Study of the Reaction of Silkworm Hybrid and Line Varieties against Individual Selection in Spring and Autumn Seasons

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Abstract: In this program, existed data in Iran silkworm research center related to individual selection system was used. For data collection and data recording, researchers used standard forms of economical recording in silkworm and Excel Software and for statistical analysis we used Generalized Linear Models (GLM) of SAS Software. Data was recorded in Excel Software and analyzed with SAS Software and for comparing the average, Student t-test was used. In this study, 27 traits in 12 varieties including six lines and six hybrids in two Spring and Autumn were studied. Study results showed that selection increases the performance in silkworm varieties. The selection effect varied in different seasons. In all varieties in Autumn, pupae vitality percentage in middle cocoon, middle produced cocoon number, middle cocoon percentage, larvae duration and unfertilized larvae number were significantly increased ($p<0.05$). In all varieties in Spring, alive larvae number, alive pupae number, produced cocoon number, best produced cocoon number, middle produced cocoon number, total best cocoon weight, single best cocoon weight and hatched larvae number responded to selection and showed significant increase ($p<0.05$).

Key words: *Bombyx mori*, selection, economical traits, season, variety, Iran

INTRODUCTION

The increase of silk products used in the world is reducing or stopping sericulture activity in advanced countries due to land restriction for constructing mulberry fields, water required for water shading, expensive energy, providing suitable opportunities for developing countries to extend sericulture activities and silk production regarding to human source, low cost energy, prolific water and soil. It should be noted that sericulture, however is viewed as side activity but with developing technology and industrialization, there is the opportunity for more productivity and constant occupation so that in relative desired climate conditions due to rapid berry tree growth and silkworm breeding possibility for two or three times (in modest regions) and four to five times (in semi-tropical and tropical regions) can be as a full income supportive job in rural family income. Therefore, appropriate extension relating to climate conditions of different regions can play a valuable role as proper programs in removing some economical and social problems, especially exchange requirements in larvae breeding countries. Productive potential of each being are under three factors of genetic, environmental and mutual effects. Being genetic is responsible for major share if productive potential (Salehi, 2010). Yet, there are many

improvements in important economical traits of silkworm. Using variety of hybrids for cocoon production that started from early twenty century was the largest factor in reaching success during history. Now, more attempts for breeding a variety have focused with set of best traits (Bizhannia and Seidavi, 2008).

In individual or mass selection, only individual phonotype amount is considered. Here, phonotype term can be used for a trait in an individual or set of traits which integrated in an indicator. Individual selection has the most benefit when researchers can measure a trait in both gender and before puberty. Some traits such as growth rate, body efficiency prominence, wool weight and back fat thickness are part of this group of traits and for selection program to be effective. It is necessary to have efficient record of all individuals under the selection program.

Individual selection has great benefit in comparison to offspring test which due to high cost, only a few population individuals are tested because with this method, all the animals can be evaluated. Also, in this method, emissive individuals can be easily determined and ability records of animals in population can be easily obtained from family records.

There are many reports about silkworm genetics, nutrition and biochemistry (Seidavi, 2009, 2010a-c,

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2011a-c; Seidavi *et al.*, 2008, 2009) however, there is not efficient reports about effects of silkworm selection on obtained hybrids based on seasons.

The main selection role is gene redundancy change in community. Since, quantitative traits are controlled by many gene sites and each of these sites has low effects, on the other hand, phonotype amount of these traits may be affected under additive or un-additive gene effects or both of them. Gene redundancy change may be unrevealed, so researchers should use another method for measuring selection result with measurable quantities such as mean, variance and standard deviation which show community features. Selection performance is carried out by an adjustor so that beings of each generation divide into two selected and emissive groups and selected beings will be future generation parent. The important result of selection is mean community change called response to selection (Fatehi, 2007).

Selection is the most important part of silkworm breeding (Seidavi *et al.*, 2008). The diversity existence in population is necessary for selection success. Economical, silkworm traits are typically quantitative and affected by environmental factors. For obtaining suitable response to selection, researchers should identify that part of population diversity under effect of additive genetic factors and then after phenotype correction traits from constant and environmental effects, selection based on additive genetic value is carried out (Seidavi *et al.*, 2010).

Because of difference of heritability and standard deviation phenotype traits in different lines, response to selection amount for economical traits is not the same. Therefore, in studying response to selection amount and using the most effective breeding method for increasing silkworm lines performance, it is necessary to study heritability traits in used lines (Petkove and Nguyenvan, 1987; Naserani *et al.*, 2010).

For determining suitable selection strategy, researchers should consider different factors such as type and amount of traits and their economical importance, heritability and genetic correlation between traits, amount of economical and genetic response to selection, breeding object, charity type, existed facilities and production, economical conditions and use of proper selection method in lines selection. The performance of individual selection methods will improve lines performance. Researches have shown that the performance of selection indicating method in 3P line has genetic progress (Ghanipoor, 2002; Seidavi, 2005).

At present, selection systems in the world, sequence methods, independent emissive levels and selection indicator are considered and selecting parents based on

them. Proper, accurate and doctrinaire selection will improve quality and quantity variety performance during eugenics processes so that today they can use parameters such as genetic variance and covariance, correlation, heritability and economical coefficient traits for selection (Falconer, 1989; Kalpana, 1992; Anonymous, 1993; Ho, 1996).

The purpose of this research was to study line varieties and silkworm hybrid reaction against individual selection in Spring and Autumn seasons.

MATERIALS AND METHODS

In this method, six parental pure lines of Iran silkworm were recorded individually and forty males and forty females in each of these six parental lines as parents of selected groups and also forty males and forty females having average equal with average community in each one of these six parental lines as random groups were selected. In 2000, forty selected males and females with forty random males and females were intercourse and many children were obtained and then in 2001, eighty obtained butterfly products (forty selected butterfly products and forty random butterfly products) were cultured from eight selected butterfly products and eight random butterfly products that were recorded and intercourse separately in each line. In the next year 2002 as happened in the last year, eight selected butterfly products and eight random butterfly products were cultured and recorded. In the last year 2003 selected and random individuals in each line were intercourse as follows:

Hybrid 31×32: Forty random females from line 31 intercourses with forty random males from line 32 to produce random larvae egg hybrid 31×32. Also, forty random males from line 31 intercourses with forty random females from line 32 to produce random larvae egg hybrid 32×31. Then, forty selected females from line 31 intercourses with forty selected males from line 32 to produce selected larvae egg hybrid 31×32. Also, forty selected males from line 31 intercourses with forty selected females from line 32 to produced selected larvae egg hybrid 32×31.

Hybrid 32×31: Forty random females from line 32 intercourses with forty random males from line 31 to produce random larvae egg hybrid 32×31. Also, forty random males from line 32 intercourses with forty random females from line 31 to produce random larvae egg hybrid 31×32. Then, forty selected females from line 32 intercourse's with forty selected males from line 31 to

produce selected larvae egg hybrid 32×31. Also, forty selected males from line 32 intercourses with forty selected females from line 312 to produced selected larvae egg hybrid 31×32.

Hybrid 103×104: Forty random females from line 103 intercourses with forty random males from line 104 to produced random larvae egg hybrid 103×104. Also, forty random males from line 103 intercourse's with forty random females from line 104 to produce random larvae egg hybrid 104×103. Then, forty selected females from line 103 intercourse's with forty selected males from line 104 to produced selected larvae egg hybrid 103×104. Also, forty selected males from line 103 intercourse's with forty selected females from line 104 to produce selected larvae egg hybrid 104×103.

Hybrid 104×103: Forty random females from line 104 intercourses with forty random males from line 103 to produce random larvae egg hybrid 104×103. Also, forty random males from line 104 intercourses with forty random females from line 103 to produced random larvae egg hybrid 103×104. Then, forty selected females from line 104 intercourses with forty selected males from line 103 to produced selected larvae egg hybrid 104×103. Also, forty selected males from line 104 intercourses with forty selected females from line 103 to produce selected larvae egg hybrid 103×104.

Hybrid 107×110: Forty random females from line 107 intercourses with forty random males from line 110 to produce random larvae egg hybrid 107×110. Also, forty random males from line 107 intercourses with forty random females from line 110 to produce random larvae egg hybrid 110×107. Then, forty selected females from line 107 intercourses with forty selected males from line 110 to produce selected larvae egg hybrid 107×110. Also, forty selected males from line 107 intercourses with forty selected females from line 110 to produce selected larvae egg hybrid 110×107.

Hybrid 110×107: Forty random females from line 110 intercourses with forty random males from line 107 to produced random larvae egg hybrid 110×107. Also, forty random males from line 110 intercourses with forty random females from line 107 to produce random larvae egg hybrid 107×110. Then, forty selected females from line 110 intercourses with forty selected males from line 107 to produce selected larvae egg hybrid 110×107. Also, forty selected males from line 110 intercourses with forty selected females from line 107 to produce selected larvae egg hybrid 107×110.

So, in this study, 27 different traits of the six varieties of silkworms over individual selection of cocoon weight in three successive generations were tested and overall performance were mixed together. After data analysis, a total of six hybrid results (32×31, 31×32, 104×103, 103×104, 110×107 and 107×110) in Spring and Autumn were presented in years 2000-2003 from Iran silkworm research center.

Economic traits studied in this research: Traits studied were live larvae number, live pupae number, pupae vitality in best cocoons, pupae vitality in middle cocoons, produced cocoon number, best, middle, low and double cocoon number and percentage, double cocoon weight, 10000 larvae cocoon weight, larvae duration, hatched larvae number, un-hatched larvae number, unfertilized larvae number, hatched larvae percentage, un-hatched larvae percentage and total produced larvae.

Data collection tools and data analyzing method: For data collection and data recording, standard forms of economical recording in silkworm and Excel software in 2007 was used. For statistical analysis software SAS Software (Version 6.12) was used. Data was recorded in Excel Software and analyzed with SAS Software in 1997 and for comparing the average, t-student test was used.

RESULTS

The comparisons of total varieties in Autumn season
Comparison of parental selection lines based on cocoon weight from total varieties of surviving larvae number in Autumn season: Analysis results showed that selection in base community based on cocoon weight reduce surviving number of larvae from 350.49 larvae in random community to 304.23 larvae in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is not statistically significant (p>0.05).

Comparison of parental selection lines based on cocoon weight from total surviving number of pupae varieties in Autumn season: Analysis results showed that selection in base community based on cocoon weight reduce surviving number of pupae from 268.02 pupae in random community to 336.38 pupae in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is not statistically significant (p>0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of pupae vitality percentage in Autumn season: Analysis results showed that selection in base community based on cocoon weight increase

pupae vitality percentage from 90.96% in random community to 106.09% in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is not statistically significant (p>0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of pupae vitality percentage in best cocoon in Autumn season: Analysis results showed that selection in base community based on cocoon weight decrease pupae vitality percentage in best cocoon from 95.9306% in random community to 94.4770% in selected community. Comparison of average response to selection of this trait showed that the difference of the response to selection in this hybrid is not statistically significant (p>0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of pupae vitality percentage in middle cocoon in Autumn season: Analysis results showed that selection in base community based on cocoon weight decrease pupae vitality in middle cocoon from 90.044% in random community to 87.361% in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is statistically significant (p<0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of produced cocoon number in Autumn season: Analysis results showed that selection in base community based on cocoon weight increase produced cocoon number from 281.85 cocoons in random community to 296.55 cocoons in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is not statistically significant (p>0.05).

Comparison of parental selection lines based on cocoon weight from total best varieties of cocoon in Autumn season: Analysis results showed that selection in base community based on cocoon weight increase best cocoon number from 213.00 cocoons in random community to 216.55 cocoons in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is not statistically significant (p>0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of middle cocoon number in Autumn season: Analysis results showed that selection in base community based on cocoon weight increase middle cocoon number from 53.723 cocoons in random community to 63.617 cocoons in selected community.

Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is statistically significant (p<0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of low cocoon number in Autumn season: Analysis results showed that selection in base community based on cocoon weight increase low cocoon number from 5.915 cocoons in random community to 8.021 cocoons in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is not statistically significant (p>0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of double cocoon number in Autumn season: Analysis results showed that selection in base community based on cocoon weight decrease double cocoon number from 9.213 cocoons in random community to 8.362 cocoons in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is not statistically significant (p>0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of best cocoon percentage in Autumn season: Analysis results showed that selection in base community based on cocoon weight increase best cocoon percentage from 68.812% in random community to 71.170% in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is not statistically significant (p>0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of middle cocoon percentage in Autumn season: Analysis results showed that selection in base community based on cocoon weight increase middle cocoon percentage from 15.894% in random community to 22.387% in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is statistically significant (p<0.05).

Comparison of parental selection lines based on cocoon weight from low total varieties of low cocoon percentage in Autumn season: Analysis results showed that selection in base community based on cocoon weight increase low cocoon percentage from 2.2681% in random community to 2.6772% in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is not statistically significant (p>0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of double cocoon percentage in Autumn season: Analysis results showed that selection in base community based on cocoon weight decrease double cocoon percentage from 3.1230% in random community to 2.8194% in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is not statistically significant (p>0.05).

Comparison of parental selection lines based on cocoon weight total varieties of best cocoon weight in Autumn season: Analysis results showed that selection in base community based on cocoon weight increase total best cocoon weight from 303.05 g in random community to 323.99 g in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is not statistically significant (p>0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of double cocoon weight in Autumn season: Analysis results showed that selection in base community based on cocoon weight increase double cocoon weight from 2.78583 g in random community to 2.81356 g in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is not statistically significant (p>0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of single (best) cocoon weight in Autumn season: Analysis results showed that selection in base community based on cocoon weight decrease single best cocoon weight from 2.0741 g in random community to 1.7836 g in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is not statistically significant (p>0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of 10,000 pupae cocoon weight in Autumn season: Analysis results showed that selection in base community based on cocoon weight increase 10000 pupae cocoon weight from 14784.4 g in random community to 14898.4 g in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is not statistically significant (p>0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of larvae duration in Autumn season: Analysis results showed that selection in base

community based on cocoon weight decrease larvae duration from 640.6915 h in random community to 637.9468 h in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is statistically significant (p<0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of hatched larvae in Autumn season: Analysis results showed that selection in base community based on cocoon weight increase hatched larvae number from 455.30 numbers in random community to 469.28 numbers in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is not statistically significant (p>0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of un-hatched larvae number in Autumn season: Analysis results showed that selection in base community based on cocoon weight decrease un-hatched larvae number from 25.383 numbers in random community to 20.532 numbers in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is not statistically significant (p>0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of unfertilized larvae in Autumn season: Analysis results showed that selection in base community based on cocoon weight decrease unfertilized larvae number from 14.064 numbers in random community to 9.511 numbers in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is statistically significant (p<0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of hatched larvae percentage in Autumn season: Analysis results showed that selection in base community based on cocoon weight, increase hatched larvae percentage from 92.355% in random community to 93.839% in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is not statistically significant (p>0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of un-hatched larvae percentage in Autumn season: Analysis results showed that selection in base community based on cocoon weight

decrease un-hatched larvae percentage from 4.7996% in random community to 4.2011% in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is not statistically significant (p>0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of unfertilized larvae percentage in Autumn season: Analysis results showed that selection in base community based on cocoon weight decrease unfertilized larvae percentage from 2.8460% in random community to 1.9596% in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is not statistically significant (p>0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of hatched percentage in Autumn season: Analysis results showed that selection in base community based on cocoon weight increase hatched percentage from 95.0343% in random community to 95.7106% in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is not statistically significant (p>0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of produced larvae in Autumn season: Analysis results showed that selection in base community based on cocoon weight increase total produced larvae from 494.74 larvae in random community to 499.328 larvae in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is not statistically significant (p>0.05).

The comparison of total varieties in Spring season
Comparison of parental selection lines based on cocoon weight from total varieties of surviving larvae number in Spring season: Analysis results showed that selection in base community based on cocoon weight increase alive larvae number from 230.875 larvae in random community to 253.950 larvae in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is statistically significant (p<0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of surviving pupae number in Spring season: Analysis results showed that selection in base community based on cocoon weight increase surviving pupae number from 205.425 pupae in random community to 224.008 pupae in selected community.

Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is statistically significant (p<0.05).

Comparison of parental selection lines based on cocoon weight on from total varieties of pupae vitality percentage in Spring season: Analysis results showed that selection in base community based on cocoon weight increase pupae vitality percentage from 88.452% in random community to 87.600% in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is not statistically significant (p>0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of pupae vitality percentage of best cocoon in Spring season: Analysis results showed that selection in base community based on cocoon weight decrease pupae vitality percentage in best cocoon from 92.977% in random community to 92.673% in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is not statistically significant (p>0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of pupae vitality percentage of middle cocoon in Spring season: Analysis results showed that selection in base community based on cocoon weight increase pupae vitality in middle cocoon from 82.209% in random community to 82.282% in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is not statistically significant (p>0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of produced cocoon number in Spring season: Analysis results showed that selection in base community based on cocoon weight increase produced cocoon number from 222.025 cocoons in random community to 245.200 cocoons in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is statistically significant (p<0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of best cocoon number in Spring season: Analysis results showed that selection in base community based on cocoon weight increase best cocoon number from 161.992 cocoons in random community to 176.600 cocoons in selected community.

Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is statistically significant (p<0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of middle cocoon number in spring in Spring season: Analysis results showed that selection in base community based on cocoon weight increase middle cocoon number from 43.758 cocoons in random community to 51.692 cocoons in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is statistically significant (p<0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of low cocoon number in Spring season: Analysis results showed that selection in base community based on cocoon weight increase low cocoon number from 6.4667 cocoons in random community to 7.1000 cocoons in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is not statistically significant (p>0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of double cocoon number in Spring season: Analysis results showed that selection in base community based on cocoon weight were not decrease or increase double cocoon number and remained this trait as 9.8083 cocoons both random community and elected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is not statistically significant (p>0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of best cocoon percentage in Spring season: Analysis results showed that selection in base community based on cocoon weight decrease best cocoon percentage from 72.9072% in random community to 72.2739% in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is not statistically significant (p>0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of middle cocoon percentage in Spring season: Analysis results showed that selection in base community based on cocoon weight increase middle cocoon percentage from 19.61324% in random community to 20.6573% in selected community.

Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is not statistically significant (p>0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of low cocoon percentage in Spring season: Analysis results showed that selection in base community based on cocoon weight decrease low cocoon percentage from 3.1967% in random community to 3.1243% in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is not statistically significant (p>0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of double cocoon percentage in Spring season: Analysis results showed that selection in base community based on cocoon weight increase double cocoon percentage from 4.282% in random community to 6.399% in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is not statistically significant (p>0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of best cocoon weight in Spring season: Analysis results showed that selection in base community based on cocoon weight increase total cocoon weight from 290.408 g in random community to 324.617 g in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is statistically significant (p<0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of double cocoon weight in Spring season: Analysis results showed that selection in base community based on cocoon weight decrease double cocoon weight from 6.187 g in random community to 3.616 g in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is not statistically significant (p>0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of single best cocoon weight in Spring season: Analysis results showed that selection in base community based on cocoon weight increase single best cocoon weight from 1.79630 g in random community to 1.84341 g in selected community. Comparison of

average response to selection of this trait showed that the difference to the response to selection in this hybrid is statistically significant (p<0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of 10,000 pupae cocoon weight in Spring season: Analysis results showed that selection in base community based on cocoon weight increase 10000 pupae cocoon weight from 18898.3 g in random community to 19211.8 g in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is not statistically significant (p>0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of larvae duration in Spring season: Analysis results showed that selection in base community based on cocoon weight increase larvae duration from 594.2250 h in random community to 594.2667 h in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is not statistically significant (p>0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of hatched number of larvae in Spring season: Analysis results showed that selection in base community based on cocoon weight increase hatched larvae number from 488.883 numbers in random community to 530.842 numbers in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is statistically significant (p<0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of un-hatched number of larvae in Spring season: Analysis results showed that selection in base community based on cocoon weight increase un-hatched larvae number from 22.883 numbers in random community to 23.150 numbers in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is not statistically significant (p>0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of unfertilized number of larvae in Spring season: Analysis results showed that selection in base community based on cocoon weight decrease unfertilized larvae number from 20.450 numbers in random community to 17.992 numbers

in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is not statistically significant (p>0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of hatched larvae percentage in Spring season: Analysis results showed that selection in base community based on cocoon weight increase hatched larvae percentage from 92.0183% in random community to 92.9007% in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is not statistically significant (p>0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of un-hatched larvae percentage in Spring season: Analysis results showed that selection in base community based on cocoon weight decrease un-hatched larvae percentage from 4.1423% in random community to 3.8365% in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is not statistically significant (p>0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of unfertilized larvae percentage in Spring season: Analysis results showed that selection in base community based on cocoon weight decrease unfertilized larvae percentage from 3.8393% in random community to 3.2623% in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is not statistically significant (p>0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of hatched percentage in Spring season: Analysis results showed that selection in base community based on cocoon weight increase hatched percentage from 95.7259% in random community to 96.0617% in selected community. Comparison of average response to selection of this trait showed that the difference to the response to selection in this hybrid is not statistically significant (p>0.05).

Comparison of parental selection lines based on cocoon weight from total varieties of all produced larvae in Spring season: Analysis results showed that selection in base community based on cocoon weight increase total produced larvae from 532.217 larvae in random community to 571.983 larvae in selected community. Comparison of

average response to selection of this trait showed that the difference to the response to selection in this hybrid is not statistically significant (p>0.05).

DISCUSSION

Selection is one of the most important breeding bases and diversity existence in population is necessary for selection success. Silkworm economical traits are typically quantitative and effected by environmental factors (Seidavi *et al.*, 2010). Six parental lines include 31, 32, 103, 104, 107 and 110. For data collection and data recording was used as standard forms of economical recording in silkworm and Excel Software. For statistical analysis, software SAS was used. Data was recorded in Excel Software and analyzed with SAS Software and for comparing the average, Student t-test was used.

Ashoka and Govindan (1990) noted that traits of cocoon weight and cocoon shell weight have high heritability and genetic progress. Chatterjee *et al.* (1990) showed that cocoon traits are the most important silkworm economical traits and stated that due to high heritability, direct selection efficiency on them is very high. Reddy (1986) showed that genetic progress is positive and its significant mean improvement of cocoon weight especially based on cocoon shell weight.

Ksham *et al.* (1995) showed that there is high correlation among cocoon weight and cocoon shell weight, cocoon weight and cocoon shell percentage. Nagaraja *et al.* (1996) studied some genetic parameters of 17 different traits. Obtained results showed high heritability about fertility, maximum larvae weight, produced cocoon weight and number. Accordingly, individual and direct selection results of these traits have good genetic progress. Jayaswal *et al.* (2000) reported that cocoon weight and cocoon shell weight have high heritability.

In some of studied researches obtained, conflict against this study's results. Bhargava *et al.* (1993), Singh *et al.* (1998) and Malik *et al.* (1998) observed middle heritability in cocoon production and cocoon shell percentage indicating environmental effects.

Ashoka and Govindan (1994) and Bhargava *et al.* (1995) reported that the reason of cocoon number increase in per liter in Autumn over Spring is due to decreasing cocoon weight mean in Autumn season and this type of environmental effects cause larvae duration decrease in Autumn culture conditions over spring culture. Seidavi *et al.* (2010) reported significant and positive genetic process in estimating genetic parameters of pure

lines of commercial silkworm. In other studies conducted by Ghanipoor *et al.* (2006), genetic correlation of cocoon weight and cocoon shell weight were negative reported. Also, it is possible to create difference in lines which culture under same time and place conditions and diversity due to environmental effects on studied traits, so difference in heritability traits in different lines are due to additive genetic variance in lines (Pashaki, 2010).

CONCLUSION

In this research, different traits in six verities were studied and based on research results, it can be seen that selection increases performance in silkworm lines and hybrids and selection effect in different seasons are different. In all hybrids, traits such as surviving larvae number, produced cocoon number, single best cocoon weight and 10000 larvae cocoon weight showed significant increase. In all varieties in autumn season, traits such as pupae vitality percentage in middle cocoons, middle produced cocoon number, middle cocoon percentage, larvae duration and unfertilized egg number showed significant increase. In all varieties in spring season, traits such as surviving larvae number, surviving pupae number, produced cocoon number, best produced cocoon number, middle produced cocoon number, total best cocoon weight, single best cocoon weight and hatched larvae number showed significant increase.

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