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PERFORMANCE OF SOME FABA BEAN BAT FREE CAGE CONDITIONS

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ABSTRACT

Twenty-seven diversity faba bean (*Vicia faba L.*) genotypes were used to explore the potentiality of these genotypes and to investigate caging effects. The influence of insect free cage on performance of different studied characters was estimated as percentages of the insect free cage values to their corresponding open field ones. Results indicated that caged grown plants were taller, and produced lesser number of branches. The caged plants produced lower number of pods, seeds and seed yield/plant comparing genotypes under open field. In general all characters were more depressed by caging except flowering and ripening as well as plant height. High heritability values in broad sense were detected under open field and caged conditions for plant height, number of pods and 100-seed weight .

INTRODUCTION

Faba bean (*Vicia faba L.*) is the most important food legume that has the potential to provide the Egyptians' increasing demand for food. The crop is generally included in the crop rotation and has succeeded to keep the Egyptian soil fertile and productive through biological N2-fixation. The national faba bean acreage over last five years (2002-2007) was 215,000 feddan with an average productivity of 9.0 ardabs/feddan.

Faba bean is known as a partially cross-pollinated crop with natural outcrossing ranged from 30 – 60 % El-Emam (2005) depending on genetic, environmental, insect pollinator factors and their interactions.

Honeybees (*Apis mellifra*) were used to hybridize *Vicia faba* consequently increasing plant seed yield. Using a genetic marker, it was found that 79% cross-pollination could be reached by introducing honeybees in the population cage during flowering Nassib *et al* (1979). Seed yield in caged plots with bees was 25% higher than in those without bees(Somerville 1994 and 1999) .

The uncovered plots gave higher seed yield than the covered ones (Svendsen and Brodsgaard. 1997).

Heterozygosity and heterogeneity could improve yield performance and stability (Stelling *et al*., 1994, Darwish *et al*., 2001 and El-Emam, 2005).

Drayner (1959) stated that the ability of a plant to set seed in the absence of pollinating insects is known as auto-fertility, which varies with the genotype and the level of inbreeding, hybrids plants being more auto-fertile than inbred plots.

Drayner (1956) found that the hybrid plants produced more pollen, a factor that may be important in explaining auto-fertility. Auto-fertility may be measured by the ratio of seed set after tripping to seed set in the absence of tripping (Hays and Hanna, 1968). The ratio of seeds to flowers also provides

a good measure and seed set in the absence of insect pollinators compared to seed set in their presence can also be used to estimate auto-fertility. Kambal, (1969) stated that auto-fertility is an important characteristic in faba beans since it enables good yields to be produced even in the absence of pollinating insects. Lines exhibiting high level of auto-fertility have been widely reported (Holden and Bond 1960, Hanna and Lawes 1967 and Poulsen 1975 and 1979).

The efficiency of a breeding program depends largely on the availability of useful genetic variation, the heritability of traits and the selection procedure El-Emam, (2005). The success of selection depends upon the presence of sufficient genetic variability within and between populations to permit effective selection Abdalla, (1976).

Genetic information on faba bean is required to help breeder in planning suitable programs to develop early maturing cultivars that allow early sowing of summer crops is a request. El-Hosary (1983); El-Hady (1988) and El-Hady *et al*., (1991 a and b) pointed out that both additive and dominance gene effects were the important contribution for flowering date and other yield components.

Pedigree selection in segregating populations for targeted traits under improving is widely used for building open pollinated varieties. Within and between family selection are practiced until F_5 generation. The most homogeneous families that possessed reliable performance are the components of open variety, which engaged to early yield traits.

Therefore, the objective of this study was to explore the potentiality of seven diverse faba bean genotypes (Nubaria 1, Giza 461, Giza 429, T.W., ILB 938, Giza 2 and Giza 40), along with their F_5 lines and to investigate caging effects.

MATERIALS AND METHODS

The present investigation was carried out at Gemmeza Research Station, Gharbia Governorate, Agriculture Research Center (ARC), Egypt from 2001/02 to 2006/2007 seasons. All possible crosses of diallel mating design excluding reciprocals among seven faba bean (*Vicia faba L.*) parental genotypes were done by hand pollination, under insect free cage during 2001/02 growing season. The origin and characteristics of these parental genotypes are shown in Table (1). In 2006/2007 season, an experimental field trial was conducted under both open and caged conditions included seven parents and their available promising F_5 line selected from each crosses in a randomized complete block design (RCBD) with three replications. Each genotype was represented by two ridges, 3 m long and 60 cm apart. Single-seed per hill was planted at the two sides of the ridge, 20 cm between. All recommended cultural practices were applied. At maturity, all guarded plants were harvested individually. The following traits were collected:

1- Days to Flowering.
2- Days to Maturity
3- Plant height, (cm).

4- Number of branches/plant .
5- Number of pods/plant.
6- Number of seeds/plant.
7- Seed yield/plant, (g).
8- 100-seed weight, (g).

Statistical Manipulation:

The data were analyzed at randomized complete block design as outlined by Gomez and Gomez (1984).

The genotypic and phenotypic variances (δ^2g and δ^2ph) were calculated from the pertinent mean squares expectation as follows:

$\delta^2 g = (M_a - M_e)/r$

$\delta^2_{ph} = (\delta^2_g + \delta^2_e/r$, where $Ma = \delta^2_e + r\delta^2_g$, $Me = \delta^2_e$

broad sense heritability was calculated as follows:

$h^2_B = (\delta^2_g / \delta^2_{ph}) X 100$

The genotypic (G.C.V. %) and phenotypic coefficient of variability (P.C.V. %) were calculated as $\sqrt{(\delta^2_g/x)} X 100$ and $\sqrt{(\delta^2_{ph}/x)} X 100$.

The influence of insect free cage on performance of characters directly related to seed set i.e. plant height, number of branches /plant, number of pods/plant, number of seeds/plant, seed yield and 100-seed weight as well as days to flowering and maturity was studied by calculating the relative values as percentages of the insect free cage values to their corresponding open field ones.

Table (1): Origin, pedigree and characteristics of the seven parental genotypes.

Genotype	Origin	Pedigree	Special characteristic
Nubaria 1(P_1)	FCRI*	Individual selected plant from Spanish variety Reina Blanca	Large-seeded, foliar-disease resistant, colorless-hilum seed .
Giza 461(P_2)	FCRI	Giza 3 X ILB 938	Medium seeded type, moderately disease resistant, light brown hilum color, late flowering and maturity.
Giza 429(P_3)	FCRI	Individual Selected plant from Giza 402	Resistant to Orobanche crenata.
Triple white (T. W.) (P_4)		Introduced from England	High degree of auto-fertility, colorless stem, white flower with light seed coat color, colorless hilum.
ILB 938 (P_5)	Colombia	Germ accession from Colombia, Equador	Late flowering, green seed coat color, foliar disease resistant.
Giza 2(P_6)	FCRI	Single plant selection	Early flowering and medium seed size.
Giza 40(P_7)	FCRI	Individual selected plant from Rebaya 40	Small-seeded, early maturing.

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RESULTS AND DISCUSSION

The analysis of variance for each environment (caged or open field) for yield and its components are presented in Table 2.

Genotype mean squares were highly significant for all traits.

The performance of caged and open field genotypes are presented in Table 3. In general cage grown plants were taller, and produced lesser number of branches, Varis and Brax, (1990) found that the shading effect of cages resulted in taller plants. Similar results were found by El-Harty (1999) and El-Emam (2005).

All parental genotypes flowered and matured earlier in open field than those under caged condition. On the other hand, three lines (P_2XP_4) L6, (P4X P6) L14 and (P4XP7) L19, and flowered and matured earlier under cage condition than open field.

Table (3): Mean performance of open field materials and sister ones grown in the caged conditions .

Genotype	Days to Flowering		Days to Maturity		Plant height (cm)		Number of branches/plant	
	Open	Cage	Open	Cage	Open	Cage	Open	Cage
Nubaria 1 (P1)	75.0	82.7	164.7	173.3	90.7	130.0	5.6	1.8
Giza 461 (P2)	58.0	62.7	157.7	163.7	98.7	113.3	4.3	1.0
Giza 429 (P3)	52.7	60.7	154.0	161.7	95.7	123.3	3.5	1.8
T. W. (P4)	45.0	51.3	146.0	153.7	81.7	105.0	2.3	1.3
ILB 938 (P5)	82.3	87.7	164.3	172.0	93.0	131.7	4.5	2.2
Giza 2 (P6)	54.3	57.7	154.7	159.3	87.0	125.0	4.3	1.7
G.iza 40 (P7)	56.3	61.7	159.0	164.3	86.7	126.7	3.8	2.5
P_1 x P_2 (L_1)	58.0	60.0	157.0	164.7	109.7	124.0	5.3	4.9
P_1 x P_3 (L_2)	59.7	57.0	157.7	166.0	113.7	126.0	5.3	4.5
P_1 x P_4 (L_3)	63.3	60.0	163.7	166.7	119.0	120.0	5.3	5.0
P_1 x P_5 (L_4)	57.3	67.0	159.3	166.7	109.3	126.0	5.0	4.7
P_2 x P_3 (L_5)	60.3	56.0	158.3	166.3	112.3	124.7	5.2	3.4
P_2 x P_4 (L_6)	61.7	58.3	164.7	162.0	111.0	124.0	4.4	3.7
P_2 x P_5 (L_7)	61.7	63.0	161.7	167.7	113.0	123.3	5.3	3.8
P_3 x P_4 (L_8)	60.3	56.3	159.7	163.3	113.0	124.0	6.1	3.5
P_3 x P_5 (L_9)	61.0	65.3	162.7	165.7	111.3	124.7	5.1	3.4
P_4 x P_5 (L_{10})	59.3	60.7	164.0	162.3	118.0	129.0	5.5	3.6
P_1 x P_6 (L_{11})	59.3	61.0	159.0	166.0	116.0	115.3	5.7	3.5
P_2 x P_6 (L_{12})	60.0	59.0	159.0	164.0	116.7	123.0	5.8	3.8
P_3 x P_6 (L_{13})	50.7	57.0	155.7	162.0	115.0	129.3	4.6	3.6
P_4 x P_6 (L_{14})	60.7	51.0	159.7	158.7	116.3	133.3	5.1	3.5
P_5 x P_6 (L_{15})	58.7	66.0	160.0	166.3	118.7	142.3	5.8	3.4
P_1x P_7 (L_{16})	56.3	62.0	158.3	166.0	118.7	119.0	4.7	3.7
P_2 x P_7 (L_{17})	56.0	54.7	158.3	162.3	110.7	141.7	6.3	4.1
P_3 x P_7 (L_{18})	57.0	55.7	158.7	162.3	109.7	141.0	5.5	6.5
P_5 x P_7 (L_{19})	61.0	51.0	159.7	158.7	111.7	134.7	4.6	3.9
P_5 x P_7 (L_{20})	53.3	61.7	157.0	163.0	111.7	122.3	4.7	3.4
Mean	59.2	61.0	159.1	164.0	107.7	126.0	4.9	3.4
LSD0.05 genotypes (G)	10.5	2.9	5.1	3.4	7.7	10.3	1.5	1.0

Table (3): Cont.

Genotype	Number of pods / plant		Number of seeds / plant		Seed yield / plant (g)		100-seed weight (g)	
	Open	Cage	Open	Cage	Open	Cage	Open	Cage
Nubaria 1 (P1)	15.3	10.0	57.7	29.3	63.1	36.7	109.5	125.0
Giza 461 (P2)	24.0	7.7	66.0	21.3	44.8	16.9	67.9	79.4
Giza 429 (P3)	24.0	14.3	76.0	23.7	50.3	17.4	66.2	73.4
T. W. (P4)	19.7	8.0	42.3	15.7	20.9	8.5	49.4	54.5
ILB 938 (P5)	19.0	14.0	42.7	24.3	31.0	21.3	72.7	87.5
Giza 2 (P6)	23.7	16.0	62.3	37.5	34.7	24.8	55.6	66.1
G.iza 40 (P7)	17.7	16.7	47.7	44.7	30.6	31.7	62.3	71.0
P_1 x P_2 (L_1)	20.9	20.2	59.6	52.8	50.8	43.0	85.2	81.3
P_1 x P_3 (L_2)	24.4	25.1	63.2	58.9	49.2	45.1	76.9	76.6
P_1 x P_4 (L_3)	24.3	18.9	63.4	56.6	45.4	46.0	72.0	81.4
P_1 x P_5 (L_4)	22.4	20.9	61.1	50.6	50.2	40.0	81.8	79.2
P_2 x P_3 (L_5)	24.3	25.9	66.3	56.2	54.8	39.9	82.0	70.9
P_2 x P_4 (L_6)	20.6	24.8	51.9	60.2	36.9	37.8	70.7	62.6
P_2 x P_5 (L_7)	24.7	20.8	63.8	40.9	47.4	31.9	74.9	76.6
P_3 x P_4 (L_8)	22.3	20.5	64.7	50.4	56.1	34.9	86.5	69.1
P_3 x P_5 (L_9)	21.3	22.2	59.3	49.2	41.7	32.6	70.6	66.4
P_4 x P_5 (L_{10})	21.2	23.9	59.7	51.0	41.5	35.7	69.5	69.9
P_1 x P_6 (L_{11})	24.5	14.7	66.3	35.2	48.1	25.0	72.5	71.2
P_2 x P_6 (L_{12})	25.3	24.0	79.6	60.5	60.5	41.5	77.4	68.6
P_3 x P_6 (L_{13})	25.6	26.6	65.8	70.2	44.8	45.4	68.0	64.6
P_4 x P_6 (L_{14})	23.2	21.2	66.1	47.8	48.8	32.9	73.7	68.8
P_5 x P_6 (L_{15})	25.9	28.3	66.4	42.8	47.0	29.3	71.4	68.5
P_1x P_7 (L_{16})	21.0	21.3	56.4	44.1	42.6	31.1	75.6	70.5
P_2 x P_7 (L_{17})	25.9	19.7	73.8	37.1	53.3	27.6	71.8	74.4
P_3 x P_7 (L_{18})	26.3	18.9	68.1	48.5	47.8	34.2	70.2	70.7
P_5 x P_7 (L_{19})	21.3	23.1	63.4	50.1	50.9	33.1	79.9	66.2
P_5 x P_7 (L_{20})	24.2	17.2	64.2	42.0	46.2	32.7	71.4	77.7
Mean	22.7	19.4	62.1	44.5	45.9	32.5	73.5	73.8
LSD0.05 genotypes (G)	11.32	10.64	16.6	6.1	13.3	4.3	9.0	3.1

Concerning number of pods, number of seeds and seed yield/plant, it was observed that these characters were badly affected by caging than open field condition. The following genotypes: Giza 461(P_2), Giza 429 (P_3) and T.W. (P_4) (recorded 7.7, 14.3 and 8.0 pods/plant under cage in spite of 24.0, 24.0 and 19.7 pods/plant under open condition. Also the same genotypes exhibited 21.3, 23.7 and 15.7 seeds/plant under cage condition compared with 66.0, 76.0 and 42.3 seeds/plant under open field.

These results are in full agreement with those obtained by El-Harty (1999).

All lines have been affected by caging except (P_2XP_4) L6 and (P_3XP_6) L13, which recorded lower estimates of pods, seeds and seed yield/plant (20.6, 51.9 and 36.9 respectively) in open than cage condition (24.8, 60.2 and 37.8 in the same order) .

Regarding seed index, caging parental genotypes exceeded their sisters under open field, on the contrary, all lines under open field exceeded the other ones under cage condition except the four lines: (P_1 XP_4) L3 (P_2 XP_5) L7 (P_2XP_7) L17 and (P_5 X P_7) L20.

Table (4) show the performance of caged grown plots relative to field grown ones assuming the field grown ones to be 100. All parental genotypes were taller, flowered and matured latterly, and produced lower number of branches/plant as well as exhibited heaviest 100-seed weight under caging .

Concerning number of pods, seeds and seed yield/plant, the cage plants produced lower number of pods, seeds and seed yield/plant comparing the parental genotypes under open field.

Regarding F_5 lines ten, sixteen, nineteen, one, nine, two, three and six lines expressed highly relative percentages for flowering date, maturity date, plant height, number of branches , number of pods/ plant, number of seeds/plant, seed yield/plant and seed index with a range of 1.02 – 1.17; 1.02 – 1.05; 1.01 – 1.29; 1.18; 1.01– 1.20; 1.07 – 1.16; 1.01 – 1.02 and 1.01 – 1.13 %, respectively. In general all characters were more depressed by caging except flowering and ripening as well as plant height (El-Harty 1999).

All tested genotypes were different in tolerating caging effects. In this respect Koltwiski (1996) found that the open pollinated plants produced, on average 30% more pods, 13 % more seed /pod, 47% more seeds/m^2 and 23% higher seed yield/m^2.

The genetic statistics estimated of obtained data regarding the expected progress for improving various traits either under cage or under open field are presented in Table (5).

The tabulated data revealed that genotypes under open field possessed wide phenotypic and genotypic variances than their sister under cage condition for all studied traits except plant height.

All studied genotypes showed slight variations for flowering and maturity, the open field possessed (2 – 5 days) earlier than caged ones for these two traits.

Also genotypes under open field exhibited greater phenotypic (PCV %) and genotypic (GCV %) coefficient of variation, than those under caged condition except plant height, number of branches/plant and seed yield/plant. This situation reflected in higher estimated of heritabilities for these traits than caged ones.

Heritability in broad sense for all studied traits under both cage and open field is presented in Table (5) .

In all cases, high heritability values in broad sense were detected and ranged from 80.84% for plant height to 99.20 % for 100-seed weight (under open field) and from 35.33% for number of pods/plant to 94.00 % for plant height (under caged conditions) Accordingly .

According, it is expected that an effective selection in these traits could be achieved with a satisfactory degree of accuracy.

The above mentioned results are in full agreement with those obtained by El-Harty (1999) and El-Emam (2005), who mentioned that faba bean genotypes under open field exceeded those under caged condition

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Auto-fertility provides yield stability in absence of the fluctuating pollinating agents. Consequently some breeders may be interested to include this characteristic in the developed stocks. But most breeders prefer to breed for heterozygosity-heterogeneity that will result in stability and high yield. It worth mention that Kambal (1969) and El-Harty (1999) reported that local Sudanese line T.W. was highly auto-fertile. Abdalla and Fischbeck (1983) reported that hybridization between different fertility groups improved fertility of low fertility sorts. Self-fertility has been previously studied by different authors.

Drayner (1959) reported that the expression of auto-fertility was affected by many genetic factors. Adcock and Lawes (1976) suggested that self fertile genotypes not only yield well in the absence of bee pollination but also have the ability to transmit the characters of self fertility to their progeny.

Table (5): The phenotypic (δ^2ph), genotypic(δ^2g) variances, mean, broad sense heritability(h^2B), phenotypic (PCV%) and genotypic (GCV%) coefficients of variability of various traits under open and caged condition.

	Days to Flowering	Days to Maturity	Plant height (cm)	No. of branches /plant	No. of pods / plant	No. of seeds /plant	Seed yield /plant	100-seed weight (g)
	Under open field							
δ^2ph	66.70	15.91	68.78	1.48	29.54	175.75	84.65	151.26
δ^2g	65.66	14.50	55.60	1.35	28.54	171.22	82.35	150.06
Mean	59.20	159.10	107.70	4.90	22.70	62.10	45.90	73.50
H^2B %	98.45	91.10	80.84	90.94	96.61	97.43	97.29	99.20
PCV %	13.80	2.51	7.70	24.85	23.94	21.35	20.04	16.73
GCV %	13.69	2.39	6.92	23.69	23.53	21.07	19.77	16.67
	Under cage							
δ^2ph	47.67	15.36	123.87	0.74	7.35	74.77	84.66	115.86
δ^2g	34.05	12.07	116.44	0.47	2.60	40.67	62.68	105.93
Mean	61.00	164.0	126.0	3.40	19.40	44.50	32.50	73.80
H^2B %	71.43	78.62	94.00	63.01	35.33	54.40	74.04	91.42
PCV %	11.32	2.39	8.83	25.28	13.97	19.43	28.31	14.59
GCV %	9.57	2.12	8.56	20.07	8.30	14.33	24.36	13.95

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أداء بعض التراكيب الوراثية من الفول البلدي تحت ظروف الحقل المفتوح والشباك المانعة للحشرات

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تم دراسة أداء سبعة وعشرون تركيباً وراثياً من الفول البلدي متباعدة وراثياً ، وتأثير الشباك المانعة للحشرات على المحصول ومكوناته، مثل طول النبات، عدد أفرع النبات، عدد قرون النبات، عدد بذور النبات، محصول النبات ووزن الـ ١٠٠ بذرة ، بالإضافة لصفتي التزهير والنضج ، وذلك عن طريق حساب نسبة قيم هذه الصفات تحت الشباك المانعة للحشرات بمثيلتها تحت الحقل المفتوح. وقد أظهرت النتائج أن النباتات تحت الشباك المانعة للحشرات كانت أطول وأقل تفريعاً ، كما أنها أنتجت عدد أقل من القرون والبذور ومحصول النبات بالمقارنة بالنباتات تحت ظروف الحقل المفتوح. وقد انخفضت قيم صفات النباتات المغطاة عدا صفتي التزهير والنضج ، بالإضافة إلى صفة طول النبات. وقد تباينت التراكيب الوراثية من حيث تأثرها بالشباك المانعة للحشرات . كانت قيم المكافئ الوراثي تحت الحقل المفتوح عالية ، حيث تراوحت بين ٨٠,٨٤ % لصفة طول النبات حتى ٩٩,٢٠ % لصفة وزن الـ ١٠٠ بذرة، مما يوضح فاعلية الانتخاب لتحسين هذه الصفات. في حين أن النسب تراوحت بين ٣٥,٣٣% لصفة عدد قرون النبات وحتى ٩٤ % لصفة طول النبات وذلك تحت ظروف الشباك المانعة للحشرات.

Table (2): Significance of mean squares due to different sources of variation for studied traits under open ands caged conditions .

Source of variance	d.f.	Days to Flowering		Days to Maturity		Plant height (cm)		No. of branches /plant	
		Open	Caged	Open	Caged	Open	Caged	Open	Caged
Genotype (G)	26	200.10**	143.02**	47.74**	46.07**	206.33**	371.62**	4.45**	0.22**
Error	52	3.11	40.86	4.24	9.85	39.53	22.31	0.40	0.82

Table (2) Cont.

Source of variance	d.f.	Number of pods / plant		Number of seeds / plant		Seed yield / plant (g)		100-seed weight (g)	
		Open	Caged	Open	Caged	Open	Caged	Open	Caged
Genotype (G)	26	59.98**	86.58	527.24**	224.30**	253.94**	253.99**	453.78**	347.59**
Error	52	22.370	19.77	13.58	102.29	6.88	65.94	3.62	29.81

** Significant at 0.01 level

Table (4): Relative performance of open field materials to sister ones grown in the caged conditions.

Genotype	Days to Flowering			Days to Maturity			Plant height (cm)			Number of branches/plant		
	Open	Cage	Relative	Open	Cage	Relative	Open	Cage	Relative	Open	Cage	Relative
Nubaria 1 (P1)	75.0	82.7	1.10	164.7	173.3	1.05	90.7	130.0	1.43	5.6	1.8	0.32
Giza 461 (P2)	58.0	62.7	1.08	157.7	163.7	1.04	98.7	113.3	1.15	4.3	1.0	0.23
Giza 429 (P3)	52.7	60.7	1.15	154.0	161.7	1.05	95.7	123.3	1.29	3.5	1.8	0.51
T. W. (P4)	45.0	51.3	1.14	146.0	153.7	1.05	81.7	105.0	1.29	2.3	1.3	0.57
ILB 938 (P5)	82.3	87.7	1.07	164.3	172.0	1.05	93.0	131.7	1.42	4.5	2.2	0.49
Giza 2 (P6)	54.3	57.7	1.06	154.7	159.3	1.03	87.0	125.0	1.44	4.3	1.7	0.40
G.iza 40 (P7)	56.3	61.7	1.10	159.0	164.3	1.03	86.7	126.7	1.46	3.8	2.5	0.66
P_1 x P_2 (L_1)	58.0	60.0	1.03	157.0	164.7	1.05	109.7	124.0	1.13	5.3	4.9	0.92
P_1 x P_3 (L_2)	59.7	57.0	0.95	157.7	166.0	1.05	113.7	126.0	1.11	5.3	4.5	0.85
P_1 x P_4 (L_3)	63.3	60.0	0.95	163.7	166.7	1.02	119.0	120.0	1.01	5.3	5.0	0.94
P_1 x P_5 (L_4)	57.3	67.0	1.17	159.3	166.7	1.05	109.3	126.0	1.15	5.0	4.7	0.94
P_2 x P_3 (L_5)	60.3	56.0	0.93	158.3	166.3	1.05	112.3	124.7	1.11	5.2	3.4	0.65
P_2 x P_4 (L_6)	61.7	58.3	0.94	164.7	162.0	0.98	111.0	124.0	1.12	4.4	3.7	0.84
P_2 x P_5 (L_7)	61.7	63.0	1.02	161.7	167.7	1.04	113.0	123.3	1.09	5.3	3.8	0.72
P_3 x P_4 (L_8)	60.3	56.3	0.93	159.7	163.3	1.02	113.0	124.0	1.10	6.1	3.5	0.57
P_3 x P_5 (L_9)	61.0	65.3	1.07	162.7	165.7	1.02	111.3	124.7	1.12	5.1	3.4	0.67
P_4 x P_5 (L_{10})	59.3	60.7	1.02	164.0	162.3	0.99	118.0	129.0	1.09	5.5	3.6	0.65
P_1 x P_6 (L_{11})	59.3	61.0	1.03	159.0	166.0	1.04	116.0	115.3	0.99	5.7	3.5	0.61
P_2 x P_6 (L_{12})	60.0	59.0	0.98	159.0	164.0	1.03	116.7	123.0	1.05	5.8	3.8	0.66
P_3 x P_6 (L_{13})	50.7	57.0	1.12	155.7	162.0	1.04	115.0	129.3	1.12	4.6	3.6	0.78
P_4 x P_6 (L_{14})	60.7	51.0	0.84	159.7	158.7	0.99	116.3	133.3	1.15	5.1	3.5	0.69
P_5 x P_6 (L_{15})	58.7	66.0	1.12	160.0	166.3	1.04	118.7	142.3	1.20	5.8	3.4	0.59
P_1x P_7 (L_{16})	56.3	62.0	1.10	158.3	166.0	1.05	118.7	119.0	1.00	4.7	3.7	0.79
P_2 x P_7 (L_{17})	56.0	54.7	0.98	158.3	162.3	1.03	110.7	141.7	1.28	6.3	4.1	0.65
P_3 x P_7 (unTha	57.0	55.7	0.98	158.7	162.3	1.02	109.7	141.0	1.29	5.5	6.5	1.18
P_5 x P_7 (L_{19})	61.0	51.0	0.84	159.7	158.7	0.99	111.7	134.7	1.21	4.6	3.9	0.85
P_5 x P_7 (L_{20})	53.3	61.7	1.16	157.0	163.0	1.04	111.7	122.3	1.09	4.7	3.4	0.72
Mean	59.2	61.0	1.03	159.1	164.0	1.03	107.7	126.0	1.17	4.9	3.4	0.69

Table (4): Cont.

Genotype	Number of pods / plant			Number of seeds / plant			Seed yield / plant (g)			100-seed weight (g)		
	Open	Cage	Relative	Open	Cage	Relative	Open	Cage	Relative	Open	Cage	Relative
Nubaria 1 (P1)	15.3	10.0	0.65	57.7	29.3	0.51	63.1	36.7	0.58	109.5	125.0	1.14
Giza 461 (P2)	24.0	7.7	0.32	66.0	21.3	0.32	44.8	16.9	0.38	67.9	79.4	1.17
Giza 429 (P3)	24.0	14.3	0.60	76.0	23.7	0.31	50.3	17.4	0.35	66.2	73.4	1.11
T. W. (P4)	19.7	8.0	0.41	42.3	15.7	0.37	20.9	8.5	0.41	49.4	54.5	1.10
ILB 938 (P5)	19.0	14.0	0.74	42.7	24.3	0.57	31.0	21.3	0.69	72.7	87.5	1.20
Giza 2 (P6)	23.7	16.0	0.68	62.3	37.5	0.60	34.7	24.8	0.71	55.6	66.1	1.19
G.iza 40 (P7)	17.7	16.7	0.94	47.7	44.7	0.94	30.6	31.7	1.03	62.3	71.0	1.14
P_1 x P_2 (L_1)	20.9	20.2	0.97	59.6	52.8	0.89	50.8	43.0	0.85	85.2	81.3	0.95
P_1 x P_3 (L_2)	24.4	25.1	1.03	63.2	58.9	0.93	49.2	45.1	0.92	76.9	76.6	1.00
P_1 x P_4 (L_3)	24.3	18.9	0.78	63.4	56.6	0.89	45.4	46.0	1.01	72.0	81.4	1.13
P_1 x P_5 (L_4)	22.4	20.9	0.93	61.1	50.6	0.83	50.2	40.0	0.80	81.8	79.2	0.97
P_2 x P_3 (L_5)	24.3	25.9	1.07	66.3	56.2	0.85	54.8	39.9	0.73	82.0	70.9	0.86
P_2 x P_4 (L_6)	20.6	24.8	1.20	51.9	60.2	1.16	36.9	37.8	1.02	70.7	62.6	0.89
P_2 x P_5 (L_7)	24.7	20.8	0.84	63.8	40.9	0.64	47.4	31.9	0.67	74.9	76.6	1.02
P_3 x P_4 (L_8)	22.3	20.5	0.92	64.7	50.4	0.78	56.1	34.9	0.62	86.5	69.1	0.80
P_3 x P_5 (L_9)	21.3	22.2	1.04	59.3	49.2	0.83	41.7	32.6	0.78	70.6	66.4	0.94
P_4 x P_5 (L_{10})	21.2	23.9	1.13	59.7	51.0	0.85	41.5	35.7	0.86	69.5	69.9	1.01
P_1 x P_6 (L_{11})	24.5	14.7	0.60	66.3	35.2	0.53	48.1	25.0	0.52	72.5	71.2	0.98
P_2 x P_6 (L_{12})	25.3	24.0	0.95	79.6	60.5	0.76	60.5	41.5	0.69	77.4	68.6	0.89
P_3 x P_6 (L_{13})	25.6	26.6	1.04	65.8	70.2	1.07	44.8	45.4	1.01	68.0	64.6	0.95
P_4 x P_6 (L_{14})	23.2	21.2	0.91	66.1	47.8	0.72	48.8	32.9	0.67	73.7	68.8	0.93
P_5 x P_6 (L_{15})	25.9	28.3	1.09	66.4	42.8	0.64	47.0	29.3	0.62	71.4	68.5	0.96
P_1x P_7 (L_{16})	21.0	21.3	1.01	56.4	44.1	0.78	42.6	31.1	0.73	75.6	70.5	0.93
P_2 x P_7 (L_{17})	25.9	19.7	0.76	73.8	37.1	0.50	53.3	27.6	0.52	71.8	74.4	1.04
P_3 x P_7 (L_{18})	26.3	18.9	0.72	68.1	48.5	0.71	47.8	34.2	0.72	70.2	70.7	1.01
P_5 x P_7 (L_{19})	21.3	23.1	1.08	63.4	50.1	0.79	50.9	33.1	0.65	79.9	66.2	0.83
P_5 x P_7 (L_{20})	24.2	17.2	0.71	64.2	42.0	0.65	46.2	32.7	0.71	71.4	77.7	1.09
Mean	22.7	19.4	0.86	62.1	44.5	0.72	45.9	32.5	0.71	73.5	73.8	1.00