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Determination and Comparison of Performance and Production Properties in Eight Iranian Silkworm Hybrids

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Abstract: This experiment was performed to estimate some important indicators of performance on commercial silkworm hybrids and to compare commercial hybrids of Iran silkworm due to its production characteristics and study of superior hybrid selection and performance. In this experiment, eggs of eight commercial silkworm hybrids including hybrids of 104×103, 103×104, 32×31, 31×32, 154×151, 151×154, 154×153 and 153×154 as a treatment in the form 4 repeats was used and every repeat was involved 50 Lavrhybrids. After nurturing hybrids and gaining different characteristics records, first variance analysis and average comparison of traits was performed then we use two methods of assessment index and sub-ordinate function to integrate and aggregate. According to the results based on evaluation index method, hybrid 154×151 with the 799.4063 score gains the highest rank and then it was the 31×32 hybrid. Hybrids 104×103 and 153×154 also obtained the lowest score. According to the Sub-Ordinate Function 31×32 hybrid also obtained the highest rank with 13057.43 score. About 151×154 hybrids and 153×154 also obtained the lowest score. Based on results in hybrid 31×32 beyond desired hybrids has higher yield potential and its use is recommended.

Key words: *Bombyx mori*, yield, index, hybrid, income, Iran

INTRODUCTION

Everything that is desired in any breeding program is genetically development and productive and economical characteristic progress to increase the product, reduces the production costs and finally increases the profits of producers. This goal in country sericulture is significantly palpable. In sericulture various economic characteristics in each step are considerable.

Introducing hybrids with proper genetic potential in multiple economic characteristics along with increasing sericulture income will insure this industry development. Silkworm variety is the most important item in silkworm industry and it is considered as key factor in egg quality determination and directly affects the silkworm quality (Zhao *et al*., 2007). Among the basic principles of genetics and eugenic methods we can mention to hydro vigor usage phenomena as one of the main strategies eugenic that has great role in reaching new and high production hybrids.

Ashoka and Govindan (1994) has studied 4 double cross hybrid performance obtained from varieties and tested their 10,000 Larvae cocoon weight, cocoon weight and its shell weight, silk shell percent and fibers length and researchers found that double cross hybrids have better performance. In another research Rao *et al*. (1997) express after surveying some features of multiple pure silkworm variety and related hybrids, multiple multi generation lines have lower weight than pure mono generation lines in cocoon weight. Ksham *et al*. (1995) with heritability analysis of few traits found that above traits has high heritability in domain of 0.48 up to 0.64 and traits related to the stability and competence has lower heritability in domain of 0.18 up to 0.25.

Bhargava *et al*. (1993) studies indicates that heritability of larval period, cocoon shell weight, fibers length, larval weight and larvae weight are very high. Also there was average heritability (<0.7), cocoon production (0.65) and cocoon shell percent (0.7) which was observed and indicates that these two traits are under environmental effects. Malik *et al*. (1999) and Sing *et al*. (1998) also in their researches reach to same results Ashoka and Govindan (1990) stated that cocoon weight traits and shell weight has shown high genetic progress and high heritability. Obtained results confirm effect of increasing genetic influences on above traits. This is while the average heritability oriented to the high level along with the slow genetic progress for cocoon shell percent shows that these traits are controlled by genes posses increasingly traits. Silkworm pure line crosses with each other lead to gaining a superior power of hybrids than parents in cocoon production and other productive

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traits. For these purpose extensive surveys has implemented on the hybrid power in silkworm (Kobayashi *et al*., 1968; Rao and Sahai, 1990). High percent of productive traits Heterosis can be explained by estimating the additive genetic variance and non additive of cocoon traits. In contrast non additive genetic variance has lower role in phenotypic appearance of resistance traits that is larvae death and pupa survival percent and it is expected that mentioned traits are less affected by the heterotic influence. Cocoon traits are of the most important economical traits of silkworm and due to high heritability (40-50%), direct selection performance on them is very high (Mirhosseini *et al*., 2007).

In a research performed by Vishkaee *et al*. (2008) it was clear that heterosis percentage of cocoon shell shows the lowest amount. So that for some hybrids heterosis is negative. Overall, the heterotic effect of cocoon shell weight and coccon weight is more than cocoon shell percent (Sing *et al*., 1990; Malik *et al*., 1999).

Previous studies indicate that native x Chinesehybrid average heterosisis more than native x Japanese hybrid average heterosis (Sing *et al*., 1990; Vishkaee *et al*., 2008). Totally native silkworm types of Iran has high general combining ability rather than modified types which currently are used for commercial silkworm production. So with regard to special combining ability and high heterosis of modified types hybrids and also native ones, possibility of native type usage in breeding programs can exist (Vishkaee *et al*., 2008). In quantitative traits, genetic correlation and heritability are considered along with each other (Sing *et al*., 1998; Seidavi *et al*., 2007).

The correlation between traits results from polytropy. Gene's linkage on a chromosome also leads to short time correlation. About silkworm (Sing *et al*., 1998) argue that more case selecting for more eggs depends on pupa's weight. But pupa's weight must not be very high because it will lead to genetic progress reduce. These scientists said that correlation beyond female pupa weight and laying in pupas with high weight reduces.

Sing *et al*. (1998) said that pupation rate traits and cocoon weight was affected by high dominance and both of them were affected by epistasis. Also pupation rate is under cytoplasm effects. Different researchers has reported laying trait heritability, larvae weight, larval period length, growth rate, cocoon weight, pupa's weight, shell's weight and finally silkworm cocoon percent in silkworm. In silkworm breeding traits correlation also has very high importance. Research results indicate that laying correlation with cocoon production power is negative. Produced cocoon amount correlation with survival was positive and laying correlation with female pupa weight is positive and laying correlation with butterfly weight is positive too (Ghanipoor, 2003; Seidavi *et al*., 2007). Kumar *et al*. (1995) shows that there is high correlation between cocoon weight traits, cocoon shell weight and also cocoon weight and cocoon shell percent. Jayswal *et al*. (2000) and Sofi *et al*. (1999) reported high genetic correlation beyond cocoon traits. Ksham *et al*. (1995) reported high positive genetic and phenotype correlation between total cocoon production and individual cocoon weight. They also reach to same results between cocoon shell weight traits and silk fiber length and expressed that selection for fiber length and Diner has positive effect on cocoon production increase (Seidavi *et al*., 2007). Until now these commercial hybrids of silkworm performance has not been compare and there is no precise and academic information about production performance degree and there is no meaningful or meaningless difference between performance and production features.

Therefore, this research purposes contains some important performance indexes estimating in commercial silkworm hybrids in Iran and surveying the performance and superior hybrid selection with regard to different quantitative and qualitative features to produce and provide the superior hybrids. Since there is some new silkworm hybrids in silkworm research center of the Iran, performance of these hybrids must be studied.

MATERIALS AND METHODS

The research location was placed in Iran Silkworm Research Center in Rasht, Pasikhan village in Guilan province of Iran. The implementation steps of this survey were performed in spring of 2008. In this experiment, eggs of eight commercial silkworm hybrids, including hybrids of 104×103, 103×104, 32×31, 31×32, 154×151, 151×154, 154×153 and 153×154 as a treatment in the form 4 repeats was used and every repeat was involved 50 larvae hybrids. This experiment was performed to study the productive and economical traits of these commercial hybrids and introducing the superior hybrid.

Silkworm's egg related to each one of these hybrids was taken from Iran silkworm research center. Silkworm eggs were stored under situation such 25°C and 80-75% humidity in hatching room for 12 days. After hatching, every hybrid was breed separately and under standard situations. Breeding in young silkworm period was performed by chopped leaves and paraffin paper coverage and in the adult period it was performed with leaves and branches. In cocoon webby stage, Mabshi will be used separately for each repeat. After larvae to pupa stages complementation within the cocoons (7 days after starting to webby stage), cocoon collecting and clean of each repeat was started. After breeding step, cocoons were categorized into 4 groups named, the best, the middle, the double and the low groups and after every determination of each group percent, complete shell and cocoon all the best cocoons of the repeats were weighed. Studied traits will involve alive larvae and pupa number, pupa vitality percent, produced cocoon number, best, middle, low and double cocoon number and percent, male and female cocoon weight, male and female silk shell weight, double cocoon weight, total produced cocoon weight, 1000 larvae cocoon weight, larval period, time needed for Mabshi of all the larvae, produced cocoon amount from 10,000 larvae within 4th instar and produced cocoon amount of each egg box. Different records of studied traits entered into the Excel. Then data received from computer and were statistically analyzed with SAS software. This experiment was performed in a completely randomized frame with 8 treatments (which are hybrids) and for repeat and within every repeat there were 50 larvae. Averages were compared with Duncan multi domain test. Statistical model was as follow:

$$Y_{ijk} = H+H_i+RK+e_{ijk}$$

Where:

Y_{ijk} = Record or observation
H = Average traits
H_i = ith hybrid effect
Rk = Rth repeat
E_{ijk} = Other factors effect

After evaluating and comparing average traits in Duncan method and providing SD (Standard Deviation) experimental data to detect the superior hybrid it is utilize from evaluation index method and sub-ordinat function (Mano *et al*., 1993; Rao *et al*., 2006). Used formula is as follow:

$$EI = [(A-B)/C]\times 10+50$$

Where:

A = Mean of particular trait in a hybrid
B = Overall mean of particular trait in total hybrids
C = Standard deviation
50 = Fixed value
10 = Standard unit

Formulas used in the method under transverse function were as follows (Gower, 1971):

$$Xu = (Xi-Xmin.)/(Xmax-Xmin.)$$

Where:

Xu = Sub ordinate function
Xi = Measurement of trait of tested breed
Xmin. = The minimum value of the trait among all the tested hybrids
Xmax. = The maximum value of the trait among all the tested hybrids

From total obtained numbers of these two methods, at the end by using defined formulas in excel, total evaluation index method and total sub ordinate function were used for introducing superior hybrid.

RESULTS AND DISCUSSION

Results of this experiment are shown in Table 1-4 and Fig. 1-61. In fresh larva weight trait in beginning of 1st instars, in studied hybrids to levels of performance were observed, hybrids 32×31 and 31×32 and 154×151 and 151×154 that significantly ($p<0.05$) with high performance level have placed in low performance level along with other hybrids showed differences. In larva weight in beginning of 2nd instars 103×104 significantly ($p<0.05$) has the highest performance while this hybrid in larva weight in beginning of 1st instars was in low level.

Hybrids 31×32, 104×103 and 154×151 have shown middle performance in terms of numerical that there is no significant deference between them and others. Between hybrids 32×31, 151×154, 153×154 and 154×153 there is no significant difference in this trait. In larva weight in beginning of 3rd instars hybrids 103×104 and 104×103 have highest weighty in this trait (0.02675 g). There is no significant difference between these two hybrids with hybrids 31×32 and 32×31 and 154×151 ($p>0.05$). Hybrid 104×103 had the highest record in larva weight in beginning of 4th instars (0.16650 g) which in this trait had no significant difference with hybrids 151×154, 153×154 ($p<0.05$). Studying results in larva weight in the beginning of 5th instars indicates that there is no significant difference between hybrids 103×104, 104×103 ($p>0.05$). But this trait amount in hybrid 103×104 was different with others ($p<0.05$). Hybrid 103×104 in larva weight in the finishing of 1st instars had the highest record in this trait but it did not significant difference with hybrid 31×32. Between these two mentioned hybrids and hybrids 32×31, 104×103, 151×154 and 154×151 there were no significant difference ($p>0.05$). But all of these hybrids have shown highest performance rather than two hybrids 153×154 and 154×153 ($p<0.05$). Hybrid 103×104 revealed highest record in larva weight in finishing of the 2nd instars (0.28 g). Despite this difference there were no significant difference between this hybrid and hybrids 31×32, 32×31,104×103, 151×154 and 154×151 ($p>0.05$). Hybrid 154×153 was at the lowest record in this trait (0.2375 g) which showed significant difference along with 31×32, 103×104, 104×103 and 151×154 ($p<0.05$) but it did not has significant difference with other hybrids ($p>0.05$). By evaluating this

Table 1: Evaluation index points based on individual traits

Hybrid traits	31×32	32×31	103×104	104×103	151×154	154×151	153×154	154×1533
Larva weight in beginning of 1st instar	60.00	60.00	40.000	40.00	60.00	60.00	40.00	40.000
Larva weight in beginning of 2nd instar	-809.63	6079.71	-797.343	-809.63	-817.83	-809.63	-821.93	-813.730
Larva weight in beginning of 3rd instar	55.75	54.31	58.620	58.62	47.13	45.69	42.82	37.070
Larva weight in beginning of 4th instar	49.22	50.18	57.410	63.20	54.52	44.64	44.88	35.960
Larva weight in beginning of 5th instar	44.13	53.27	64.410	61.80	47.01	42.00	42.00	45.370
Larva weight in finishing of 1st instar	73.51	62.53	77.650	63.02	-35.52	57.65	48.38	52.770
Larva weight in finishing of 2nd instar	54.20	48.82	59.580	55.54	52.86	48.82	43.45	36.730
Larva weight in finishing of 3rd instar	56.10	55.34	57.360	46.54	55.85	54.59	36.73	37.490
Larva weight in finishing of 4th instar	47.31	52.57	58.870	63.35	49.85	41.31	43.55	43.190
Larva weight in finishing of 5th instar	57.46	57.87	56.230	58.28	45.17	36.30	45.44	43.260
Larva gain in 1st instar	60.63	49.88	67.380	52.38	46.13	44.38	37.38	41.880
Larva gain in 2nd instar	53.26	51.95	40.890	53.91	53.91	50.65	50.00	45.440
Larva gain in 3rd instar	55.52	54.98	56.340	44.62	56.88	55.79	36.98	38.890
Larva gain in 4th instar	46.51	53.05	58.880	62.82	49.98	40.21	43.05	45.490
Larva gain in 5th instar	60.37	58.31	53.070	56.40	45.14	36.42	46.89	43.400
Larva gain in 1-5 instars	57.56	57.93	56.610	57.93	44.36	37.07	46.05	42.510
Best cocoon number	55.74	55.28	53.010	55.28	43.92	41.65	45.74	49.380
Best cocoon percentage	55.36	57.61	53.240	52.17	42.72	44.18	44.61	50.110
Fresh best cocoon weight	54.70	56.61	54.350	57.85	42.12	41.34	46.29	46.740
Dried best cocoon weight	54.74	56.37	54.330	57.92	42.08	41.47	46.34	46.750
Pupae vitality percentage in best cocoon	52.44	54.95	55.090	52.04	39.22	48.29	48.46	49.510
Middle cocoon number	43.96	43.96	47.040	51.16	49.10	52.18	59.38	53.210
Middle cocoon percentage	43.41	43.27	47.070	50.52	49.60	54.47	58.27	53.400
Fresh middle cocoon weight	47.49	43.81	46.770	51.16	50.11	46.95	59.12	54.590
Dried middle cocoon weight	46.70	48.98	45.890	50.78	49.35	46.13	58.53	53.640
Pupae vitality percentage in middle cocoon	60.57	53.19	52.980	50.63	48.98	40.69	50.72	42.240
Low cocoon number	42.94	46.37	48.660	44.09	41.13	66.93	66.93	42.940
Low cocoon percentage	49.84	50.53	50.850	50.06	49.50	49.62	49.76	49.840
Fresh low cocoon weight	43.25	42.30	19.620	34.73	91.27	55.13	65.05	48.660
Dried low cocoon weight	-235.52	236.12	-787.540	-489.07	1135.80	103.41	538.74	-101.904
Pupae vitality percentage in low cocoon	42.12	42.12	42.120	42.12	60.14	77.14	52.13	42.120
Double cocoon number	56.48	48.20	39.920	56.48	44.06	48.20	56.48	50.180
Double cocoon percentage	51.23	49.39	47.820	51.37	48.82	49.64	51.62	50.110
Fresh double cocoon weight	43.18	57.93	73.530	30.11	56.63	41.15	52.06	45.400
Dried double cocoon weight	44.50	57.07	69.080	33.30	55.30	42.72	51.70	46.320
Pupae vitality percentage in double cocoon	65.45	65.45	61.130	15.74	65.45	15.74	45.57	65.450
Total produced cocoon number	53.08	50.94	50.940	55.22	47.72	42.37	50.40	49.330
Total produced cocoon weight	53.12	53.42	54.150	56.26	38.56	45.51	50.40	48.580
Total produced fresh cocoon weight	51.88	52.18	59.610	56.10	44.88	41.79	48.25	45.300
Alive larvae number	48.23	48.23	48.230	62.38	48.23	48.23	48.23	48.230
Pupae vitality percentage in total cocoon	86.75	89.95	90.200	85.00	72.45	78.88	80.88	83.850
Male fresh cocoon weight	51.63	58.58	55.970	63.35	43.81	41.21	44.25	41.210
Male dried cocoon weight	49.74	58.81	56.520	63.81	44.01	41.39	44.46	41.250
Male fresh cocoon shell weight	50.05	60.24	56.420	61.92	42.09	36.27	49.33	43.680
Male dried cocoon shell weight	49.98	60.22	56.500	62.03	42.09	36.38	49.16	43.630
Male fresh cocoon percentage	49.41	59.77	56.040	59.09	41.97	34.68	52.82	46.210
Male dried cocoon percentage	50.51	59.67	55.810	59.00	41.92	34.56	52.31	46.220
Female fresh cocoon weight	56.07	54.82	53.080	56.32	49.10	48.85	43.37	38.390
Female dried cocoon weight	55.72	55.01	53.320	55.72	49.27	49.01	43.46	38.500
Female fresh shell cocoon weight	54.12	56.31	54.300	55.60	44.29	42.10	53.47	39.790
Female dried shell cocoon weight	54.07	56.29	54.270	55.62	44.28	42.19	53.59	39.690
Female fresh cocoon percentage	52.37	56.03	54.540	54.13	43.43	41.13	56.57	41.800
Female dried cocoon percentage	53.12	44.40	53.830	53.68	40.36	48.80	55.81	49.990
Fresh cocoon weight	54.59	56.56	54.290	60.36	45.94	44.42	44.73	39.110
Dried cocoon weight	48.45	62.58	48.500	48.77	48.10	48.04	47.77	47.780
Fresh shell cocoon weight	48.36	62.74	48.640	48.85	47.72	47.58	48.40	47.700
Dried shell cocoon weight	48.49	62.67	48.560	48.74	47.84	47.63	48.35	47.720
Fresh cocoon shell percentage	51.04	58.35	55.630	56.78	42.17	37.40	55.31	43.320
Dried cocoon shell percentage	51.41	57.75	55.030	56.34	41.76	36.96	56.44	44.300
10000 larva fresh cocoon weight	53.02	58.79	57.910	56.04	40.66	43.27	44.72	45.580
10000 larva dried cocoon weight	52.61	58.80	57.890	56.07	40.78	43.37	44.82	45.660

Table 2: Evaluation index points based on total traits

Hybrid	31×32	32×31	103×104	104×103	151×154	154×151	153×154	154×153
Evaluation index points based on total traits	2943.03	3540.60	2505.90	2750.00	4063.80	2869.70	3318.90	2676.00

Table 3: Sub-ordinate function points based on individual traits

Hybrid traits	31×32	32×31	103×104	104×103	151×154	154×151	153×154	154×153
Larva weight in beginning of 1st instar	1.00	1.00	0.00	0.00	1.00	1.00	0.00	0.00
Larva weight in beginning of 2nd instar	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Larva weight in beginning of 3rd instar	0.87	0.80	1.00	1.00	0.47	0.40	0.27	0.00
Larva weight in beginning of 4th instar	0.49	0.52	0.79	1.00	0.68	0.32	0.33	0.00
Larva weight in beginning of 5th instar	0.10	0.50	1.00	0.88	0.22	0.00	0.00	0.15
Larva weight in finishing of 1st instar	0.96	0.87	1.00	0.87	0.00	0.82	0.74	0.78
Larva weight in finishing of 2nd instar	0.76	0.53	1.00	0.82	0.71	0.53	0.29	0.00
Larva weight in finishing of 3rd instar	0.76	0.53	1.00	0.82	0.71	0.53	0.29	0.00
Larva weight in finishing of 4th instar	0.27	0.51	0.80	1.00	0.39	0.00	0.10	0.09
Larva weight in finishing of 5th instar	0.96	0.98	0.91	1.00	0.40	0.00	0.42	0.32
Larva gain in 1st instar	0.78	0.42	1.00	0.50	0.29	0.23	0.00	0.15
Larva gain in 2nd instar	0.95	0.85	0.00	1.00	1.00	0.75	0.70	0.35
Larva gain in 3rd instar	0.93	0.90	0.97	0.38	1.00	0.95	0.00	0.10
Larva gain in 4th instar	0.28	0.57	0.83	1.00	0.43	0.00	0.13	0.23
Larva gain in 5th instar	1.00	0.91	0.70	0.83	0.36	0.00	0.44	0.29
Larva gain in 1-5 instars	0.98	1.00	0.94	1.00	0.35	0.00	0.43	0.26
Best cocoon number	1.00	0.97	0.81	0.97	0.16	0.00	0.29	0.55
Best cocoon percentage	0.85	1.00	0.71	0.63	0.00	0.10	0.13	0.50
Fresh best cocoon weight	0.81	0.93	0.79	1.00	0.05	0.00	0.30	0.33
Dried best cocoon weight	0.81	0.91	0.78	1.00	0.04	0.00	0.30	0.32
Pupae vitality percentage in best cocoon	0.83	0.99	1.00	0.81	0.00	0.57	0.58	0.65
Middle cocoon number	0.00	0.00	0.20	0.47	0.33	0.53	1.00	0.60
Middle cocoon percentage	0.01	0.00	0.25	0.48	0.42	0.75	1.00	0.68
Fresh middle cocoon weight	0.24	0.00	0.19	0.48	0.41	0.20	1.00	0.70
Dried middle cocoon weight	0.06	0.24	0.00	0.39	0.27	0.02	1.00	0.61
Pupae vitality percentage in middle cocoon	1.00	0.63	0.62	0.50	0.42	0.00	0.50	0.08
Low cocoon number	0.07	0.20	0.29	0.11	0.00	1.00	1.00	0.07
Low cocoon percentage	0.26	0.77	1.00	0.42	0.00	0.09	0.19	0.26
Fresh low cocoon weight	0.33	0.32	0.00	0.21	1.00	0.50	0.63	0.41
Dried low cocoon weight	0.29	0.53	0.00	0.16	1.00	0.46	0.69	0.36
Pupae vitality percentage in low cocoon	0.00	0.00	0.00	0.00	0.51	1.00	0.29	0.00
Double cocoon number	1.00	0.50	0.00	1.00	0.25	0.50	1.00	0.62
Double cocoon percentage	0.90	0.41	0.00	0.93	0.26	0.48	1.00	0.60
Fresh double cocoon weight	0.30	0.64	1.00	0.00	0.61	0.25	0.51	0.35
Dried double cocoon weight	0.31	0.66	1.00	0.00	0.61	0.26	0.51	0.36
Pupae vitality percentage in double cocoon	1.00	1.00	0.91	0.00	1.00	0.00	0.60	1.00
Total produced cocoon number	0.83	0.67	0.67	1.00	0.42	0.00	0.63	0.54
Total produced cocoon weight	0.82	0.84	0.88	1.00	0.00	0.39	0.67	0.57
Total produced fresh cocoon weight	0.57	0.58	1.00	0.80	0.17	0.00	0.36	0.20
Alive larvae number	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00
Pupae vitality percentage in total cocoon	0.81	0.99	1.00	0.71	0.00	0.36	0.47	0.64
Male fresh cocoon weight	0.47	0.78	0.67	1.00	0.12	0.00	0.14	0.00
Male dried cocoon weight	0.38	0.78	0.68	1.00	0.12	0.01	0.14	0.00
Male fresh cocoon shell weight	0.54	0.93	0.79	1.00	0.23	0.00	0.51	0.29
Male dried cocoon shell weight	0.53	0.93	0.78	1.00	0.22	0.00	0.50	0.28
Male fresh cocoon percentage	0.59	1.00	0.85	0.97	0.29	0.00	0.72	0.46
Male dried cocoon percentage	0.64	1.00	0.85	0.97	0.29	0.00	0.71	0.46
Female fresh cocoon weight	0.99	0.92	0.82	1.00	0.60	0.58	0.28	0.00
Female dried cocoon weight	1.00	0.96	0.86	1.00	0.63	0.61	0.29	0.00
Female fresh shell cocoon weight	0.87	1.00	0.88	0.96	0.27	0.14	0.83	0.00
Female dried shell cocoon weight	0.87	1.00	0.88	0.96	0.28	0.15	0.84	0.00
Female fresh cocoon percentage	0.73	0.96	0.87	0.84	0.15	0.00	1.00	0.04
Female dried cocoon percentage	0.83	0.26	0.87	0.86	0.00	0.55	1.00	0.62
Fresh cocoon weight	0.73	0.82	0.71	1.00	0.32	0.25	0.26	0.00
Dried cocoon weight	0.05	1.00	0.05	0.07	0.02	0.02	0.00	0.00
Fresh shell cocoon weight	0.05	1.00	0.07	0.08	0.01	0.00	0.05	0.01
Dried shell cocoon weight	0.06	1.00	0.06	0.07	0.01	0.00	0.05	0.01
Fresh cocoon shell percentage	0.65	1.00	0.87	0.93	0.23	0.00	0.85	0.28
Dried cocoon shell percentage	0.70	1.00	0.87	0.93	0.23	0.00	0.94	0.35
10000 larva fresh cocoon weight	0.68	1.00	0.95	0.85	0.00	0.14	0.22	0.27
10000 larva dried cocoon weight	0.66	1.00	0.95	0.85	0.00	0.14	0.22	0.27

Table 4: Sub-ordinate function points based on total traits

Hybrid	31×32	32×31	103×104	104×103	151×154	154×151	153×154	154×153
Sub-ordinate function points based on total traits	36.68	43.13	40.30	42.31	20.70	15.89	27.18	16.79

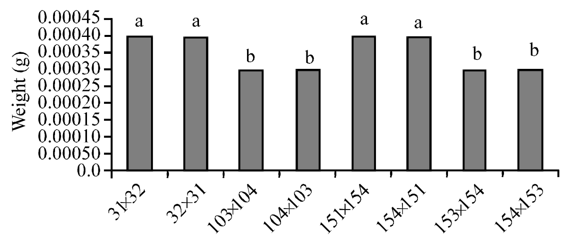

Fig. 1: Comparison of larva weight in beginning of 1st instar trait in studied hybrids

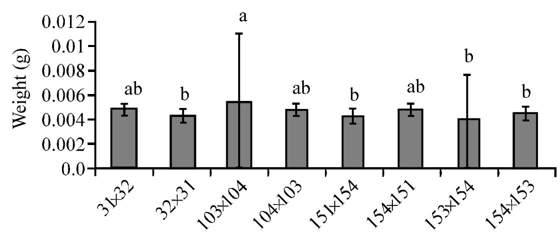

Fig. 2: Comparison of larva weight in beginning of 2nd instar trait in studied hybrids

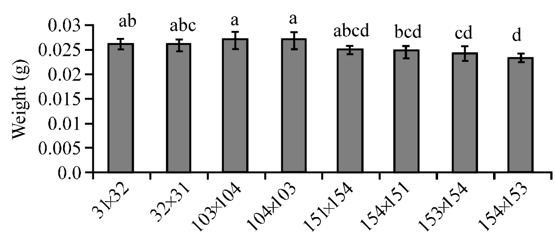

Fig. 3: Comparison of larva weight in beginning of 3rd instar trait in studied hybrids

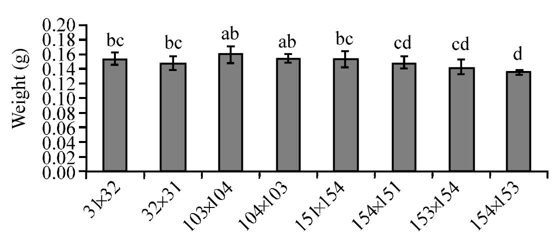

Fig. 4: Comparison of larva weight in beginning of 4th instar trait in studied hybrids

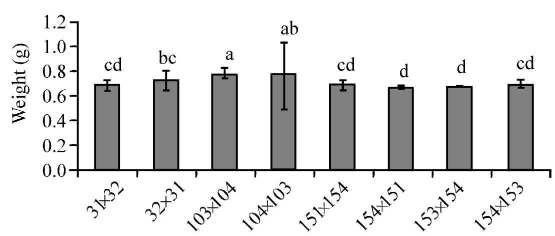

Fig. 5: Comparison of larva weight in beginning of 5th instar trait in studied hybrids

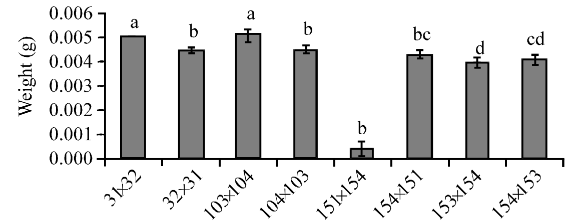

Fig. 6: Comparison of larva weight in finishing of 1st instar trait in studied hybrids

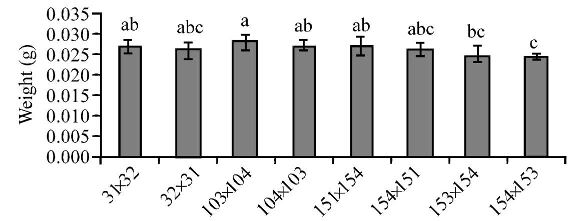

Fig. 7: Comparison of larva weight in finishing of 2nd instar trait in studied hybrids

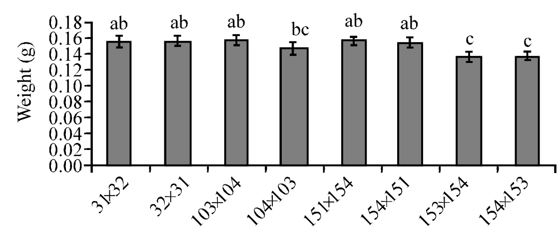

Fig. 8: Comparison of larva weight in finishing of 3rd instar trait in studied hybrids

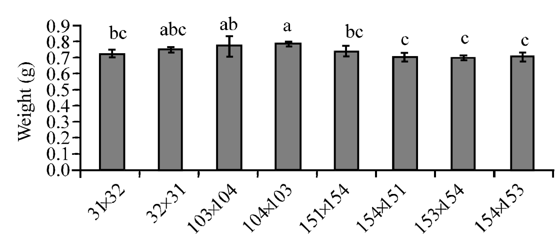

Fig. 9: Comparison of larva weight in finishing of 4th instar trait in studied hybrids

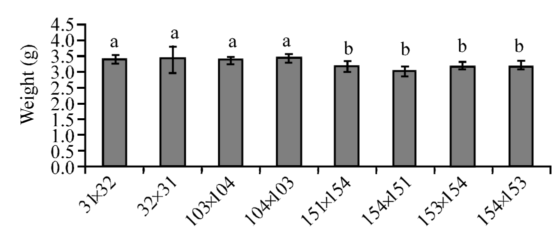

Fig. 10: Comparison of larva weight in finishing of 5th instar trait in studied hybrids

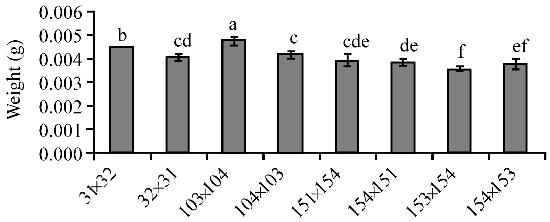

Fig. 11: Comparison of larva gain in 1st instar trait in studied hybrids

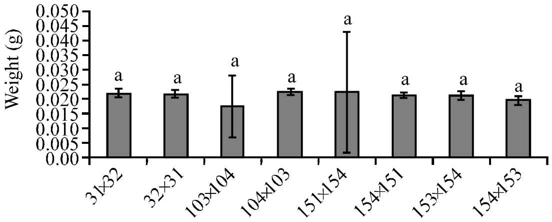

Fig. 12: Comparison of larva gain in 2nd instar trait in studied hybrids

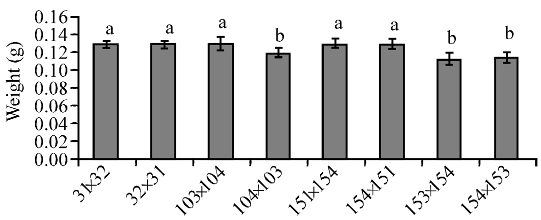

Fig. 13: Comparison of larva gain in 3rd instar trait in studied hybrids

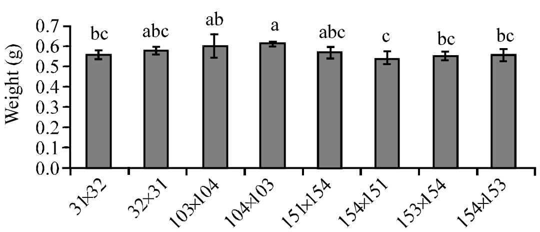

Fig. 14: Comparison of larva gain in 4th instar trait in studied hybrids

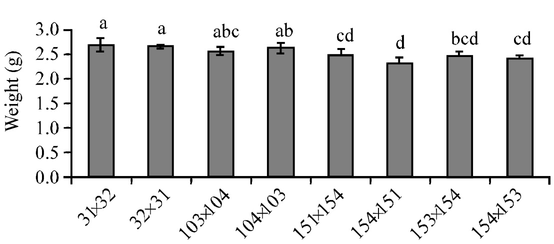

Fig. 15: Comparison of larva gain in 5th instar trait in studied hybrids

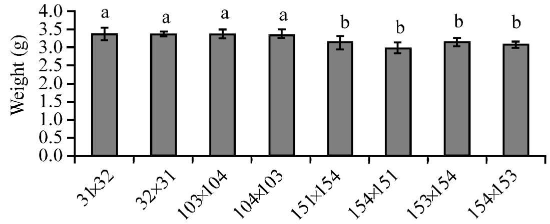

Fig. 16: Comparison of larva gain in 1-5 instar trait in studied hybrids

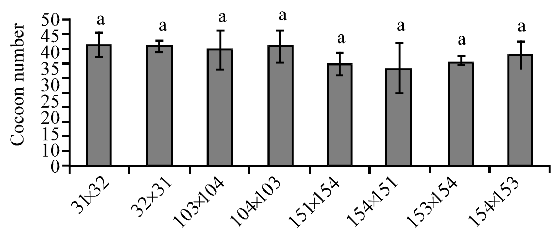

Fig. 17: Comparison of best cocoon number trait in studied hybrids

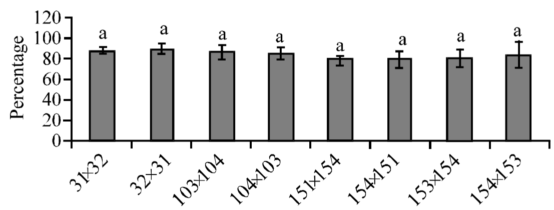

Fig. 18: Comparison of best cocoon percentage trait in studied hybrids

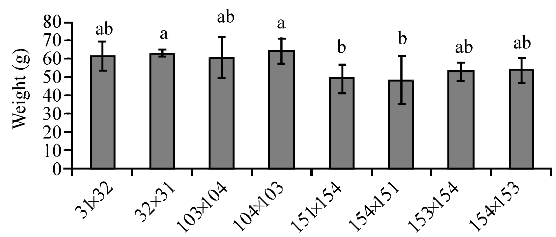

Fig. 19: Comparison of fresh best cocoon weight rait in studied hybrids

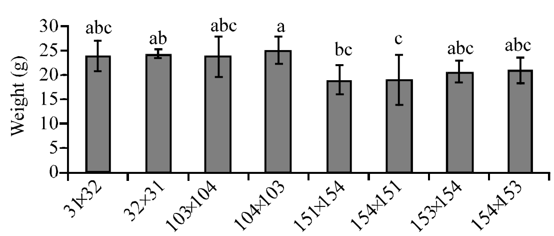

Fig. 20: Comparison of dried best cocoon weight trait in studied hybrids

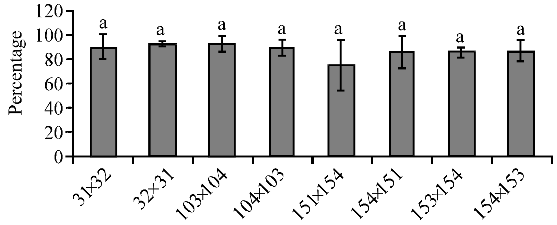

Fig. 21: Comparison of pupae vitality percentage in best cocoon trait in studied hybrids

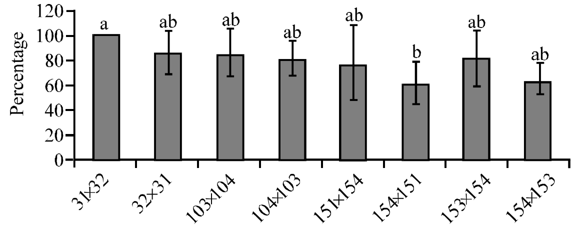

Fig. 26: Comparison of pupae vitality percentage in middle cocoon trait in studied hybrids

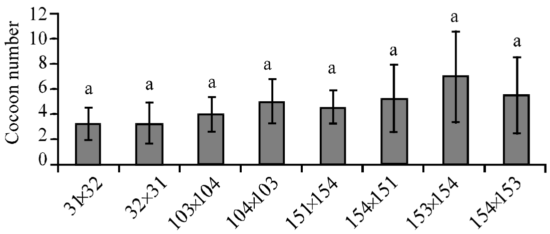

Fig. 22: Comparison of middle cocoon number trait in studied hybrids

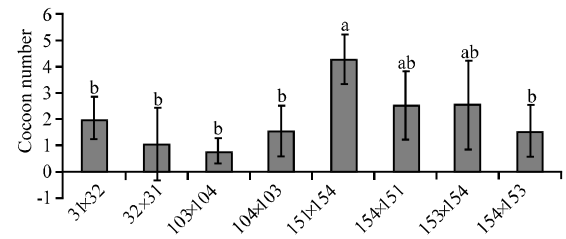

Fig. 27: Comparison of low cocoon number trait in studied hybrids

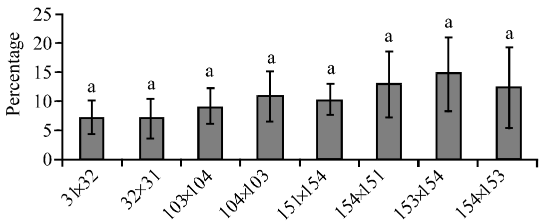

Fig. 23: Comparison of middle cocoon percentage trait in studied hybrids

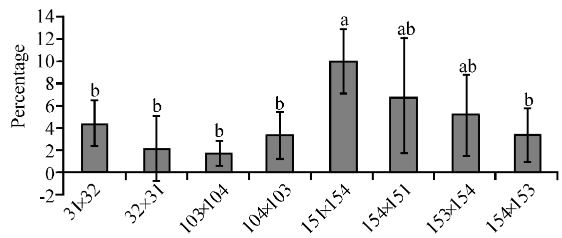

Fig. 28: Comparison of low cocoon percentage trait in studied hybrids

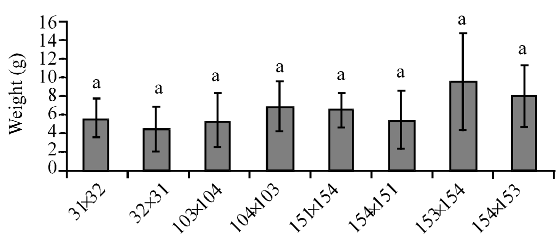

Fig. 24: Comparison of fresh middle cocoon weight trait in studied hybrids

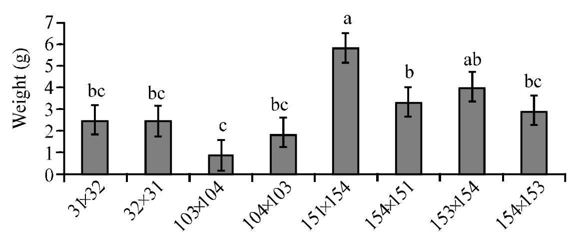

Fig. 29: Comparison of fresh low cocoon weight trait in studied hybrids

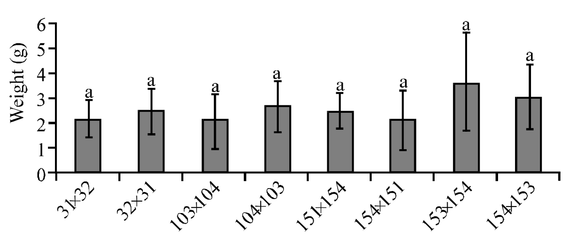

Fig. 25: Comparison of dried middle cocoon weight trait in studied hybrids

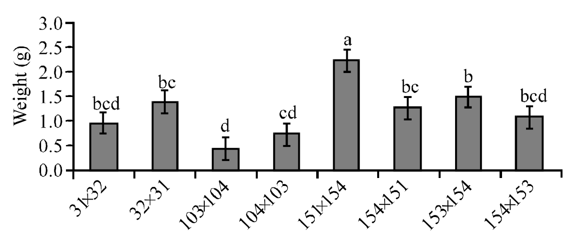

Fig. 30: Comparison of dried low cocoon weight trait in studied hybrids

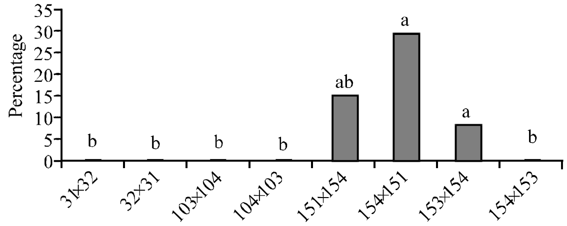

Fig. 31: Comparison of pupae vitality percentage in low cocoon trait in studied hybrids

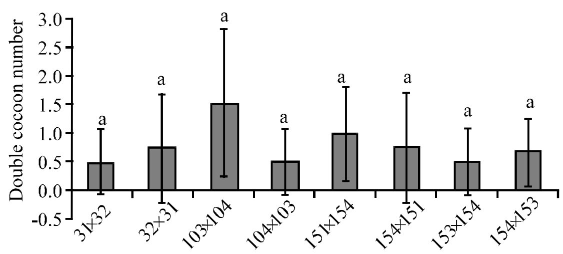

Fig. 32: Comparison of double cocoon number trait in studied hybrids

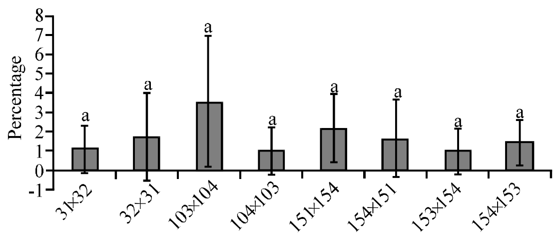

Fig. 33: Comparison of double cocoon percentage trait in studied hybrids

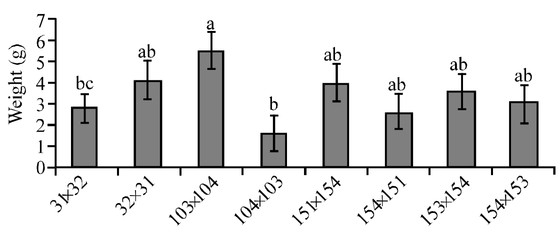

Fig. 34: Comparison of fresh double cocoon weight trait in studied hybirds

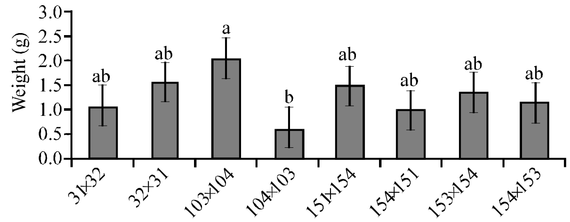

Fig. 35: Comparison of dried double cocoon weight trait in studied hybrids

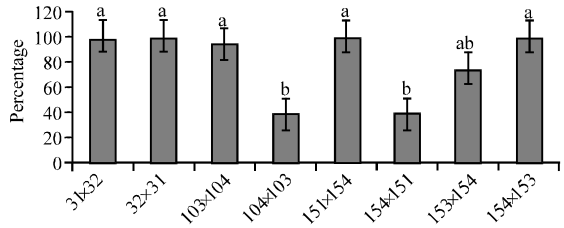

Fig. 36: Comparison of pupae vitality percentage in double cocoon trait in studied hybrids

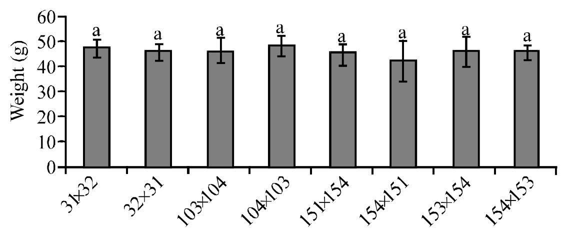

Fig. 37: Comparison of total produced cocoon number trait in studied hybrids

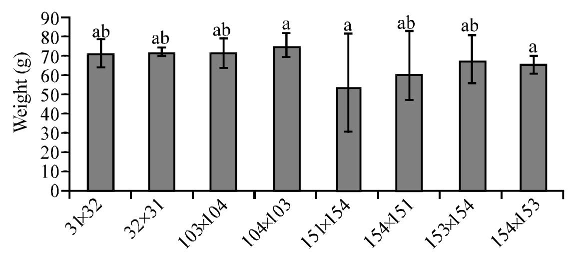

Fig. 38: Comparison of total produced cocoon weight trait in studied hybrids

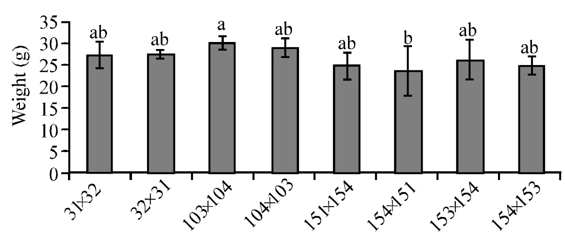

Fig. 39: Comparison of total produced fresh cocoon weight trait in studied hybrids

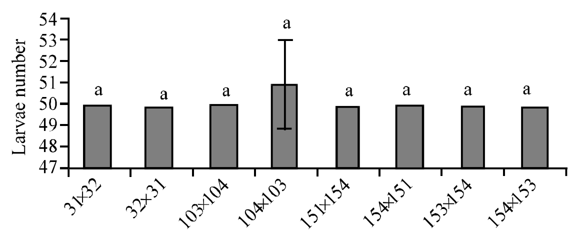

Fig. 40: Comparison of alive larvae number trait in studied hybrids

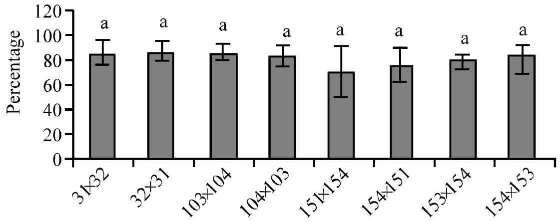

Fig. 41: Comparison of pupae vitality percentage in total cocoon trait in studied hybrids

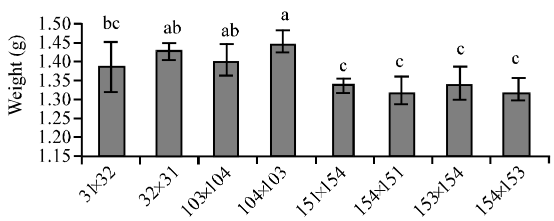

Fig. 42: Comparison of male fresh cocoon weight trait in studied hybrids

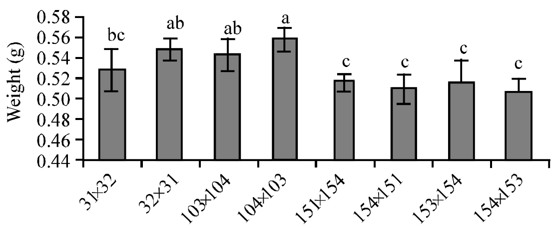

Fig. 43: Comparison of male dried cocoon weight trait in studied hybrids

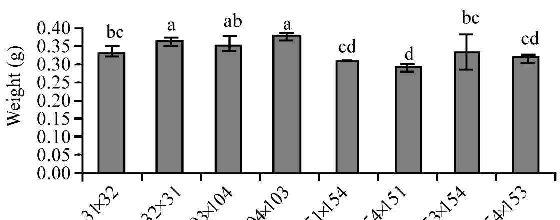

Fig. 44: Comparison of male fresh shell cocoon weight trait in studied hybrids

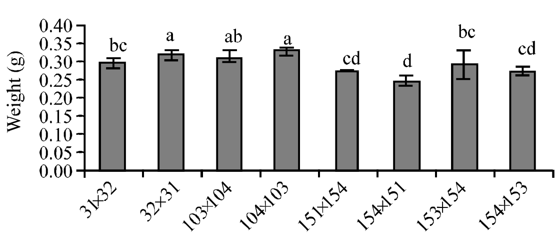

Fig. 45: Comparison of male dried shell cocoon weight trait in studied hybrids

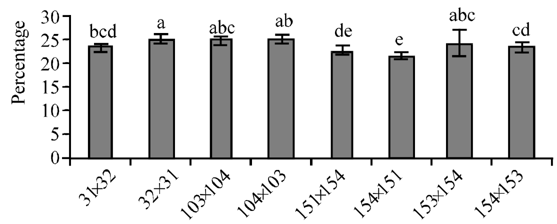

Fig. 46: Comparison of male fresh cocoon percentage trait in studied hybrids

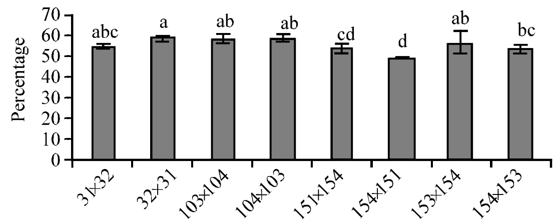

Fig. 47: Comparison of male dried cocoon percentage trait in studied hybrids

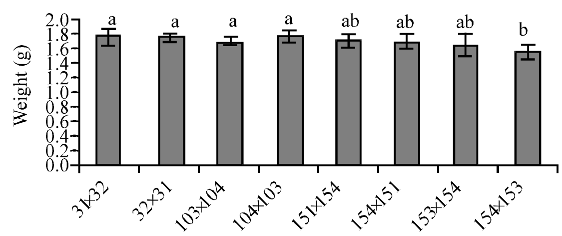

Fig. 48: Comparison of female fresh cocoon weight trait in studied hybrids

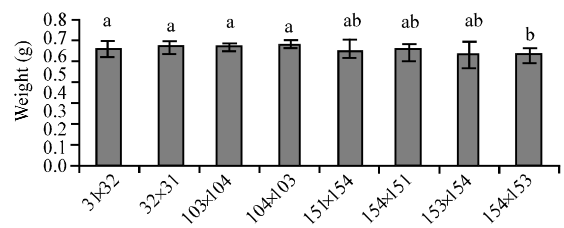

Fig. 49: Comparison of female dried cocoon weight trait in studied hybrids

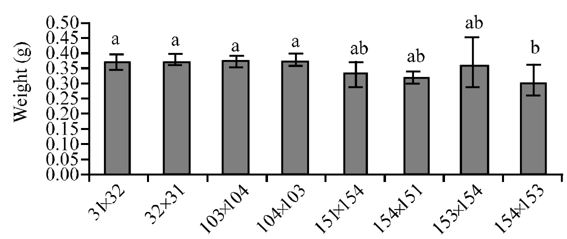

Fig. 50: Comparison of female fresh shell cocoon weight trait in studied hybrids

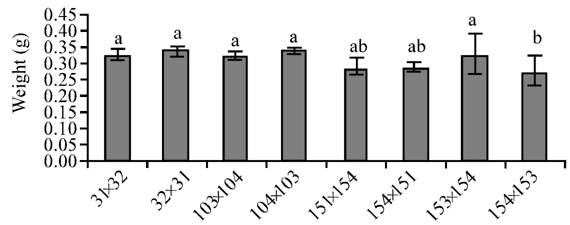

Fig. 51: Comparison of female dried shell cocoon weight trait in studied hybrids

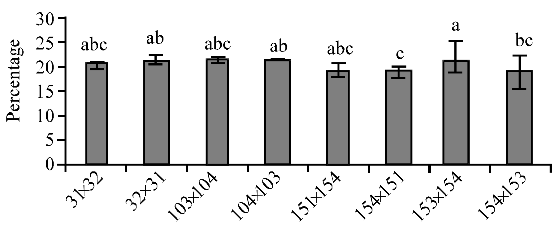

Fig. 52: Comparison of female fresh cocoon percentage trait in studied hybrids

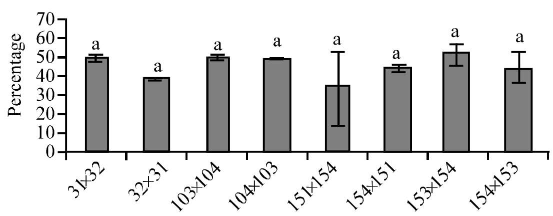

Fig. 53: Comparison of female dried cocoon percentage trait in studied hybrids

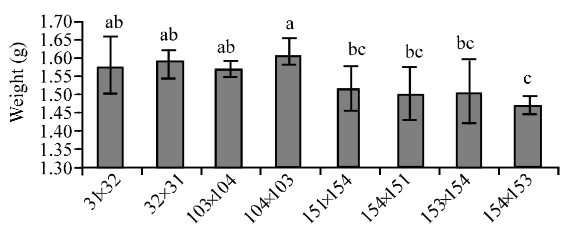

Fig. 54: Comparison of fresh cocoon weight trait in studied hybrids

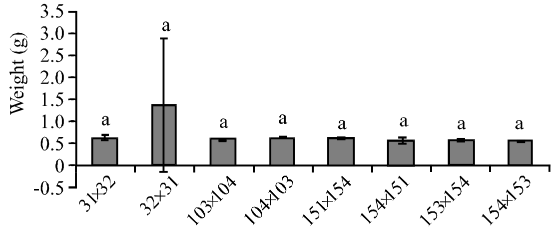

Fig. 55: Comparison of dried cocoon weight trait in studied hybrids

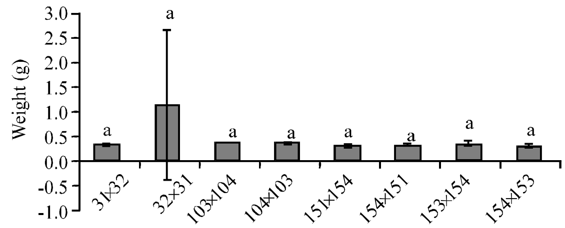

Fig. 56: Comparison of fresh shell cocoon weight trait in studied hybrids

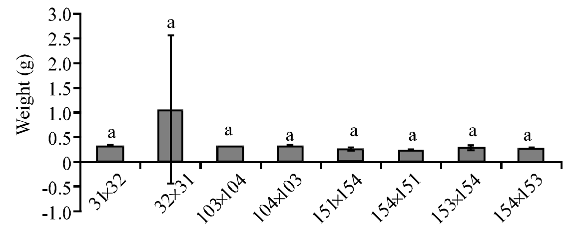

Fig. 57: Comparison of dried shell cocoon weight trait in studied hybrids

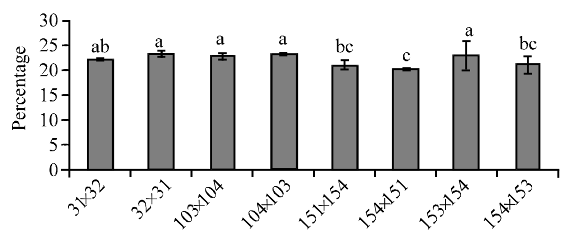

Fig. 58: Comparison of fresh cocoon percentage trait in studied hybrids

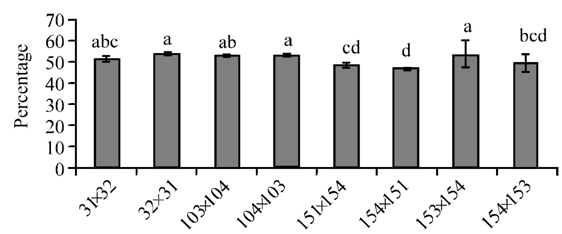

Fig. 59: Comparison of dried cocoon percentage trait in studied hybrids

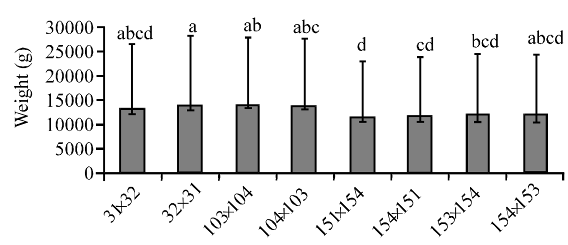

Fig. 60: Comparison of 10,000 larvae fresh cocoon weight trait in studied hybrids

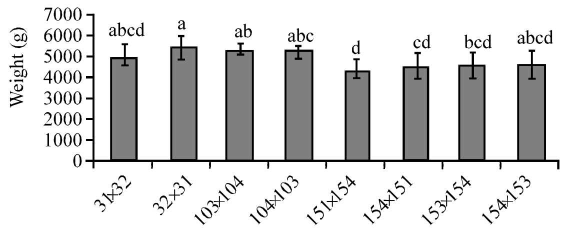

Fig. 61: Comparison of 10,000 larvae dried cocoon weight trait in studied hybrids

survey results in larva weight in finishing of the 3rd instars we found that hybrid 103×104 had the highest record (0.156 g) that despite of being different in numerical value it did not have significant different with hybrids 31×32, 32×31, 151×154, 154×151 (p.0.05). Performance of hybrids 153×154 and 154×153 in this trait was significantly lower than mentioned hybrids ($p<0.05$). Hybrid 104×103 had the highest record in larva weight in finishing if the 4th instars. Despite this conflict there was no significant difference between this hybrid and hybrids 103×104 and 31×32 ($p>0.05$). In this trait between hybrids 31×32, 32×31, 151×154, 154×151, 153×154 and 154×153 despite of the numerical value difference there were no significant difference ($p>0.05$). This research results about larva weight in finishing of 5th instars indicated that there were no significant difference between hybrids 31×32, 32×31, 103×104, 104×103 ($p>0.05$). But this trait amount in these hybrids were significantly higher than hybrids 151×154,154×151, 153×154 and 154×153 ($p<0.05$).

Larva gain in 1st instars in hybrid 103×104 was significantly higher than other hybrids ($p<0.05$). Between hybrids 32×31, 104×103 and 154×151 there were no significant difference in this trait ($p>0.05$). This research results showed that there were no significant difference between hybrids under study in larva gain in 2nd instars ($p>0.05$). In this research it was revealed that larva gain in 3rd instars in hybrids 104×103, 153×154 and 154×153 was significantly lower than other hybrids ($p>0.05$). Hybrid 104×103 in larva gain in 4th instars had the highest record (0.614 g) which was significantly higher than hybrids 31×32, 154×151, 153×154 and 154×153 ($p<0.05$). Larva gain in 5th instars in hybrids 31×32 and 32×31 was significantly higher than hybrids 151×154, 154×151, 153×154 and 154×153 ($p<0.05$). Larva gain in 1-5th instars in hybrids 31×32, 32×31, 103×104 and 104×103 was significantly >4 other hybrids ($p<0.05$). In this study we found that best in traits as cocoon number and best cocoon percentage between hybrids there were no significant difference ($p>0.05$). Hybrids 32×31 and 104×103 were significantly higher than 151×154 and 154×151 in fresh best cocoon weight trait ($p<0.05$). Between other hybrids in this trait there was no significant difference. Dried best cocoon weight in hybrid 104×103 was significantly higher than hybrids 151×154 and 154×151 ($p<0.05$). Between these hybrids and other ones there were no significant differences. In trait of Pupa vitality percentage in best cocoon despite numerical value difference there was no significant difference between hybrids ($p>0.05$). Middle cocoon number and middle cocoon percentage in hybrid 154×153 was significantly higher than hybrids 31×32 and 31×32 ($p>0.05$). Between these hybrids with 103×104, 104×103, 151×154, 154×151 and 153×154 there were no significant differences ($p>0.05$).

Experiments results in fresh middle cocoon weight shows that hybrid 154×153 was significantly higher than 32×31, 103×104, 154×151 ($p<0.05$). Between all of the mentioned hybrids along with hybrids 31×32, 104×103, 151×154 and 153×154 there were no significant difference ($p>0.05$). In dried middle cocoon weight between 8 evaluated hybrids there was no significant difference ($p>0.05$). Pupa vitality percentage in middle cocoon in hybrid 31×32 was the highest record which had significant difference with 154×151 ($p<0.05$). Beyond other 6 hybrids there were no significant difference ($p>0.05$). In two traits of low cocoon number and low cocoon percentage hybrid 151×154 had the highest negative record (with mean of 9.775) had significant difference with hybrids 31×32, 32×31, 104×103 and 154×153 ($p<0.05$). Fresh low cocoon weight in hybrids 151×154 has shown higher performance than 31×32, 32×31, 103×104, 104×103, 154×151 and 154×153 ($p<0.05$). Between 31×32 with 153×154 in this trait there were no significant difference ($p>0.05$). Dried low cocoon weight in hybrid 151×154 beyond studied hybrids had the highest record (2.195 g). This hybrid significantly indicated higher mean than hybrids 31×32, 32×31, 103×104, 104×103, 153×154 andl54×153 ($p<0.05$). Hybrids 31×32, 32×31, 103×104, 104×103, 153×154 and 154×153 had no significant difference in this trait ($p>0.05$). Pupa vitality percentage in low cocoon in hybrid 154×151 was significantly higher than 31×32, 32×31, 103×104, 104×103 and 154×153 ($p<0.05$). But it did not have significant difference with hybrids 153×154 and 151×154 ($p>0.05$).

Double cocoon number and double cocoon percentage beyond eight hybrids did not have significant difference ($p<0.05$). Fresh double cocoon weight in hybrid 103×104 was significantly higher than 31×32 and 104×103 ($p<0.05$). But it did not have significant difference with others ($p>0.05$). Dried double cocoon weight in hybrid 103×104 was significantly higher than 104×103 ($p<0.05$). But it did not have significant difference with other hybrids ($p>0.05$). Pupa vitality percentage in double cocoon was the highest in the hybrids 31×32, 32×31, 153×154 and 154×153 (100%) which was significantly higher than 31×32, 32×31, 103×104, 151×154 and 154×153 ($p<0.05$). But they did not have significant difference with 103×104 and 153×154 ($p>0.05$). Despite of numerical difference in total produced cocoon number there were no significant differences between hybrids ($p>0.05$). Total produced cocoon weight in hybrid 104×103 was significantly higher than 151×154 ($p<0.05$) but it did not have significant difference with others ($p>0.05$). Hybrid 104×103 in total produced fresh cocoon weight was significantly higher than 151×154 ($p<0.05$). But it didn't have significant difference with others ($p>0.05$). This study revealed that hybrid 103×104 in total produced dried cocoon weight was significantly higher than 154×151 ($p<0.05$). Between other hybrids in this trait there were no significant difference ($p>0.05$). In total alive larvae number there were no significant difference ($p>0.05$).

In pupa vitality percentage in total cocoon there were no significant difference ($p>0.05$). Hybrid 104×103 in male fresh cocoon weight has showed higher performance than 31×32, 151×154, 154×151, 153×154 and 154×153 ($p<0.05$). Experiment results in male dried cocoon weight were equal to male fresh cocoon weight. About 2 hybrids 32×31 and 104×103 in male fresh cocoon shell weight was significantly higher than 31×32, 151×154, 154×151, 153×154 and 154×153 ($p<0.05$). In this trait between hybrids 31×32, 151×154, 154×151, 153×154 and 154×153 there were no significant difference ($p>0.05$). This study showed completely same results in male fresh cocoon shell weight with male dried cocoon shell weight. Male fresh cocoon percentage was significantly higher in hybrid 32×31 than 31×32, 151×154, 154×151, 154×153 ($p<0.05$). In this trait there were no significant difference between 31×32, 103×104, 104×103 and 153×154 ($p>0.05$). Male dried cocoon percentage in hybrid 32×31 had the highest performance than 151×154, 154×151 and 154×153 ($p<0.05$). Hybrids 31×32, 32×3, 103×104, 104×103 and 153×154 had no significant difference ($p>0.05$).

Female fresh cocoon weight in 154×153 was significantly lower than 31×32, 32×31, 103×104 and 104×103 ($p<0.05$). But this hybrid did not significant difference with 151×154, 154×151 and 153×154 ($p>0.05$). This experiment indicated that performance of 8 hybrids was completely same in two female fresh cocoon weight and female dried cocoon weight so that hybrid 153×154 was significantly lower than hybrids 31×32, 32×31, 103×104 and 104×103 ($p<0.05$) whereas between 154×151, 151×154 and 154×153 were not significantly differences ($p>0.05$). Hybrid 154×153 in female fresh cocoon shell weight was lower than hybrids 31×32, 32×31, 103×104, 104×103, 153×154 ($p<0.05$). Female fresh cocoon percentage in hybrid 153×154 was significantly higher than 154×151 and 154×153 ($p<0.05$). In this trait between 31×32, 32×31, 103×104, 104×103, 151×154 and 153×154 were no significant differences ($p>0.05$). Female dried cocoon percentage in 8 studied hybrids did not have significant differences ($p>0.05$).

Fresh cocoon weight in 104×103 was significantly higher than 151×154, 154×151, 153×154 and 154×153 ($p<0.05$). Between hybrids in dried cocoon weight, fresh cocoon shell and dried cocoon shell weight despite of difference in numerical value there were no significant difference ($p>0.05$). This study showed that fresh cocoon shell percentage in hybrids 31×32, 32×31, 103×104, 104×103 and 153×154 has no significant differences ($p>0.05$). Hybrid 154×151 was significantly lower than them ($p<0.05$). Dried cocoon shell percentage in hybrids 32×31 mL 04×103 and 153×154 was significantly higher than 154×151, 154×153 ($p<0.05$). Hybrids 31×32, 151×154 and 154×153 has no significant differences in this trait ($p>0.05$). This experiment results showed that in 10,000 larva fresh cocoon weight between hybrids 31×32, 32×31, 103×104, 104×103, 154×153 there were no significant difference ($p>0.05$) but hybrids 32×31 and 103×104 shown higher performance than 151×154 and 154×151 ($p<0.05$). Experiment results in 1000 larva dried cocoon weight completely equal with 10,000 larva fresh cocoon weight. Genetic objects evaluating also helps to determine special features like web length, fluoride stability, stability towards illness, etc. (Li *et al*., 2001) reaching to different genetic strains has provided extensive approaches for producers in selecting the main parents which they are intended. Even half of the eggs that are in suitable genetic groups can potentially turn the silkworm researches to the mush extended domains (Arai and Ito, 1967; Chandrashekharaiah and Babu, 2003). In recent experiments there were attempts to determine and evaluating the polyvoltine type features based on index evaluating method and sub ordinate function statistical method that often is used to evaluate different hybrids of different silkworms. Type evaluating leads to determine the genetic capability of different group strains of silkworm to economical utilization.

Since features and specifications related to the silkworm were studied in different climates there is regular evaluation of available types to have suitable usage and the gained data and information will be useful for future breeding (Rao *et al*., 2006). After 1905 that Toyama in Japan stated the positive heterosis effect for silkworm hybrids, important egg producer countries started to breed and modify the parent's basis (Chinese and Japanese lines) and market their hybrids. Various reports shows that many of quantitative traits of silkworm has heterotic effect and therefore silkworm hybrids have the highest performance in traits than parents. To produce commercial parent hybrids (P) there is a need of two reproduced within variety steps. Therefore producer companies first breed silkworm eggs 3 and 2p and then produce silkworm P. Hybrids and their parent basis are constantly under evaluating and if necessary research projects are performed to make new varieties (Ashoka *et al*., 1993). In a research accomplished by Rao with the name of evaluation of silkworm genetic capability of polyvoltine type and parent worm determination for breeding programs, it studied 21 types of oval cocoon and 10 types of Dumbbell it was revealed that beyond 21 species of oval silks, all of them were flat except type APM19 that there were some signs on silkworm back. But cocoons of this type have different colors such as white, yellowish gray, yellow and these cocoon seeds were very soft, middle and hard. Between studied traits, fertility of their oval types was 438 up to 567 and mean number of their fertility was 474 times. The lowest cocoon product (1000 larva weight produced silk) in AMG1 (8.836 kg) and its highest one was categorized in 28APM with mean product of 10.85 kg. In all of the species; pupa vitality was recorded >80% except in type 1 AMPG (72.55%) and 11APM (76.73) and its mean vitality was 86.40%. The highest cocoon pure weight was 26 APM and 1.412 g and its lowest APMW12 was 1.199 g and its mean was 1.312 g. Tallest web length to APM11 with 996 m and its shortest was 28APM 604 m. Maximum raw silk 11APM was 13.03 and its minimum was 20 APM 10.48%.

In all oval types, silk week capability was observed >70% (Rao *et al*., 2006). In this experiment based on performed categorization qualitative features of types were evaluated according to different parameters such as fertility, production, pupation amount, cocoon weight, cocoon shell weight, shell portion, web length, raw silk, (percentage) silk week capability and cleanliness by using the index evaluating method and sub ordinate function and then after this act it was obvious that between hybrids under study there is significant difference which was like the research in this manner and its detail is as follow. Various evaluating has been done to best determination and the best strain assessment in which they could provide silkworm breeding programs (Raju and Krishnamurthy, 1993; Rao *et al*., 2006; Zanatta *et al*., 2009). With this purpose in mind, its necessary that all of features related to silkworm in each step of its life period be under study. During silkworm various life cycle, environmental features affect on the produced silk worm quality (Ohi *et al*., 1970; Zanatta *et al*., 2009; Hannia *et al*., 2009) also more extended researches are needed to improve economical goals and these researches improve new strains during breeding programs which its goal was improvement of silk performance (usage), concordance with external environment and ability to bear and stability against illness (Yokoyama, 1979; Sen *et al*., 1999; Li *et al*., 2001; Zanatta *et al*., 2009).

Other studies related to using the performance usage (Miyagawa and Sato, 1954; Marco *et al*., 2005; Zanatta *et al*., 2009) and apparent differences (Aagaard *et al*., 2002; Pilgrim *et al*., 2002; Dujardin and Le Pont, 2004; Zanatta *et al*., 2009) that indicates better strains for breeding in terms of product. Cocoon external features that are related to its shape are strongly depends on silkworm strain origin. Chinese strains have white school body and forms an oval cocoon while Japanese strains have colorful school body and its shape looks like oval (Zanatta *et al*., 2009).

All studied strains here are polyvoltine which are very resistance against climate changes and produce less silks than the Polyvoltine strains (Rao *et al*., 2006; Seidavi *et al*., 2008; Zanatta *et al*., 2009). Vigor hybrid is an important factor in increasing the cocoon production, evaluation and formed lines stability by sibling worms and suitable intercourse determination for commercial productivity (Nagaraju *et al*., 1996; Ghanipoor *et al*., 2007; Ramesha *et al*., 2009). That according to silks features importance produced from hybridization were suitably improved and evaluated by silkworm breeders. Some of them have long time production and just a few of them had short time production.

The main problem of manufactures was priority of worm important trait ordering to improve their life. However, finding important factors that are responsible for worms surviving are very important for silkworm breeders. The most important goal of worm breeding is matching and synchronization of new genotypes with more coordination in various climates and also selecting more stable bonding than silkworm to commercial productivity (Ramesha *et al*., 2009). Also it is found that most of the genetic features in silkworm are under multi gene control and under affect of environmental factors and nutrients same as other systems. Therefore, in the entire researches hybrid compounds are breeding in same conditions and are feed with similar species of leaves to be evaluated with important quantitative traits in hybrid performance analysis. The main goal of silkworm breeders is using silkworm hybrids with stable level of profitability in silk production and improved cocoon production (Kovalov, 1970; Ramesha *et al*., 2009).

The goal of silkworm breeding is not only combine and intercourse new genotypes but also is to determine the stable silkworm hybrids to have commercial productivity by farmers. Suitable parent worm selection and information about nature and the gene performance value and important economical traits can increase production successfulness (Chouhan *et al*., 2000; Ramesha *et al*., 2009). Assessment and evaluation about current combination in insects breeding is one of the necessary prerequisites to shim the combining way of most desired features available in various genotype in one hybrid intercourse, of course parent breeding is usually is not good reflection of capabilities combination but however helps to breeders to determine related parent relations nature and also next generation nature (Ramesha *et al*., 2009).

Polygenic status results in stability or vitality in pupa products (Pallavi and Basavaraja, 2007). Also polygenic in bivoltine hybrids causes more vitality than monovoltine hybrid in bad environmental conditions that is because of the variability gene formation beyond the communities (Watanabe, 2002; Pallavi and Basavaraja, 2007). Furthermore facility in breeding and better growth power and economical improvement leads better results than monovoltine hybrids (Kumar *et al*., 1998; Mal Reddy *et al*., 2005; Pallavi and Basavaraja, 2007). So current research based on suitable basis selection to improve bivoltine hybrids to industrial productivity (Pallavi and Basavaraja, 2007).

CONCLUSION

After evaluating data with two used statistical method to compare productive and economical trait performance of height commercial studied hybrids these results were determined according to simple evaluating index, hybrids151×154 with 4063.799 scores gained the highest rank and after that hybrid 32×31 was placed. Hybrids 103×104, 154×153 also gained the lowest ranking. According to sub ordinate function hybrid 32×31 with 43.13057 gained the highest ranking. Hyhbrids151×154 also gained the lowest ranking. According to this experiment results hybrid 32×31 has the higher potential performance beyond other ones and its use is recommended.

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