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Estimation of Regional Effect, Evaluation Index and Subordinate Function of Mulberry Silkworm in Some Egyptian Governorates

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ABSTRACT

Two local and important hybrids of silkworm, *Bombyx mori* L. were reared in three Egyptian governorates of Qalubya, Giza and Sohag (Q, G and S). Fourteen parameters of 5th instar duration (FD), whole larvae duration (LD), mortality percentage (MP), number of cocoon/liter (C /L), cocooning percentage (CP), duple cocooning percentage (DCP), cocoon crop by number (Crop/N), cocoon crop by weight (Crop/W) were recorded. Cocoon weight (CW), cocoon shell weight (CSW), pupae weight (PW), cocoon shell ratio (CSR), silk productivity (SP) for females and males were investigated. The results revealed that rearing silkworm was better in Qalubya and Giza comparing with Sohag governorate. Some modifications for adjusting the rearing techniques, temperature and humidity to raise the silk production were recommended. As well as selections the hybrids suitable for Upper Egypt conditions.

Performances of hybrids characters are changed according to the environment changed. The average of CW, CSW, PW, CSR and SP traits were better for both sexes in Qalubya governorate. Hybrid of hy₁ was the best for CW, CSW, PW, CSR and SP traits for both sexes. Both of hy₁ and hy₂ were mostly the best hybrids in Qalubya, Giza and Sohag of females and males. Evaluation index and subordinate function values depended on the hybrids which represented the genetic factor and the locations that represented the environmental factor and its interactions.

INTRODUCTION

The mulberry silkworm, *Bombyx mori* L. (Lepidoptera: Bombycidae) is a monophagous insect that feeds exclusively on the mulberry (*Morus* spp.) foliage for its nutrition and produces the natural proteinous silk (Shabnam *et al.* 2018).

Sericulture activities are applied from temperate and subtropical to tropical areas. Mulberry cultivation is suitable for this region to produce mulberry leaves, which is the sole food of the silkworms (Mahmoud and Ghazy, 2005 & Ramesha *et al.* 2009).

The seasonal differences in the environmental components considerably were affecting the genotypic expression in the form of phenotypic output of silkworm characters. The variations in the environmental conditions day to day and season to season emphasize the need for management of temperature and relative humidity for sustainable cocoon production Madhusudhan *et al.* (2017).

Egypt lies between 22° and 32° N latitude. It is part of the Sahara of North Africa and covers a total area of over one million km² in the hyper-arid region. The biggest part is located in the temperate zone with most of its landmass below 500 m above sea level, which limits potential diversity (Zahran and Willis 2009). The impact of climate change on sericulture required modifying of rearing and development of silkworm hybrids to be suitable for changes. Sericulture scientists try to obtain hybrid suitable for the seasonal fluctuations conditions Hosny *et al.* (1984); Thiagarajan *et al.* (1993); Eid *et al.* (2002); Gangwar (2012) & Ghazy (1999, 2012, 2014a).

The main aim of silkworm breeding is not only to synthesis new genotype but also to adjudicate the productive hybrids for commercial exploitation, the most important aim of silkworm breeding is coordinating new genotype with more coordination properties in different climates and selecting stable links in order to increase the commercial productivity Ghazy (2007 a & Ghazy and Mahmoud 2013a).

This study aims to determine the regional effect on silkworm productivity. Also, evaluate the performance of local and imported hybrids in three different locations. Study the effect of the different locations on evaluation indices and subordinate function.

MATERIALS AND METHODS

Three Egyptian governorates of Qalubya, Giza, and Sohag (Q, G, and S) were selected for evaluation. Three professionals' rearers were choosing one rearer for each governorate.

Room temperature and relative humidity were registered by the rearers using a thermometer and hygrometer four times during the larval duration. Averages of temperature were 27.231±0.252 °C, 29.470±0.242 °C and 32.017±0.279°C for Qalubya, Giza and Sohag governorates, respectively. The averages of relative humidity were 54.695±1.032%, 55.929±0.710% and 42.374±1.066%.

Mulberry leaves of *Morus alba* var canva-2 used for fed silkworm larvae. Leaves were chopped during the first three instars. Whole leaves and shoots were offered to fourth and fifth instar larvae. Larvae were fed four times daily.

During the young instars polyethylene sheets are used as cover and bottom of trays (Ghazy, 2008). As well strips of wet foam were surrounded young silkworm larvae.

A wooden stand with trays measured 60 X 90 X 10 cm was utilized for rearing silkworm larvae. Each stand contains ten trays. Common larvae disinfectant was adopted (Hosny *et al.* 2002). Collapsible frames applied for a moutage. Before starting rear silkworm the rearing room and rearing equipment were disinfected by formalin solution with 5 % concentration.

Local hybrids selected from developed hybrids of the silkworm breeding program of Sericulture Research Department-Plant Protection Research Institute -Agriculture Research Center (Ghazy, 2014 a and Ghazy *et al.* 2017). Firstly, the parental races were reared to the collected proper amount of eggs during the Spring season. Eggs are prepared to hatch during autumn seasons by means of artificial hatching (Fouad, 2008). Hybridization was made to obtain two developed local hybrids. Local hybrids named F₂₇₂ X D₁₆₂ (hy₁) and C₁₃₇ X O₃₂₃ (hy₂). The comparison used Bulgarian Imported hybrid named H₁X KK X G₂ X V₂ (hy₃). Three gram of silkworm eggs for each hybrid was divided on to three replicates.

Data were registered for Fourteen parameters; 5th instar duration (FD), whole larvae duration (LD), mortality percentage (MP), number of cocoon/liter (C /L), cocooning percentage (CP), double cocooning percentage (DCP), cocoon crop by number (Crop/N), cocoon crop by weight (Crop/W) was recorded. Cocoon weight (CW), cocoon shell weight

(CSW), pupae weight (PW), cocoon shell ratio (CSR), silk productivity (SP) for females and males were registered.

Pupation ratio was estimated by the following equation:

$$\text{Pupation ratio (\%)} = \frac{\text{No. of healthy pupae}}{\text{Correct basic No. of examined}} \times 100$$

Silk productivity was adopted by the following equation of Chattopadhyay *et al.* (1995).

$$\text{Silk productivity (cg)} = \frac{\text{Cocoon shell weight (cg)}}{\text{Fifth instar duration (day)}}$$

where cg: Centigram

Statistical analysis was adopted according to SAS (1998).

Modified Evaluation index and subordinate function were estimated by the formulae of Ghazy (2014 b) as follows:

Evaluation index (EI) = ((A – B) / C × 10) + 50 for Positive traits

Evaluation index (EI) = 50 - ((A – B) / C × 10) for negative traits

$X_U = (X_i - X_{\text{worst}}) / (X_{\text{best}} - X_{\text{worst}})$

Where X_U = Subordinate Function, X_i = Measurement of the character of a tested genotype, X_{worst} = the worst value of this character among all the tested genotypes, X_{best} = the best value of this character among all the tested genotypes.

RESULTS AND DISCUSSION

Differences between the local and imported hybrids for fourteen characters were founded in Table 1. Data observed that there were significant differences for all traits except the fifth larval duration (FD) traits. Regardless of the insignificant difference, hybrid hy_3 has the lowest average for FD, LD and MP characters. The best average for C/L, CP, DCP, Crop/N, Crop/W, PR, CW, CSW, PW, CSR and SP traits were observed of hy_1 . While hy_2 have better means for C/L, Crop/W, PR, CW, CSW, PW, CSR and SP traits. So, hy_1 and hy_2 were superior over hy_3 hybrid for most characters under investigation.

These results are in agreement with the findings of Ghazy (2007 a and b) who evaluated 42 hybrids containing 37 local hybrids and 5 imported hybrids. Five local hybrids of C X H, D X F, F X A, F X D and G X K are superior for all traits that can be used instead of the imported hybrids.

Table. 1. Differences between the local and imported hybrids for fourteen characters of mulberry silkworm, *Bombyx mori* L.

character Hybrid	FD (days)	LD (days)	MP (%)	C/L (No)	CP (%)	DCP (%)	Crop/N (No)	Crop/W (Kg)	PR (%)	CW (g)	CSW (g)	PW (g)	CSR (%)	SP (Cg)
hy₁	9.667	34.097	13.667	92.960	83.556	0.785	8355.56	15.407	98.000	1.776	0.325	1.390	18.561	3.292
hy₂	9.764	34.097	14.778	113.027	72.778	5.444	7277.78	12.531	94.667	1.655	0.280	1.313	18.442	2.842
hy₃	8.222	30.333	8.356	134.173	79.001	0.898	7900.01	7.911	93.333	0.993	0.182	0.748	17.105	2.298
F between hybrids	1.040	16.820*	5.410**	179.260**	30.400**	12.730**	112.85**	128.420**	4.060*	823.100**	368.290**	705.500**	12.210**	153.600**
LSD 5%	-	1.574	4.384	4.331	2.916	2.214	151.3	0.991	3.358	0.041	0.011	0.037	0.643	0.112

Where: hy_1 , hy_2 , hy_3 (hybrids) & (*) significant at 0.05, (**) highly significant at 0.01.

Data in Table 2 illustrated the regional effect of different locations for fourteen characters of mulberry silkworm. Significant differences were registered for all characters except those of FD and CSR. Superior Governorates were Qalubya and Giza for characters

of mortality percentage (MP), a number of cocoons/liter (C/L), cocooning percentage (CP), cocoon crop/number (Crop/No), cocoon crop by weight (Crop/W), pupation ratio (PR), cocoon weight (CW), cocoon shell weight (CSW), pupae weight (PW) and silk productivity (SP).

While Sohag governorate has the best values of fifth duration (FD), larvae duration (LD) and double cocoon percentage (DCP). Rearing silkworm was better in Qalubya and Giza comparing with Sohag governorate.

These results are coincidence with those found by Ghazy and Mahmoud (2013b) who reported that all hybrids reared under Qalubya conditions have better results in silk productivity than those reared under Alexandria conditions.

Table 2. Regional effect of different locations for fourteen characters of mulberry silkworm, *Bombyx mori* L.

Character Location	FD (days)	LD (days)	MP (%)	C/L (No)	CP (%)	DCP (%)	Crop/N (No)	Crop/W (Kg)	PR (%)	CW (g)	CSW (g)	PW (g)	CSR (%)	SP (Cg)
Qalubya	9.889	34.667	9.800	86.800	93.778	3.225	9377.78	16.377	97.333	1.750	0.306	1.377	18.017	3.234
Giza	9.431	32.639	10.111	103.040	78.446	3.778	7844.46	12.564	98.333	1.580	0.287	1.231	18.127	2.865
Sohag	8.333	31.222	16.889	150.320	63.111	0.124	6311.11	6.988	90.333	1.099	0.194	0.843	17.963	2.334
F Between locations	0.890	10.670 **	7.370**	459.610**	244.120**	6.990**	906.410**	203.840**	13.340**	520.53**	248.760**	437.350**	0.130	126.890**
LSD 5%	-	1.574	4.384	4.331	2.916	2.214	151.3	0.991	3.358	0.041	0.011	0.037	-	0.112

Where: (*) significant at 0.05, (**) highly significant at 0.01.

Table 3. Represented the differences of interactions between locations and hybrids for fourteen traits. Significant differences were detected for all characters except those of FD, LD and MP. A hybrid of hy_3 has the lowest values for FD, LD and MP for Qalubya, Giza and Sohag governorates. While hy_1 and hy_3 were better hybrids in Sohag governorate. Performances of hybrids characters are changed according to the environment changed.

The previous results are agreed with these obtained by Mahmoud and Ghazy (2005) they studied the performance of two imported hybrids in different locations. They reported that the performances of two hybrids are better in Qalubya than those of Giza governorates.

Table 3. Differences of interaction between locations and hybrids for fourteen traits.

Character Location	FD (days)	LD (days)	MP (%)	C/L (No)	CP (%)	DCP (%)	Crop/No (No)	Crop/W (Kg)	PR (%)	CW (g)	CSW (g)	PW (g)	CSR (%)	SP (Cg)	
Qalubya	hy_1	10.000	35.000	11.667	68.880	94.667	0.667	9466.667	19.787	100.000	2.091	0.373	1.655	18.270	3.734
	hy_2	10.000	35.000	13.334	89.600	93.333	9.000	9333.333	19.295	96.000	2.068	0.339	1.667	16.454	3.387
	hy_3	9.667	34.000	4.400	101.920	93.333	0.007	9333.333	10.050	96.000	1.077	0.228	0.808	19.329	2.580
Giza	hy_1	10.000	34.292	12.333	72.800	93.000	1.667	9300.000	18.698	99.000	2.011	0.382	1.567	19.097	3.710
	hy_2	10.292	34.292	13.000	90.720	65.667	7.000	6566.667	11.497	96.000	1.751	0.304	1.385	17.425	2.955
	hy_3	8.000	29.333	5.000	145.600	76.670	2.667	7666.700	7.496	100.000	0.978	0.174	0.741	17.860	1.929
Sohag	hy_1	9.000	33.000	17.000	137.200	63.000	0.020	6300.000	7.735	95.000	1.228	0.219	0.947	18.316	2.432
	hy_2	9.000	33.000	18.000	158.760	59.333	0.333	5933.333	6.802	92.000	1.147	0.197	0.888	17.436	2.184
	hy_3	7.000	27.667	15.667	155.000	67.000	0.020	6700.000	6.187	84.000	0.924	0.167	0.694	18.136	2.385
F Location X Hybrid	0.160	2.280	0.630	40.520*	20.180**	3.600*	74.940**	29.960**	29.960**	88.460**	41.910**	76.000**	3.490**	43.740**	
LSD 5%	-	-	-	7.502	5.050	3.834	262.100	1.717	1.717	0.092	0.019	0.084	1.168	0.202	

Where: hy_1 , hy_2 , hy_3 (hybrids) & (*) significant at 0.05, (**) highly significant at 0.01.

The effect of the interactions between locations and sexes on five characters of mulberry silkworm was founded in Table 4. It was clear that highly significance was detected between sexes for CW, CSW, PW, CSR and SP characters and CW & PW for the interactions between locations and sexes. Regardless the insignificant differences between some characters. The average of CW, CSW, PW, CSR and SP traits is better for both sexes in Qalubya governorate. Similar results are obtained by Hussain *et al.* (2011) who evaluated eleven inbred silkworm lines for various parameters of cocoon production under different temperature and relative humidity conditions (25 ± 1 , 30 ± 1 and $35\pm 1^\circ\text{C}$ in combination with 55, 65, and 75% RH) for three hrs during 4th and 5th instar. Significant variations in the performance of silkworm lines were noticed due to the influence of temperature and RH treatment on 4th and 5th instar larvae. The silkworm lines performed significantly better when the larvae were reared at ($25\pm 1^\circ\text{C}$ with 70 – 80% RH) while almost all the silkworm lines showed poor performance at higher temperature exposures for 3 hrs. Exposures to lower humidity (55%) during larval rearing in 4th and 5th instar at different temperatures (25 ± 1 , 30 ± 1 , and $35\pm 1^\circ\text{C}$) resulted in lowering the cocoon production.

Table.4. Effect of the interactions between locations and sexes on five characters of mulberry silkworm.

Character	Cocoon weight (g)		Cocoon shell weight (g)		Pupae weight (g)		Cocoon shell ratio (%)		Silk productivity (C.g)	
	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
Location										
Qalubya	1.933	1.557	0.316	0.296	1.554	1.199	16.993	19.042	3.355	3.112
Giza	1.756	1.404	0.305	0.268	1.389	1.073	17.292	18.962	3.044	2.686
Sohag	1.190	1.009	0.205	0.184	0.923	0.763	17.483	18.443	2.460	2.208
Average	1.626	1.323	0.275	0.249	1.289	1.012	17.256	18.816	2.953	2.669
F between Sex	318.070**		34.930**		330.670**		34.090**		37.550**	
LSD 5%	0.334		0.009		0.030		0.525		0.091	
F Location X Sex	13.100**		1.380		15.350**		1.430		0.630	
LSD 5%	0.092		-		0.084		-		-	

Where: (*) significant at 0.05, (**) highly significant at 0.01.

Data in Table.5 showed the effect of interactions between hybrids and sexes on five traits of mulberry silkworm. It was observed significant differences for all characters. Hybrid of hy₁ was the best for CW, CSW, PW, CSR and SP traits for both sexes.

The previous results are in accordance with those found by Rajalakshmi *et al.* (1998) and Ghazy *et al.* (2009) compared some Egyptian local hybrids and one imported Bulgarian hybrid of the silkworm, *Bombyx mori* L. all local hybrids were earned the best data for the average of evaluation index. Hybrid Giza C assigned the first rank, hybrids of Giza C and D can be used for commercial exploitation.

Table.6. Containing data represented the effect of interactions between locations, sexes and hybrids on five traits of mulberry silkworm. There were significant differences for CW, CSW, PW, CSR and SP characters. Both of hy₁ and hy₂ were mostly the best hybrids in Qalubya, Giza and Sohag of females and males.

The same results are recorded by Rahmathulla (2012) who reported that the seasonal differences in the environmental components considerably affect the genotypic expression in the form of phenotypic output of silkworm crops such as cocoon weight, shell weight, and

cocoon shell ratio. The variations in the environmental conditions day to day and season to season emphasize the need for management of temperature and relative humidity for sustainable cocoon production.

Table.5. Effect of interactions between hybrids and sexes on five traits of mulberry silkworm.

Character Hybrid	Cocoon weight (g)		Cocoon shell weight (g)		Pupae weight (g)		Cocoon shell ratio (%)		Silk productivity (C.g)	
	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
hy ₁	1.967	1.586	0.331	0.319	1.574	1.205	17.087	20.034	3.351	3.233
hy ₂	1.827	1.483	0.300	0.260	1.464	1.162	16.616	17.595	3.048	2.636
hy ₃	1.085	0.900	0.195	0.170	0.828	0.668	18.066	18.818	2.460	2.137
F Hybrid X Sex	12.470**		3.660*		16.320**		6.810**		3.490*	
LSD 5%	0.074		0.019		0.068		1.135		0.196	

Where: (*) significant at 0.05, (**) highly significant at 0.01.

Table.6. Effect of interactions between locations, sexes and hybrids on five traits of mulberry silkworm.

Character Location	Cocoon weight (g)		Cocoon shell weight (g)		Pupae weight (g)		Cocoon shell ratio (%)		Silk productivity (C.g)		
	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	
Qalubya	hy ₁	2.355	1.826	0.367	0.380	1.926	1.384	15.776	20.763	3.668	3.801
	hy ₂	2.240	1.895	0.352	0.326	1.826	1.507	15.739	17.170	3.520	3.255
	hy ₃	1.202	0.951	0.230	0.183	0.910	0.707	19.464	19.193	2.878	2.281
Giza	hy ₁	2.232	1.789	0.398	0.366	1.773	1.361	17.786	20.407	3.865	3.555
	hy ₂	1.968	1.534	0.336	0.272	1.570	1.200	17.172	17.678	3.265	2.645
	hy ₃	1.068	0.888	0.180	0.167	0.825	0.657	16.919	18.801	2.002	1.857
Sohag	hy ₁	1.312	1.144	0.227	0.211	1.023	0.871	17.699	18.933	2.522	2.343
	hy ₂	1.272	1.022	0.212	0.181	0.996	0.778	16.937	17.936	2.358	2.009
	hy ₃	0.985	0.862	0.175	0.159	0.749	0.639	17.814	18.459	2.499	2.271
F Location X Hybrid X Sex	2.720**		3.090*		3.750**		3.160*		3.410**		
LSD 5%	0.092		0.019		0.084		1.168		0.202		

Where: (*) significant at 0.05, (**) highly significant at 0.01.

Figures 1 and 2 Illustrated the evaluation index value of three hybrids in three locations for characters of FD, LD, MP, C/L, CP, DCP, PR, C/N and C/W. Data described that hy₁ hybrid has evaluation index values over 50 for MP, C/L, CP, DCP, PR, C/N and C/W in Qalubya and Giza governorates. The same hybrid acquired the best values for the evaluation index for FD, LD, MP, C/L, and DCP in Sohag governorate.

Hybrid hy_2 has a better evaluation index for MP, C/L, CP, PR, C/N and C/W in Qalubya governorate. Only three characters of MP, C/L and PR for the same hybrid in Giza governorate represented a better evaluation index. Characters of DCP showed the highest evaluation index for hy_1 in Sohag governorate.

About hybrid hy_3 observed evaluation index for MP, C/L, CP, DCP, PR and C/N in Qalubya governorate and for FD, LD, MP, C/L and PR in Giza governorate. Only three characters of FD, LD and DCP in Sohag governorate were detected to the same hybrid.

From the previous results, it could be concluded that the evaluation index depended on the hybrids which represented the genetic factor, the locations that represented the environmental factor and the interactions between genetics and environment.

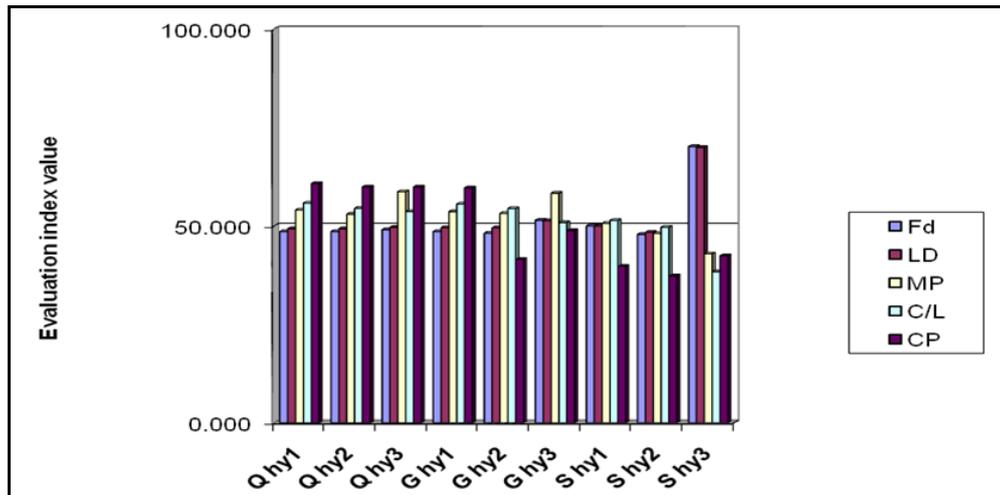


Fig.1: Evaluation index value of three hybrids in three locations for five characters.

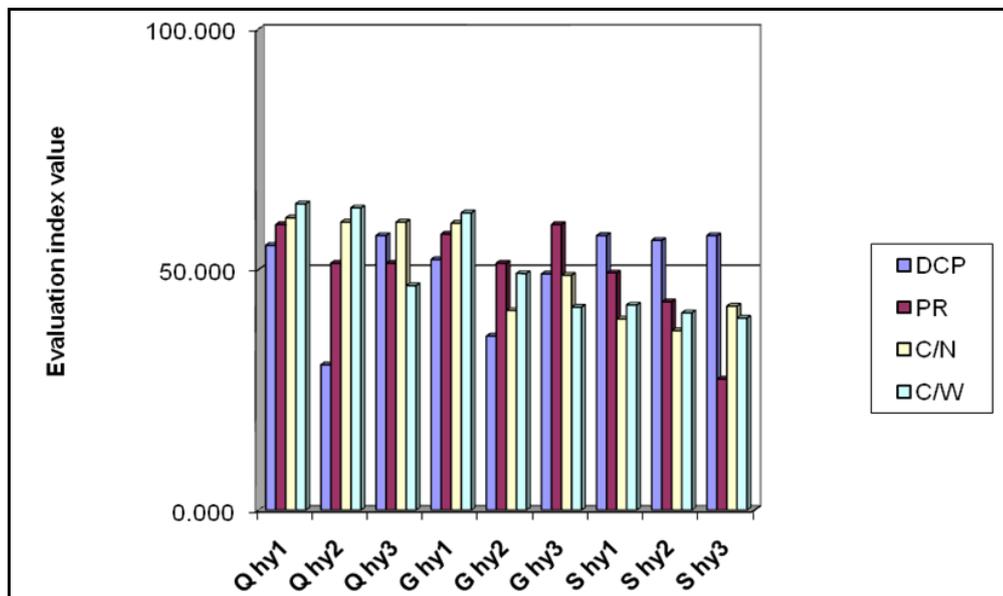


Fig.2: Evaluation index value of three hybrids in three locations for four traits.

These results are confirmed with those registered by Rao *et al.* (2001) evaluate newly evolved bivoltine hybrids of silkworm, *Bombyx mori* L. with control hybrid of KA X NB₄D₂ during three seasons of a year for seasonal performance. The result showed significant

genotype X environment interactions with respect for quantitative characters viz, fecundity, yield/10000 larvae, filament length and raw silk %. Environmental effects were significant for nine characters out of ten characters evaluated. Two hybrids were considered as highly adopted hybrids to local conditions.

The evaluation index value of three hybrids for the three locations for female and male for characters of CWF, CWM, CSWF, CSWM, PWF, PWM, CSRF, CSRM, SPF and SPM were founded in Figures 3 and 4.

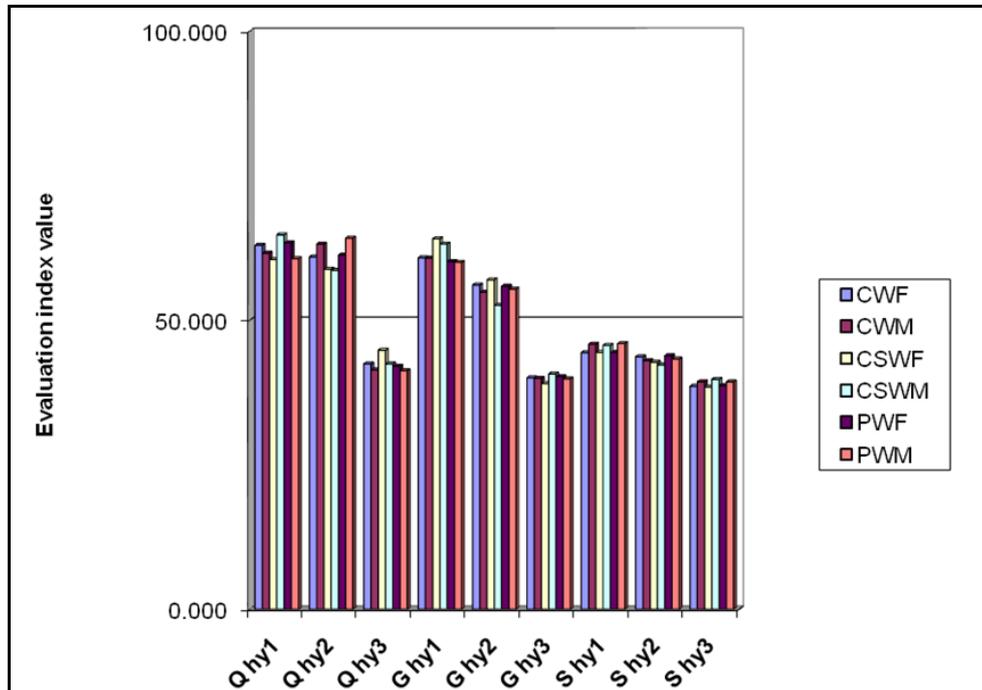


Fig. 3: Evaluation index value of three hybrids for the three locations for females and males of three characters.

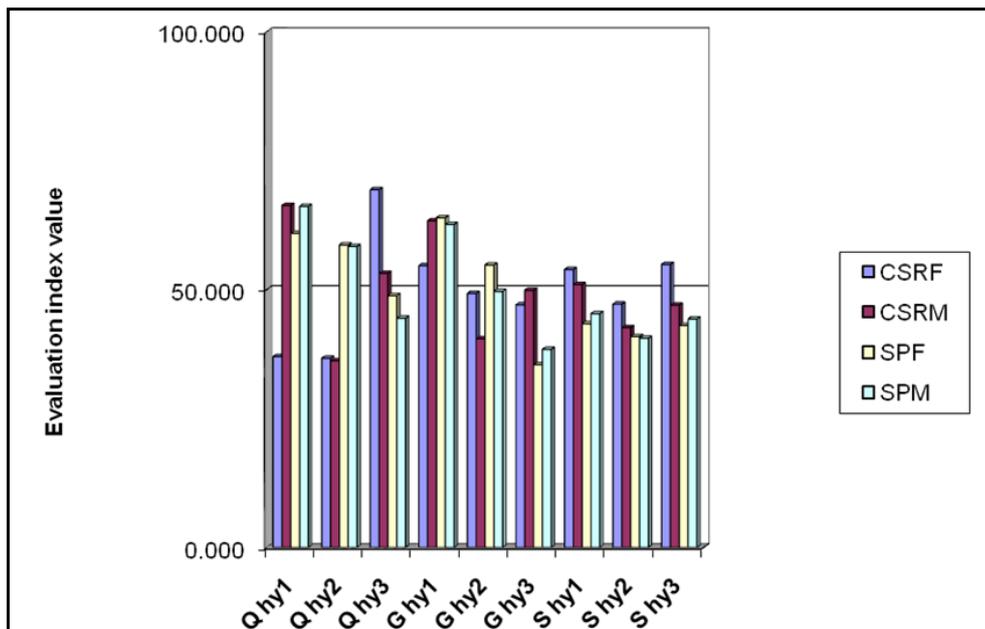


Fig.4: Evaluation index value of three hybrids for the three locations for females and males of two characters.

Almost the same trend, hy_1 has a higher value over than 50 for CWF, CWM, CSWF, CSWM, PWF, PWM, CSRM, SPF and SPM characters in Qalubya governorate and all characters for female and male in Giza governorate. While only traits of CSRF and CSRM observed a higher evaluation index of hy_1 in Sohag governorate. Hybrid of (hy_2) showed higher evaluation index in Qalubya governorate for CWF, CWM, CSWF, CSWM, PWF, PWM, SPF and SPM traits same trend recorded in Giza governorate except the SPM.

It is clear that genetic and environmental factors is very important as well as the interactions between genetic and environmental factors.

The previous results are in agreement with those founded by Buhroo *et al.* (2017) evaluates twelve potential bivoltine mulberry silkworm, *B. mori* L. genotypes during Spring and Summer seasons, data revealed that the performance of these genotypes varies according to season. Similar results were obtained for the evaluation index which differed according to season.

Averages of evaluation index for all characters were registered in Figure 5. It demonstrated that, hy_1 and hy_2 have the best averages for all characters understudy for Qalubya and Giza governorates. And hy_3 has the best evaluation index average in Qalubya governorate.

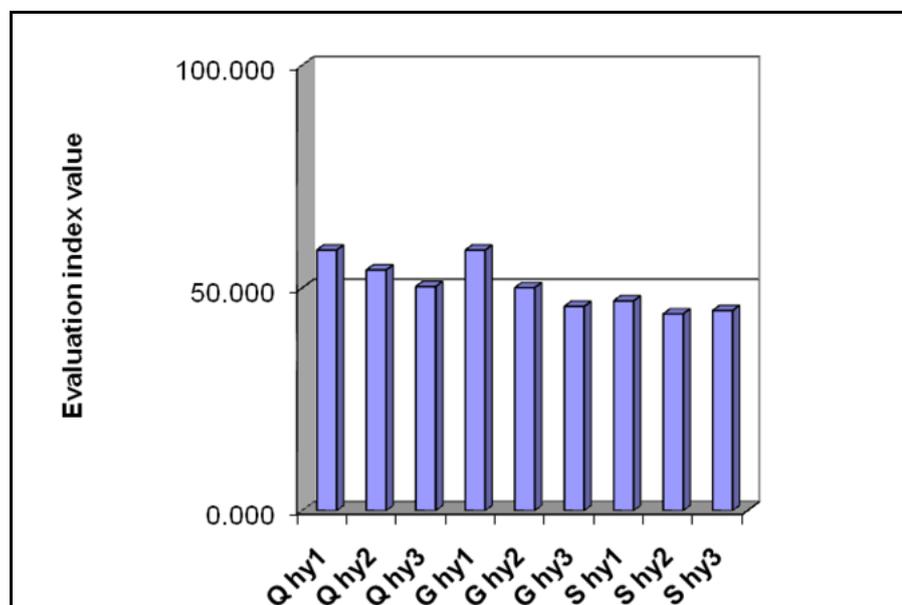


Fig. 5: Average of evaluation index for all charaters.

These results ensure the performance hybrids will be changed in different environments (locations). These results are compatible with the findings of Hussain *et al.* (2011) who reported that the average of evaluation index values for different traits showed that Pak- 4 (61.42) was the best line followed by M-101 (59.15), Pak-2 (56.37), Pak-3 (52.83) PFI-I (52.62), and M-107 (50.03). The study clearly underlines the importance of optimization of environmental conditions during larval rearing in relation to commercial cocoon production. The investigations strongly recommend that temperature and relative humidity in the range of 25-26°C and 70-80%, respectively, are mandatory for excellent results of cocoon production and Pak-4, M-101, Pak-2, Pak-3, PFI-I, and M-107 were suitable for commercial rearing.

The subordinate function of three hybrids in three locations for traits of FD, LD, MP, C/L, CP, DCP, PR, C/N and C/W were founded in Figures 6 and 7.

Three hybrids have better values subordinate for most characters in Qalubya governorate. Hybrids of hy_1 and hy_3 have better values of the subordinate function in Giza

governorate. While hy_1 and hy_2 hybrids showed better subordinate functions for two characters only and hy_3 have the best subordinate function for three characters. The variation of environment between the three governorates as well as the interactions between genetic and environmental factors affected the performance of characters which changed the subordinate function from place to place.

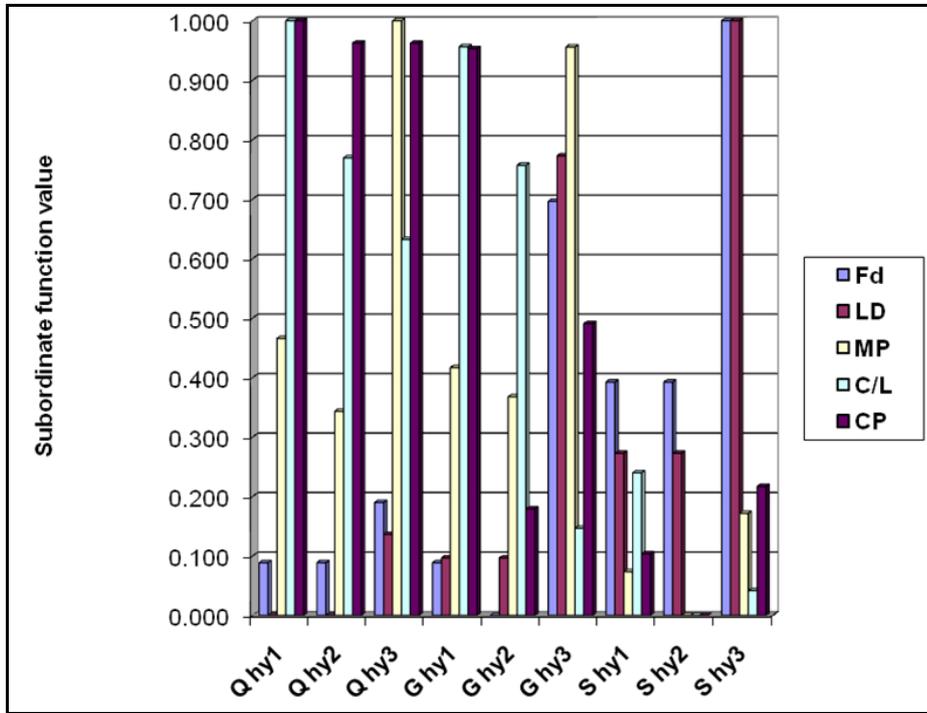


Fig. 6: Subordinate function of three hybrids in three locations for five traits.

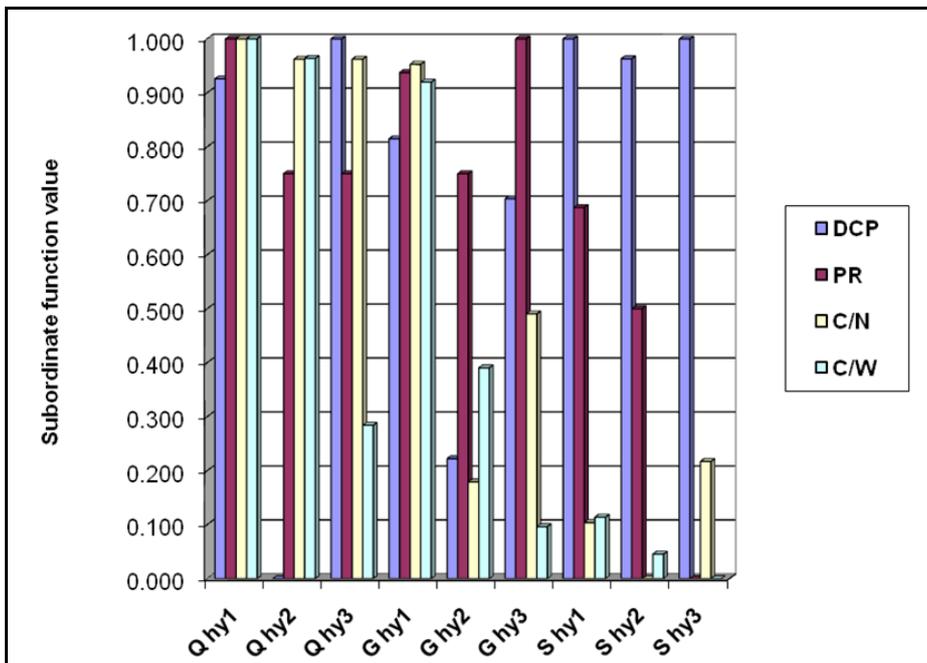


Fig. 7: Subordinate function of three hybrids in three locations for four characters.

Similar results are obtained by Rahmathulla (2012) The seasonal differences in the environmental components considerably affect the genotypic expression in the form of phenotypic output of silkworm crops such as cocoon weight, shell weight, and cocoon shell ratio. The variations in the environmental conditions day to day and season to season emphasize the need for management of temperature and relative humidity for sustainable cocoon production.

The subordinate function of three hybrids in three locations for females and males of three traits. CWF, CWM, CSWF, CSWM, PWF, PWM, CSRF, CSRM, SPF, and SPM were registered in Figures 8. and 9.

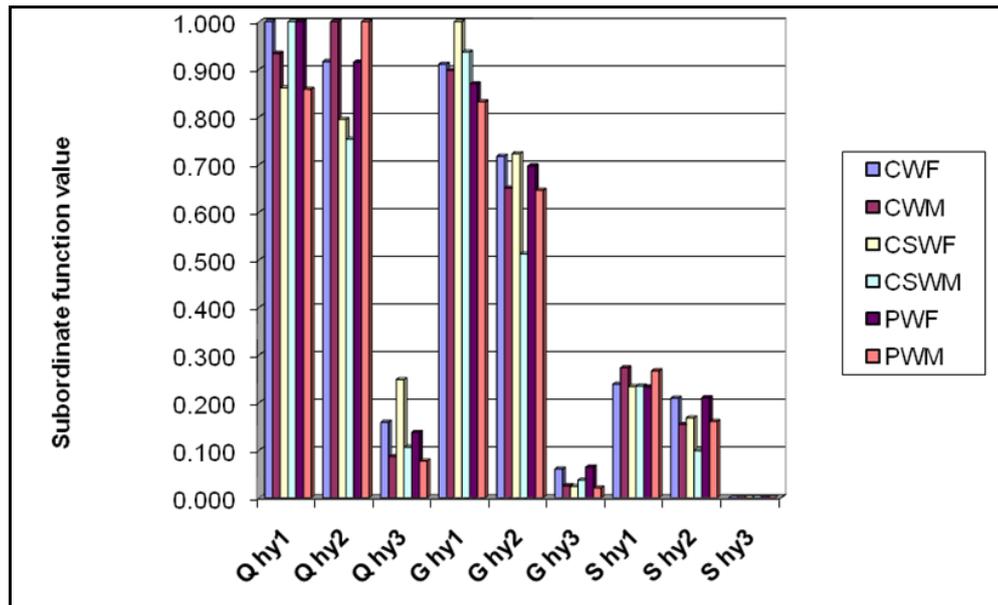


Fig. 8: Subordinate function of three hybrids in three locations for females and males of three traits.

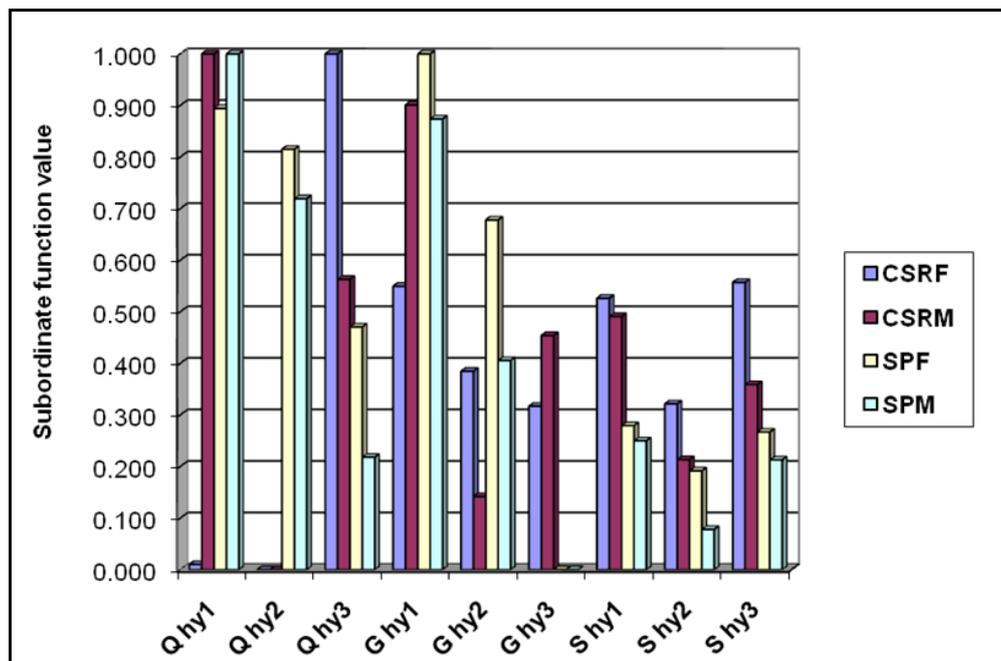


Fig. 9: Subordinate function of three hybrids in three locations for females and males of two traits.

In Qalubya governorate hybrid hy_2 earned a higher subordinate function of most characters for females and males same trend was observed for Giza governorate. For Sohag governorate only one character is better for hy_1 and hy_3 .

Obtained results are similar to the findings of Ghazy *et al.* (2017) described that Egyptian climates are changed. So, farmers need tolerant hybrids for the unstable climate to increase their crops. The double hybrids are reared under normal Egyptian conditions. The results indicated that most of the local double hybrids have superior to the imported ones. This may be there was adaptation cause by the local lines for the climatic changes. Although there was acutely changing in Egyptian conditions there were some promising double hybrids can be exploited on a commercial scale.

Fig.10. represented the cumulative subordinate function value of all traits. it is observed that $Q\ hy_1$, $Q\ hy_2$, $Q\ hy_3$, $G\ hy_1$ and $G\ hy_2$ have the highest cumulative subordinate function for all traits. Also, Data in Table 7 represented the average of the evaluation index and cumulative subordinate function value for three hybrids in three different governorates. It is obvious that hy_1 hybrid has the highest average evaluation index and cumulative subordinate function value in Qalubya and Giza governorates ($Q\ hy_1$ and $G\ hy_1$) followed by $Q\ hy_2$, $Q\ hy_3$, $G\ hy_2$, $G\ hy_3$, $S\ hy_1$, $S\ hy_3$ and $S\ hy_2$.

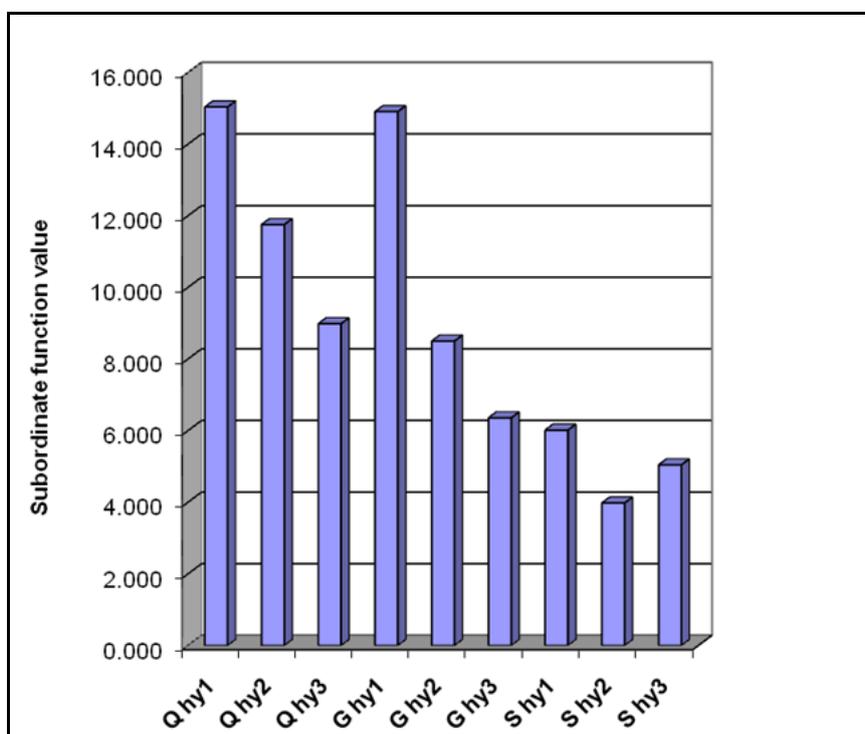


Fig. 10: Cumulative subordinate function value of all traits.

Generally, the performance of the hybrids was depending on the genetic, environmental, and the interactions between them.

These results are in accordance with the findings of Rao *et al.* (2001) registered that ten newly evolved bivoltine hybrids of silkworm, *Bombyx mori* L. were evaluated with control hybrid $K_4 \times NB_4D_2$ during three seasons of a year for their seasonal performance. Analysis of variance and other statistical methods were employed and the performance was observed in respect of 10 quantitative traits. The results showed significant genotype \times environment interactions with respect to four quantitative characters viz. fecundity, yield/10000 larvae, filament length, and raw silk (%). Environmental effects were significant for nine characters out of ten characters evaluated. $A_{105} \times J_2$ and $B \times NB_4D_2$ were considered

as highly adaptable hybrids to local conditions with a high mean for maximum characters studied and found suitable to rear in all seasons.

Conclusion

From the previous results, it could be concluded that hy_1 and hy_2 were superior over hy_3 for most characters under investigation. Rearing silkworm was better in Qalubya and Giza comparing with Sohag governorate. Performances of hybrids characters are changed according to the environment changed. The average CW, CSW, PW, CSR and SP traits is better for both sexes in Qalubya governorate. Hybrid of hy_1 was the best for CW, CSW, PW, CSR and SP traits for both sexes. Both of hybrids hy_1 and hy_2 were mostly the best hybrids in Qalubya, Giza and Sohag of females and males. Evaluation index values are depended on the hybrid which represented the genetic factor and the locations that represented the environmental factor and the interactions.

Three hybrids have better values subordinate for most characters in Qalubya governorate. Hybrids of hy_1 and hy_3 have better values of subordinate function in Giza governorate. While hy_1 and hy_2 hybrids showed better subordinate functions for two characters only and hybrid hy_3 have the best subordinate function for three characters. In Qalubya governorate hybrid hy_2 earned a higher subordinate function of most characters for females and males same trend was observed for Giza governorate. For Sohag governorate only one character is better for hy_1 and hy_3 hybrids. It recommended that some modifications for rearing technique, temperature, and humidity to be made to get better production. Q hy_1 , Q hy_2 , Q hy_3 , G hy_1 and G hy_2 have the highest cumulative subordinate function for all traits.

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ARABIC SUMMARY

تقدير تأثير الموقع ودليل التقييم و subordinate function لديدان الحرير التوتية في بعض المحافظات المصرية.

تحية عزوز فؤاد

قسم بحوث الحرير- معهد بحوث وقاية النباتات - مركز البحوث الزراعية.

تم تربية هجينين محليين وهجين مستورد من دودة الحرير *Bombyx mori* L. في ثلاث محافظات مصرية وهي القليوبية والجيزة وسوهاج. تم فحص اربعة عشر صفة وهي: طول العمر اليرقي الخامس، طول العمر اليرقي الكامل، نسبة الموت اليرقية، عدد الشرائق في اللتر، النسبة المئوية لتكوين الشرائق، النسبة المئوية للشرائق المزدوجة، النسبة المئوية للتغذير، محصول الشرائق بالعدد والوزن. أيضا بيانات وزن الشرنقة، وزن غلاف الشرنقة، وزن العذراء، نسبة المحتوي الحريري وإنتاجية الحرير لكلا من الذكور والإناث.

أظهرت النتائج أن تربية ديدان الحرير كانت أفضل في محافظة القليوبية والجيزة بالمقارنة بمحافظة سوهاج. اختلف أداء الهجن باختلاف البيئة. متوسط صفات وزن الشرائق CW، وزن غلاف الشرائق CSW، وزن العذاري PW، نسبة المحتوي الحريري CSR وإنتاجية الحرير SP كانت أفضل في كلا الجنسين في محافظة القليوبية. وكان الهجين hy_1 الأفضل في صفات CW، CSW، PW، CSR و SP لكلا الجنسين. وبصفة عامة كان الهجين hy_1 و hy_2 أفضل الهجن في القليوبية والجيزة وسوهاج للإناث والذكور.

وتعتمد قيم دليل التقييم و Subordinate function على الهجين والذي يمثل العامل الوراثي والموقع الذي يمثل العامل البيئي والتفاعل فيما بينهما.