait. It is possible to be independent correlation or having positive or negative correlation. Also the importance of different traits may not be the same. Therefore, beware of heritability and correlation among economic characteristics has high importance. For example, in a research, heritability capability trait to fluorine were studied and based on this specified research, controllers allele of this trait were control mostly by means of genes with additional effects [10,11]. In other research, genetic parameters economic characteristics six commercial lines of silkworm were estimated. In this research, for estimating different parameters of three traits of cocoon weight, cocoon shell weight, and silkworm shell cocoon percentage in six commercial lines of silkworm from successive five generation data was used. Variance and co-variance indicators were estimated by means of restricted maximal likelihood method (REML) based on three traits animal model. Other researchers have found that by analyzing eight traits have placed in two Chinese and three Japanese variety, parts of phenotype express, over pupae, cocoon shell weight, cocoon weight, silkworm shell percentage, 10000 larvae produced cocoon, and silkworm shell weigh of 10000 larvae under effect of addition genetic variance and other part under dominance variance but they have not observed epistatic effects about these traits. Also, they have stated that cocoon shell weight, cocoon shell percentage, 10000 larvae cocoon weight was mostly controlled by genes with relative dominance. But dominance variances have high effect on other studied traits. These researcher have also stated that heritability in the specified terms for traits of cocoon shell weight, cocoon shell percentage, 10000 larvae cocoon weight is more than other traits [2,12].

Some researchers have reported that productivity traits have more phenotype and genotype. Environmental effects have the most effect on productivity and cocoon shell weight. But larvae duration and silkworm shell percentage have relative low effect of environmental factors. Also, cocoon shell weight, cocoon shell percentage, and maximal larvae weight have high heritability but productivity and cocoon weight have middle heritability. Finally, larvae duration have low heritability and expected genetic improvement for cocoon weight and maximal larvae weight

was high and larvae duration over other traits was low [2, 13, 14]. Although, the main cause of genetic correlations is due to existing multi-oriented (pliotrophic), so gene linkage on a chromosome causes short-term correlation as well. Regression analysis showed that selection population, however, for higher oviparous depend on their pupae weight. But pupae weight should not be very high because sometimes cause slowing genetic oviparous improvement. This is because of in high pupae weights decreased correlation among pupae weight and oviparous. In addition, correlation between pupae and larvae weight, vitality percentage and silk fiber length is high [15]. Pupae traits are the most important economic characteristics and because of high heritability, direct efficiency selection on them is very high and genetic process of mean cocoon traits improvements, especially for cocoon shell weight is positive and meaningful. Also, obtained results of this research showed that mean difference the whole lines (31,103 and 107), based on three traits of cocoon weight, cocoon shell weight and cocoon shell weight is meaningful and constant line, generation and sex effects is also meaningful on these three traits showing different genetic commercial lines of silkworm, for this reason, it is essential for breeding optimization programs to apply lines with high genetic capacities. Positive genetic correlation and above two major and economic characteristics of cocoon weight and cocoon shell weight showed that selection for cocoon weight caused increasing cocoon shell weight and also, among cocoon weight and cocoon shell percentage, there is quantitative correlation and because of high genetic correlation among cocoon shell weight and two other traits in studied varieties, with selection in this trait can increase mean of two other traits. Cocoon shell weight trait is the most important factor and it is difficult to records them. Thus among above trait and cocoon weight, there is high genetic correlation, can increase another trait by selection of mean cocoon shell weight. Cocoon weight, cocoon shell weight and cocoon shell percentage have high inheritability as major traits of silkworm. Therefore, these traits over those which having low inheritability better response to selection.

The results of this research and comparison to response to selection of three commercial lines of silkworm 32,104 and 110 based on traits of pupae vitality percentage in middle, best cocoon percentage, hatched larvae number, un-hatched eggs number and total produced eggs is meaningful statistically. The results of this research show that among 27 traits, selection caused increasing 8 traits of 27 traits include: alive larvae number, alive pupae number, produced cocoon number, best cocoon number, middle cocoon weight, middle cocoon percentage, total best cocoon weight, and hatched eggs percentage in three commercial lines of silkworm 32, 104 and 110. In contrast, this increasing due to selection, rage of two traits of double cocoon percentage and un-hatched eggs percentage in these three studied lines is decreased. This means more interest and constantly has been considered by sericulture industry and silkworm breeding. Therefore, it should be noted that as numerical decreasing range not means fault in acted program and deficiency of carried out breeding plan and also, numerical increasing range of a trait not means efficiency of a breeding plan.

CONCLUSION

Totally, obtained reseals of this research have shown that selection in base population based on cocoon weight cause improvement of nine traits of 27 above traits, contemporary, in these above lines of silkworm 32,104 and 110 and comparison to response to these three lines showed that

the difference of response to selection of above lines is meaningful for these 5 traits statistically ($p<0.05$). In line 32, the most increasing trait by selection was for 10000 larvae cocoon weight (412.6g), in line 104 for total best cocoon weight (64.77g) and in line 110 for hatched larvae number (68.04 larvae).by comparison of above three line, there is meaningful trait for un-hatched eggs number statistically. There is only observed decreasing in un-fertilized eggs number trait, contemporary, in three lines 32, 104 and 110 (improvement by selection). Thus according to this issue, the most decreasing trait in this research in line 32 for un-fertilized eggs number (-9.33), in line 104 for un-hatched eggs number (-4.33) and in line 110 for un-hatched eggs number (-6.13) as well. It is suggested that other researchers carry out this research (estimation and comparison to response to selection) for other silkworm traits such as unconnected traits related to producing commercial cocoon (voltinism, multinism, inter-relation among multimolter, maturity, voltinism) and also qualitative traits in silkworm breeding (measurable genetic traits in silkworm such as larvae egg color, larvae marking, cocoon color, cocoon shape and offspring number) in these three lines.

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