

Full Length Research Paper

Comparison of response to selection in three peanut cocoon lines of silkworm during spring and autumn seasons

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The aim of this experiment was to study the season effect on response to selection in three Iranian silkworm pure lines. In the first year, a parental group was selected, recorded and coded for each 3 lines of 31, 103 and 107, which had further weight average than the population average. These parents were crossed with each other and a selected group was made for these three lines. Also, a parental group was chosen, recorded and coded for each of the three lines which include the weight average equal to population average weight. These parents also were crossed with each other and a coincidental group was made for these three lines in two spring and autumn seasons. The members of each group were grown up and crossed during three successive generations coincidentally with out any re selection. The 27 average records were registered and analyzed in two spring and autumn seasons. The data analysis showed that in spring, among three studied lines for larva vitality, the highest response to selection was shown by line 31 (2.706%) and line 103 (-4.489%), respectively and the least response belonged to line 107 (-5.064%). The comparison of response average to selection in these three lines also had no significant difference statistically ($P > 0.05$). In the same season, the highest response to selection for the number of produced cocoons was observed in line 103 (51.19 cocoon) and line 31 (25.56 cocoon), respectively in the base population. Also, the least response to the selection in the base population belonged to line 107 (22.44 cocoon). The comparison of average response to selection in these three lines showed no significant difference statistically ($P > 0.05$). Among these three studied lines for the best cocoon total weight in spring, the highest response in the base population belonged to line 103 (67.09 g) and line 31 (40.16 g), respectively and the least response to selection in base population belonged to line 107 (19.58 g). The comparison of response to selection in these three lines showed that there was no significant difference statistically ($P > 0.050$). Among the line for best single cocoon weight in spring, the highest response to selection in the base population belonged to line 31 (0.05888 g) and then line 103 (0.04075 g), respectively and the least response to selection belonged to line 107 (0.03863 g). The comparison of response average to selection among three lines showed that the difference of response to selection in lines was not significantly statistically ($P > 0.05$). Among lines for cocoon weight resulted from 10000 larva and in spring, the highest response to selection in the base population belonged to line 31 (728.3 g), then line 107 (401.9 g) and the least response was observed in line 103 (289.7 g). The comparison of response average to selection in lines shows that there is no significant difference statistically among these three lines ($P > 0.05$). Among the lines in autumn, for best single cocoons weight, the highest response to selection in base population belonged to line 107 (0.07700 g) and line 31 (0.05513 g), respectively and the least response to selection in line belonged to line 103 (-0.04657 g) in the base population. The comparison of response average to selection in these three lines has shown that there is a significant difference statistically for response to selection in lines ($P < 0.05$).

Key words: Silkworm, genotype, season, selection, performance.

INTRODUCTION

The sericulture industry depends on silkworm (*Bombyx mori* L.) rearing. The purpose of silkworm breeding is to gradually improve the valuable economical traits of animals to afford and increase the benefits of cocoon producer and the other parts of sericulture industry (Mirhosseini et al., 2005). The most valuable animal fiber and silk has been used to make luxurious fabrics with high quality in the past. Silk is one of the oldest world's best fibers having the natural warp and woof, strength, softness and beauty (Welford, 1969; Shelagh, 2004).

In estimating the economical genetic traits, Ghanipour et al. (2008) observed high positive correlation in six silkworm commercial lines and in two cocoon weights (from 0.827 to 0.936) that were matched with the results of Santahali et al. (1990). Cocoon tissue weight is the most important economical traits and it is difficult to take its record. Because there is a high genetic correlation between mentioned traits and cocoon weight, it is possible to make the tissue weight increase by selecting the cocoon weight (Ghanipour et al., 2008).

This aim of this experiment was to study the seasonal effect on response to selection in three Iranian silkworm pure lines (31, 103 and 107).

MATERIALS AND METHODS

The information used in this study and the single dependent records of the important economical traits included 3 pure commercial lines of 31, 103 and 107 Iran silkworm. This information was recorded, classified and saved in computer using excel software. The considered parameters included four generation used to compare the methods activity results. The record making of under studied traits was also done according to the instruction and standard protocol. After collecting the related data, the variation analysis and average SAS software was used to make comparison between the studied traits. In order to analyze the variation based on Completely Random Design (CRD) and also to compare the average, average comparison between traits was also done by Duncan's method and in a significant level ($\alpha=5\%$).

Based on having information in two separate seasons; spring and autumn, the seasonal effects in this data were separated and the response scale to selection was calculated and analyzed in each of the separate seasons. To estimate the genetic and environmental parameters, the considered traits of data that resulted from growing courses or generation were used for each of the lines.

In the beginning of the planning year, 40 female and 40 male cocoons which had weight average higher than the population average were selected, recorded and coded for each 3 lines of 31, 103 and 107. Then the female and male butterflies of these cocoons were intercrossed with each other and group members were selected in each line. At the same time, 80 cocoons were also chosen randomly, from the base population; and male and female butterflies were intercrossed with each other to make the random group in each line. So, each of the lines (31, 103 and 107) had two groups of random and selection, where in each group 8 silkworm

seeds products were brought up separately in the first generation. At the end of the first generation, 27 studied traits (31 random, 31 selection, 103 random, 103 selection, 107 random and 107 selection) were recorded and registered in each of the six groups. Any trait difference related to each line in two random and selection groups showed the response to selection of that trait in the related line. At the end of the first generation, 40 males and 40 females cocoons were randomly selected and intercrossed with each other in every one of the six studied groups to make the second-generation silkworm seed for each of the six groups. All the mentioned levels in the first generation were repeated in the second and third generations and the studied traits records were registered and crossed up in three continuous generations.

RESULTS

Spring season

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of live larvae number in spring season

Data analysis showed that among the three studied lines, the highest response to selection in zero generation belonged to lines 103 (51.38) and 31 (29.50), respectively and line 107 (26.06) had lower response to selection than other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of live pupae number in spring season

Data analysis showed that among the three studied lines, the highest response to selection in the zero generation belonged to lines 103 (36.19) and 31 (25.81), respectively and line 107 (14.13) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of pupae vitality percentage in spring season

Data analysis showed that among the three studied lines, the highest response to selection in the zero generation belonged to lines 31 (2.706%) and 103 (-4.489%), respectively and line 107 (-5.064%) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three

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studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of pupae vitality percentage (best cocoon) in spring season

Data analysis showed that among the three studied lines, the highest response to selection in the zero generation belonged to lines 31 (3.327%) and 103 (-3.583%), respectively and line 107 (-4.429%) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of pupae vitality percentage (middle cocoon) in spring season

Data analysis showed that among the three studied lines, the highest response to selection in the zero generation belonged to lines 31 (4.911%) and 103 (-3.149%), respectively and line 107 (-6.429%) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of produced cocoon number in spring season

Data analysis showed that among the three studied lines, the highest response to selection in zero generation belonged to lines 103 (51.19) and 31 (25.56), respectively and line 107 (22.44) had lower response to selection than other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of best cocoon number in spring season

Data analysis showed that among the three studied lines, the highest response to selection in the zero generation belonged to lines 103 (34.63) and 31 (17.63), respectively and line 107 (9.13) had lower response to

selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of middle cocoon number in spring season

Data analysis showed that among the three studied lines, the highest response to selection in the zero generation belonged to lines 103 (14.750) and 107 (12.250), respectively and line 31 (5.188) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of low cocoon number in spring season

Data analysis showed that among the three studied lines, the highest response to selection in zero generation belonged to lines 107 (2.063) and 103 (1.250), respectively and line 31 (-0.375) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of double cocoon number in spring season

Data analysis shows that among the three studied lines, the highest response to selection in zero generation belonged to lines 31 (3.125) and 103 (0.563), respectively and line 107 (-1.000) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of best cocoon percentage in spring season

Data analysis showed that among the three studied lines,

the highest response to selection in zero generation belonged to lines 31 (0.638%) and 103 (-1.432%), respectively and line 107 (-2.951%) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of middle cocoon percentage in spring season

Data analysis showed that among the three studied lines, the highest response to selection in zero generation belonged to lines 107 (2.583%) and 103 (1.713%), respectively and line 31 (0.368%) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of low cocoon percentage in spring season

Data analysis showed that among the three studied lines, the highest response to selection in zero generation belonged to lines 107 (1.321%) and 103 (0.054%), respectively and line 31 (-2.004%) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of double cocoon percentage in spring season

Data analysis showed that among the three studied lines, the highest response to selection in zero generation belonged to lines 31 (0.9994%) and 103 (-0.3344%), respectively and line 107 (-0.9538%) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were significant ($P < 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of best cocoon weight in spring season

Data analysis showed that among the three studied lines, the highest response to selection in zero generation belonged to lines 103 (67.09 g) and 31 (40.16 g), respectively and line 107 (19.58 g) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three

studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of double cocoon weight in spring season

Data analysis showed that among the three studied lines, the highest response to selection in zero generation belonged to lines 31 (-0.0238 g) and 103 (-0.0516 g), respectively and line 107 (-0.2588 g) had lower response to selection than other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of single best cocoon weight in spring season

Data analysis showed that among the three studied lines, the highest response to selection in zero generation belonged to lines 31 (0.05888 g) and 103 (0.04075 g), respectively and line 107 (0.03863 g) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Comparison of three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of 10000 larvae cocoon weight in spring season

Data analysis showed that among the three studied lines, the highest response to selection in zero generation belonged to lines 31 (728.3 g) and 107 (401.9 g), respectively and line 103 (289.7 g) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of larval duration in spring season

Data analysis showed that among the three studied lines, the highest response to selection in zero generation belonged to lines 103 (2.375) and 31 (-0.813), respectively and line 107 (-5.000) had lower response to

selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of hatched larvae in spring season

Data analysis showed that among the three studied lines, the highest response to selection in zero generation belonged to lines 107 (59.06) and 103 (55.13), respectively and line 31 (9.88) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of unhatched eggs in spring season

Data analysis showed that among the three studied lines, the highest response to selection in zero generation belonged to lines 31 (1.688) and 103 (-0.750), respectively and line 107 (-1.438) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of unfertilized eggs in spring season

Data analysis showed that among the three studied lines, the highest response to selection in zero generation belonged to lines 107 (8.44) and 103 (6.38), respectively and line 31 (-15.75) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of hatched eggs percentage in spring season

Data analysis showed that among the three studied lines, the highest response to selection in zero generation belonged to lines 31 (2.504) and 103 (0.406),

respectively and line 107 (-0.262) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of unhatched eggs percentage in spring season

Data analysis showed that among the three studied lines, the highest response to selection in zero generation belonged to lines 31 (0.203%) and 107 (-0.5999%), respectively and line 103 (-1.207%) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of unfertilized eggs percentage in spring season

Data analysis showed that among three studied lines, the highest response to selection in zero generation belonged to lines 107 (0.861%) and 103 (0.801%), respectively and line 31 (-2.704%) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of hatchability percentage in spring season

Data analysis showed that among the three studied lines, the highest response to selection in zero generation belonged to lines 103 (1.152%) and 107 (0.623%), respectively and line 31 (-0.076%) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of total produced eggs in spring season

Data analysis showed that among three studied lines, the

highest response to selection in zero generation belonged to lines 107 (66.06) and 103 (60.75), respectively and line 31 (-4.19) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Autumn season

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of alive larvae number in autumn season

Data analysis showed that among the three studied lines, the highest response to selection in zero generation belonged to lines 31 (51.88) and 107 (-16.63), respectively and line 103 (-56.43) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were significant ($P < 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of alive pupae number in autumn season

Data analysis showed that among the three studied lines, the highest response to selection in zero generation belonged to lines 103 (355.6) and 31 (37.1), respectively and line 107 (-20.9) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of pupae vitality percentage in autumn season

Data analysis showed that among the three studied lines, the highest response to selection in zero generation belonged to lines 103 (104.31%) and 107 (-1.56%), respectively and line 31 (-3.32%) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of pupae vitality percentage (best cocoon) in autumn season

Data analysis showed that among the three studied lines,

the highest response to selection in zero generation belonged to lines 103 (1.801%) and 107 (0.039%), respectively and line 31 (-3.083%) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of pupae vitality percentage (middle cocoon) in autumn season

Data analysis showed that among the three studied lines, the highest response to selection in zero generation belonged to lines 107 (-1.689%) and 31 (-5.319%), respectively and line 103 (-5.771%) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of produced cocoon number in autumn season

Data analysis showed that among the three studied lines, the highest response to selection in zero generation belonged to lines 31 (48.25) and 107 (-17.00), respectively and line 103 (-58.14) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were significant ($P < 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of best cocoon number in autumn season

Data analysis showed that among the three studied lines, the highest response to selection in zero generation belonged to lines 31 (39.38) and 107 (-17.75), respectively and line 103 (-68.43) had lower response to selection than other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were significant ($P < 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of middle cocoon number in autumn season

Data analysis showed that among the three studied lines,

the highest response to selection in zero generation belonged to lines 103 (16.57) and 31 (3.38), respectively and line 107 (-1.00) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of low cocoon number in autumn season

Data analysis showed that among the three studied lines, the highest response to selection in zero generation belonged to lines 103 (7.143) and 107 (2.500), respectively and line 31 (1.250) had lower response to selection than other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of double cocoon number in autumn season

Data analysis showed that among the three studied lines, the highest response to selection in zero generation belonged to lines 31 (4.250) and 103 (-0.750), respectively and line 107 (-13.429) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were significant ($P < 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of best cocoon percentage in autumn season

Data analysis showed that among the three studied lines, the highest response to selection in zero generation belonged to lines 31 (0.478%) and 107 (-1.575%), respectively and line 103 (-6.866%) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of middle cocoon percentage in autumn season

Data analysis showed that among the three studied lines,

the highest response to selection in zero generation belonged to lines 103 (7.879%) and 107 (0.763%), respectively and line 31 (-1.523%) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of low cocoon percentage in autumn season

Data analysis showed that among the three studied lines, the highest response to selection in zero generation belonged to lines 103 (2.270%) and 107 (1.191%), respectively and line 31 (0.129%) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of double cocoon percentage in autumn season

Data analysis showed that among the three studied lines, the highest response to selection in zero generation belonged to lines 31 (0.921%) and 107 (-0.378%), respectively and line 103 (-3.281%) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were significant ($P < 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of best cocoon weight in autumn season

Data analysis showed that among the three studied lines, the highest response to selection in zero generation belonged to lines 31 (67.99 g) and 107 (-6.45 g), respectively and line 103 (-107.29 g) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were significant ($P < 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of double cocoon weight in autumn season

Data analysis showed that among the three studied lines,

the highest response to selection in zero generation belonged to lines 31 (0.1631 g) and 107 (0.0213 g), respectively and line 103 (-0.3256 g) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of single best cocoon weight in autumn season

Data analysis showed that among the three studied lines, the highest response to selection in zero generation belonged to lines 31 (0.05513 g) and 107 (0.07700 g), respectively and line 103 (-0.04657 g) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were significant ($P < 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of 10000 larvae cocoon weight in autumn season

Data analysis showed that among the three studied lines, the highest response to selection in zero generation belonged to lines 107 (915.0 g) and 31 (346.5 g), respectively and line 103 (-797.2 g) had lower response to selection than other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were significant ($P < 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of larval duration in autumn season

Data analysis showed that among the three studied lines, the highest response to selection in zero generation belonged to lines 31 (0) and 103 (0), respectively and line 107 (0) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of hatched larvae in autumn season

Data analysis showed that among the three studied lines,

the highest response to selection in zero generation belonged to lines 103 (40.14) and 31 (5.38), respectively and line 107 (-39.38) had lower response to selection than other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of unhatched eggs in autumn season

Data analysis showed that among the three studied lines, the highest response to selection in zero generation belonged to lines 103 (1.14) and 107 (-7.13), respectively and line 31 (-10.50) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of unfertilized eggs in autumn season

Data analysis showed that among the three studied lines, the highest response to selection in zero generation belonged to lines 103 (8.571) and 31 (-8.625), respectively and line 107 (-11.125) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were significant ($P < 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of hatched eggs percentage in autumn season

Data analysis showed that among the three studied lines, the highest response to selection in zero generation belonged to lines 107 (2.550) and 31 (1.901), respectively and line 103 (-1.586) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of unhatched eggs percentage in autumn season

Data analysis showed that among the three studied lines, the highest response to selection in zero generation

belonged to lines 103 (0.2043%) and 31 (-0.4212%), respectively and line 107 (-0.9325%) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of unfertilized eggs percentage in autumn season

Data analysis showed that among the three studied lines, the highest response to selection in zero generation belonged to lines 103 (1.376%) and 31 (-1.480%), respectively and line 107 (-1.618%) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of hatchability percentage in autumn season

Data analysis showed that among the three studied lines, the highest response to selection in zero generation belonged to lines 107 (1.034%) and 31 (0.681%), respectively and line 103 (-0.223%) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

Comparison of the three studied lines for individual selection effect based on cocoon weight in zero generation on response to selection of total produced eggs in autumn season

Data analysis showed that among the three studied lines, the highest response to selection in zero generation belonged to lines 103 (50.29) and 31 (-13.75), respectively and line 107 (-57.63) had lower response to selection than the other lines. Meanwhile, statistical differences of response to selection among the three studied lines in this character were not significant ($P > 0.05$).

DISCUSSION

The first and the most important step in a reformatory program plan is to define and appoint the goal selection.

This stage is not considered in many inbreeding plans but it is necessary to present a long term selection program. The inbreeding goals actually distinguish the required direction for the flock genetic changes and must be exactly based on the economical truth of the breeding system. To appoint the inbreeding goal is to try to respond to the question of where are we going with this inbreeding program? (Ponzoni, 1993).

A reformer can change the population genetic traits with two methods (Falconer, 1990): the first is choosing members as the parents, which means selection. The second method is to control the parents' intercross which includes inbreeding and out-breeding. The animal reformatory is to use the scientific information and practical experiences for genetic improvement of animal's population or group. Genetic affords the basic principles to lead the inbreeding activities. Activities in ranch inbreeding have two parts (Mohit et al., 2008): choosing the best animals based on the prediction, which comes from their suitability, making superior genetic structure (genotype), using the breeding plans and different intercourse methods. In inbreeding, the most suitable condition can be made to select the best animal regarding purity and also the reformatory condition would be possible (Seidavi, 2010).

Selection is an important tool to change the genes abundance and to make more suitable members for a specific target. Selection may be defined as a kind of process in which some population members are preferred to the other members to make generation (Amanlou, 2005). Based on resource allocation theory, when the animal's resource availability would be limited, there would be an exchange between traits to allocate the resources. Thus the animals under genetic selection are gradually more at the risk of dangers caused by behavioral, physiologic and immunologic problem because of more selection emphasis on practical traits and less emphasis on related traits to suitability (Aggrey, 2003).

The real stable selection has two basic effects. First, this kind of selection acts in favor of the genotypes with the least variability (Curnow, 1964). So, except in the cases that the most invariable genotypes are heterozygotes, the stable selection stabilizes the genes which have more durability according to growing and breeding (Waddington, 1957). Second, this kind of selection declines the raising genetic variance of trait and this is done in two ways (Bulmer, 1971; Bulmer, 1976). The quicker effect and the first step is through making gametic instability. The second way of genetic variance decline is to change the genes abundance in places that influence the trait average (Mather, 1941; Robertson, 1956; Lewontin, 1974; Wright, 1969).

In defending a suitable selection strategy, different factors must be considered, which include the type, number of traits and their economical importance, inheritance taking and genetic correlation between traits,

genetical and economical response scale to selection, inbreeding aim, the variance type, the existed facilities and production and economical situations. A suitable method, which matches the existed conditions, must be used in lines selection. On the other hand, past studies show that silkworm economical traits have high inheritance taking, and phenotypical selection on individual traits have high efficiency. This research results can lead to the estimation of genetic parameters of increasing genetical and environmental co-variance; inheritance taking; and can increase environmental and phenotypical genetic correlation; cocoons weight traits, cocoon tissue weight and cocoon tissue percentage (Shabdini Pashaki, 2010).

Conclusion

Responses to selection were observed as follows: during spring, in line 31; 12 had the highest trait; nine, the least trait and six, average trait; in line 103, eight had the highest trait; two, the least trait and 17, average traits; in line 107, seven had the highest trait; six, the least trait and 13, average trait.

In autumn, in line 31, eight had the highest trait; six, the least trait and 13, average traits; in line 103, 13 had the highest trait; 11, the least trait and three, average traits; in line 107, five had the highest trait; four, the least trait and 13, average trait.

As a conclusion, in spring, line 31 had the highest functions in response to selection among the 27 mentioned traits, line 103 was the least of them and line 107 was the average among the two lines. In autumn, line 103 had the highest functions to response among the 27 mentioned traits and lines 31 and 107 had the least in both. In sum, line 31 had the highest responses to trait selection, line 103 was average and line 107 was the least.

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REFERENCES

- Aggrey SE (2003). Dynamic of relative growth rate in Japanese quail lines divergently selected for growth and their control. *Growth Dev. Aging.* 67(1): 47-54.
- Amanlou H (2005). (By: John Foster Lasely). *Genetics of Livestock Improvement.* Zanjan Univ. Press. p. 679.
- Bulmer MG (1971). The effect of selection on genetic variability. *Am. Nat.* 105: 201-211.
- Bulmer MG (1976). The effect of selection on variability: a simulation study. *Genet. Res.* 28: 101-117.
- Curnow RN (1964). The effect of continued selection of phenotypic intermediates on gene frequency. *Genet. Res.* 5: 341-353.
- Falconer DS (1990). *Introduction to quantitative genetics*, 3rd Edition. Jhon Wiley and Sons Ins. p. 438.
- Ghanipoor M, Mirhosseini SZ, Seidavi AR, Shadparvar A, Bizhannia AR (2008) Estimation of genetic parameters for economic traits in six pure lines of silkworm, *Bombyx mori*. L. *J. Agri. Sci. Guilan Univ.* 2(1): 31-38
- Lewontin RC (1974). *The Genetic Basis of Evolutionary Change.* Columbia Univ. New York.
- Mather K (1941). Variation and selection of Polygenic characters. *J. Genet.* 41: 159-193.
- Mirhosseini SZ, Ghanipoor M, Seidavi AR (2005). Study of genetic trend of biological and quantitative properties of silkworm in successive generations at non- randomized mating populations. *Proceeding of 2nd Animal Science Congress*, Sept. 4-5.
- Mohit A, Hasani Bafarani AR, Hamidian E (2008). (By: Legates JE, Warwick EJ). *Breeding and Improvement of Farm Animals.* Agricultural promotion, education and investigation organization. Karaj. p. 441.
- Ponzoni RW (1993). Genetic improvement of hair sheep in the tropics. *FAO Anim. Rome*, p. 101.
- Robertson A (1956). The effect of selection against extreme deviants based on deviation or on homozygosis. *J. Genet.* 54: 236-248.
- Satenahalli SB, Govindan R, Goud GV, Magadum SB (1990). Genetic parameters and correlation coefficient analysis in silkworm *Bombyx mori*. *Mysore J. Agr. Sci.* 24: 491-495.
- Seidavi A (2010). Relationship between season and Efficiency of Individual Selection in Six peanut and Oval Lines of Silkworm. *IACSIT Int. J. Eng. Tech.* 2: 211-214.
- Shabdini Pashaki A (2010). *Genetical Parameters Estimation of Three Commercial Lines Having Oval Cocoon in Iran.* MA Thesis. Islamic Azad University, Qaemshahr Branch.
- Shelagh V (2004). *Chinese silk: A cultural history.* London British Museum Press, p. 6-17.
- Waddington CH (1957). *The strategy of the genes.* Allen and Unwin, London.
- Welford T (1969). *The textile student manual.* 6th ition Isaac Pitman and Sons Ltd, Great Britain.
- Wright S (1969). *Evolution and the Genetics of populations.* Vol. 1. Genetic and Biometric Frequencies. Univ. Chicago, Chicago.