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EFFECTS OF SALINE AFFECTED SOIL AND RHIZOBIUM INOCULATION ON PERFORMANCE AND VARIATION OF SIXTEEN FABA BEAN GENOTYPES

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ABSTRACT

Four field experiments were carried out in 2003/2004 and 2004/2005 seasons at Demo Research Station, Faculty of agriculture, Fayoum University to study the response of 16 genotypes of faba bean to effect four Rhizobium inoculation under variable salinity soil conditions. Mean squares due to main effects salinity (S), Rhizobium treatments (R), genotypes(G) and S x R, S x G, R x G and S x R x G interaction were significant for most studied characters in both seasons. Broad sense heritability estimates were low to moderate for all recorded traits and ranged from 15.6 and 37.0% for plant dry weight to 62.8 and 58.4% for 100-seed weight in the first and second seasons, respectively. Salinity stress affected most traits studied in both seasons. Seed yield and other characters were significantly decreased by soil salinity. Most faba bean characters were significantly increased by seed inoculation. Wide range and significant differences were observed between genotypes for various traits recorded in both seasons, suggested the presence of significant genetic variability. The lines no. 15, 12, 13 and 14, are promising for improving seed yield. The interaction between different treatments under study showed significant effects on most characters in both seasons. Positive and significant correlation coefficient was found between seed yield/plant and each of plant dry weight and number of pods and seeds/plant under normal and saline soil conditions. Significant positive correlation was found between all possible pairs of traits under normal and saline soil. Plant dry weight, number of seeds/plant and number of pods/plant, respectively, were considered the most important selection criteria for improving faba bean seed yield, which had the most prominent direct positive effects on seed yield/plant in the path coefficient analysis.

Key words: ***Faba bean, Vicia faba, Rhizobium, Genotypes, Salinity, Correlation, Path coefficient analysis.***

INTRODUCTION

Faba bean (*Vicia faba* L.) is considered the major food legume crop in Egypt. This is not only for protein source with relatively low price but also its role in enriching and improving soil proprieties. The legume-*Rhizobium* symbiosis is a highly integrated system. Soil based stress may act on the symbiosis indirectly by reducing plant growth and available photosynthesis, or by directly affecting the infection process and/or nodule function. Nassef *et al.* (2005) reported that plants inoculated with *Rhizobium* increased seed yield of faba bean by 27.4 and 11.9% in Minia and 21.7 and 41.8% in New-Valley in the first and the second seasons, respectively. Also Saleh *et al* (2000) found that inoculation with *Rhizobium* increased faba bean yield by 0.28 ton/ha

(8.8%) compared with uninoculated treatments as well as Hussein *et al* (1997) who reported that the *Rhizobium* inoculation increased seed and straw yields of faba bean by average of 0.69 ton/ha and 1.08 ton/ha, respectively. Many studies indicated that *Rhizobium* inoculation increased seed and straw yields of faba bean (Abo El-Soud *et al* 2004 and Mekhemar *et al* 2005). Wide variability among faba bean genotypes regarding salinity tolerance was reported by several workers such as Yousif and Salih 1989, Dua *et al* 1989, Melesse and Caesar 1992 and Darwish *et al* (2003). Soliman *et al* (2005) reported that the response of genotypes for salinity was highly different for seed yield and yield attributes characters. Also, Pessarakil 1991 stated that salinity has been recognized as a major agricultural problem in arid and semi-arid regions. Salt tolerance of plants is of great economic and scientific importance. The economic impetus for research and developed derives from the fact that salt affected soils occupy about 10% of the world's arable land (Tanji 1990).

Correlation and path coefficient analysis are helpful to the breeder to determine the relative importance of yield attributes in influencing seed yield. The phenotypic correlation to seed yield was previously reported by Saad and El-Kholy (2000). Also, Farag (2007) who reported that number of seeds per pod and 100-seed weight appeared to the principle yield attributes for indirect selection criteria.

The aim of this study is to determine the effect of soil salinity and inoculation with different strains of *Rhizobium leguminosarum* biovar. *Vicine* on yield and some other agronomic traits of sixteen genotypes of faba bean hoping to select the more salt tolerant genotypes which responsed to *Rhizobium* inoculation.

MATERIALS AND METHODS

Four field experiments were carried out during 2003/2004 and 2004/2005 seasons at Demo Research Station, Faculty of Agriculture, Fayoum University. In each season two experiments were conducted at normal and saline soil effected soil conditions. The physical and chemical properties of soil of the experimental site showed that, the soil is sandy loamy in texture with EC 2.47 ds/m (1581 ppm) and 2.90 ds/m (1856 ppm) of normal soil conditions in first and second seasons, respectively, and 4.84 ds/m (3098 ppm) and 4.20 ds/m (2688 ppm) of saline soil conditions in the first and second seasons, respectively. Preceding crop was peanut in the 1st season and maize in the 2nd one. The genetic materials used in each experiment consisted of sixteen genotypes which included seven cultivars, namely; Sakha 2(1), Giza 40 (2), Giza 429 (3), Giza 3 (4), Nubaria 1 (5), Giza 843 (6) and Giza 716 (7) and nine promising mutant lines selected in 6th mutant generation coded: 248 (8), 258 (9), 244 (10), 252 (11), 278 (12), 332 (13), 336 (14), 285 (15) and 163 (16). These lines were derived from irradiated the seed of the varieties, Giza 461, Nubaria 1, Giza 643, Giza 461, Giza 717, Giza 714 and Giza 2, in the same order as shown in Table (1).

Four treatments of *Rhizobium leguminosarum* i.e. control (R1), F.b. ARC 200 (R2), F.b ARC 201 (R3) and F.b. ICARDA (ARC) 448 (R4) were used as seed inoculants. The experimental design was laid out in split-plot design with three replications for each experiment. *Rhizobium* inoculation was assigned in the main-plots and genotypes were arranged in the sup-plots. The experimental plot consisted of four ridges, 3m in long and 60 cm apart. Plants spaced 20 cm within the row and one plant was left per hill in two sides of the ridge. Seeds were treated with inoculants in the field directly before sowing as recommended. Normally cultural practices were followed as usual in faba bean fields. Faba bean seeds were sown on 19 and 8 November in both seasons, respectively. At harvest, 10 guarded plants per plot were sampled for recording the following characters: plant dry weight included roots (g), number of branches/plant, number of pods/plant, number of seeds/plant, seed yield/plant (g) and 100-seed weight (g).

Table 1. Mutant lines used in the study, their parents and gamma-ray doses

Line code number	Parents	γ-ray doses
248	Giza 461	3 Kr
258	Nubaria 1	3 Kr
244	Giza 643	12 Kr
252	Giza 461	6 Kr
278	Nubaria 1	3 Kr
332	Giza 717	6 Kr
336	Giza 714	3 Kr
285	Giza 643	9 Kr
163	Giza 2	3 Kr

Statistical procedures

In each season, combined analysis of variance over normal and saline experiments was done according to Snedecor and Cochran (1992) for all studied traits. Phenotypic, genotypic and environmental coefficients of variation and broad sense heritability (h^2_b) were calculated using variance components method (Fehr 1987). Phenotypic correlation coefficient over the two seasons, genotypes and *Rhizoium* inoculation treatments under normal and saline soil conditions for seed yield/plant and other characters were determined as shown by Singh and Chaudhary (2004). Partitioning of phenotypic correlation coefficient to direct and indirect effects were made by determining path coefficient analysis using the method explained by Dewey and Lu (1959), to estimate the relative importance (RI %) of each variable to the total yield variation under normal and saline soil conditions.

RESULTS AND DISCUSSION

Analysis of variance components

The significance of mean squares of combined analysis over saline soil conditions during 2003/2004 and 2004/2005 seasons is presented in Table (2). Soil salinity highly significantly affected all recorded traits in both seasons except 100-seed weight in the first season and no. of pods/plant, seeds/plant and seed yield/plant in the second season. Concerning *Rhizobium* treatments, all characters differed highly significant or significant in both seasons except no. of branches/plant in the first season. Highly significant differences were observed among faba bean genotypes for all characters in both seasons. The effects of the interaction between different factors in this study were found to be highly significant or significant for all traits recorded in both seasons, except of SXR interaction for 100-seed weight in the first season. These results indicated the wide diversity among the faba bean genotypes concerning the performance of different traits affected by various investigated factors. Furthermore, such genotypes performance varied significantly from illustrated treatment to another. Moreover, the environmental conditions significantly affected the performance of faba bean genotypes as proved by different magnitude of variance and significance that was not consistent between both seasons. The sensitivity of faba bean to environmental effects was recorded by (Darwish and Abdalla 1994 and Abdalla and Darwish 1996). These results are in agreement with those obtained by EL-Hosary and Sedhom (1990) and Alghamdi and Ali (2004). Darwish *et al* (2003) recorded that salinity levels and genotypes significantly influenced the performance of faba bean characters. Moreover, faba bean genotypes reacted differently to various levels of salinity, which offered opportunities of selecting an appropriate genotype for certain salinity level.

Phenotypic, genotypic and environmental coefficients of variation and broad sense heritability are presented in the same Table (2). The results illustrated that the magnitude of environmental variance was greater than that of genotypic variance for all studied traits in both seasons, except no of branches/plant and 100-seed weight in the first season, as well as no. of pods and seeds/plant and 100-seed weight in the second season. Broad sense heritability estimates were low to moderate for all recorded traits and ranged from 15.6 and 37.0% for plant dry weight to 62.8 and 58.4% for 100-seed weight in the first and second seasons, respectively. The results indicated that the environment had a wide effect on inheritance of such characters (Omar 2003).

Table 2. Significance of mean squares, phenotypic (σph), genotypic (σg) and environmental (σe) coefficients of variation and broad sense heritability (h^2_b) for recorded traits of combined analysis over two soil salinity levels during 2003/2004 and 2004/2005 seasons.

S.O.V	DF	Plant dry weight		Branches/ plant		Pods /plant		Seeds /plant		Seed yield /plant (g)		100-seed weight (g)	
Saline soil (S)	1	37827.9	**	106.8	**	1845.4	**	14660.7	**	8315.2	**	25.9	
Replications	4	63.4		0.8		3.5		37.4		23.5		45.1	
Rizobyme (R)	3	281.0	**	0.6		27.7	**	80.0	*	52.0	*	586.5	**
SXR	3	706.5	**	1.2	*	9.9	*	70.3	*	72.7	**	61.2	
Error	12	37.9		0.3		2.8		15.1		9.6		61.2	
Genotype (G)	15	790.8	**	15.9	**	174.6	**	843.8	**	253.1	**	2254.3	**
SXG	15	351.2	**	2.2	**	37.8	**	232.2	**	104.4	**	183.1	**
RXG	45	321.0	**	1.6	**	21.2	**	155.7		100.9	**	97.6	**
SXRXG	45	410.9	**	2.4	**	24.0	**	167.5		115.2	**	95.7	**
Error	240	119.1		0.5		7.5		51.3		33.9		51.0	
σph		141.1		1.1		13.3		77.3		40.7		137.3	
σg		22.1		0.6		5.8		26.0		6.8		86.2	
σe		119.1		0.5		7.5		51.3		33.9		51.0	
h^2_b		15.6		53.6		43.7		33.6		16.7		62.8	
						Second season							
Saline soil (S)	1	182.5	**	27.9	**	4.1		21		3.1		2031.3	**
Replications	4	20.8		0.3		2.8		13.5		5.9		33.4	
Rizobyme (R)	3	670.4	**	0.8	*	58.5	**	260.7	**	149.6	**	547.9	**
SXR	3	613.2	**	12.6	**	68.3	**	287.7	**	120.	**	168.4	*
Error	12	11.0		0.1		1.2		4.8		2.5		45.4	
Genotype (G)	15	427.4	**	8.5	**	66.6	**	328.0	**	125.1	**	1262.7	**
SXG	15	72.6	**	2.6	**	6.0	**	29.8	**	13.2	**	140.9	**
RXG	45	106.5	**	1.1	**	8.5	**	47.0	**	26.3	**	150.0	**
SXRXG	45	88.0	**	1.2	**	8.9	**	48.0	**	22.2	**	181.3	**
Error	240	23.9		0.3		1.9		9.6		5.0		34.2	
σph		37.9		0.5		4.4		22.1		9.5		82.2	
σG		14.0		0.3		2.5		12.5		4.5		48.0	
σe		23.9		0.3		1.9		9.6		5.0		34.2	
h^2_b		37.0		48.8		57.6		56.5		47.1		58.4	

* and ** denote significant differences at 0.05 and 0.01 of probability levels, respectively

Effects of soil salinity

Normal and saline soil and *Rhizobium* inoculation effects on traits recorded are presented in Table (3). By exposing faba bean plants to salinity stress, all traits studied in both growing seasons varied significantly, except 100-seed weight in the first season and no. of pods and seeds/plant and seed yield/plant in the second season. Seed yield/plant and other agronomic characters significantly decreased under salinity conditions by about 46.56, 16.50, 41.07, 47.29, and 46.36%, for plant dry weight, no. of branches/plant, no. of pods and seeds/plant and seed yield/plant, respectively, in the first season and 6.29, 9.96, 6.21%, for plant dry weight, no. of branches/plant and 100-seed weight, respectively, in the second season. This proved that the studied genotypes exhibited variable degrees of reduction in their traits as a

Table 3. Mean performance of studied traits under normal and saline soils and *Rhizobium* treatments during 2003/2004 and 2004/2005 seasons.

Character	First season			Second season			First season					Second season				
	Soil		LSD	Soil		LSD	*Rhizobium* inoculation				LSD	*Rhizobium* inoculation				LSD
	N	S	0.05	N	S	0.05	R1	R2	R3	R4	0.05	R1	R2	R3	R4	0.05
Plant dry weight	42.6	22.8	1.4	21.9	20.6	0.7	32.7	34.7	33.0	30.5	1.9	24.3	22.0	18.0	20.7	1.0
branches/plant	6.4	5.3	0.1	5.4	4.9	0.1	5.8	5.9	6.0	5.8	0.2	5.2	5.2	5.1	5.0	0.1
pods/plant	10.7	6.3	0.4	5.8	6.0	NS	8.0	8.1	9.1	8.8	0.5	6.8	6.1	4.9	5.9	0.3
seeds/plant	26.1	13.8	0.9	12.6	13.1	NS	18.9	20.0	21.2	19.8	1.2	14.8	13.2	10.8	12.5	0.7
Seed yield/ plant	20.1	10.8	0.7	9.1	9.0	NS	15.2	15.5	16.4	14.6	1.0	10.3	9.6	7.4	8.9	0.5
100-seed weight	78.9	79.4	NS	74.1	69.5	1.5	82.1	79.9	78.6	76.2	2.5	70.0	74.4	69.5	73.2	2.1

N = normal soil S = saline soil

* *Rizobium* inoculation : R1=Control R2: F.b.ARC200 R3=F.b.ARC201 R4=F.b: TCARDA (ARC) 448

consequence of reaction to salinity level (Darwish *et al* 2003). These results confirmed the results obtained by Soliman *et al* 2005.

Effects of *Rhizobium* inoculation

With respect to *Rhizobium* inoculation treatments, results in Table (3) exhibited significant effects for all tested traits in both seasons. In the first season, plants inoculated with strain ARC 201 had significant increase of no. of branches, pods and seeds/plant and seed yield/plant compared to uninoculated plants. For plant dry weight, plants inoculated with strain ARC 200 significantly exceeded the uninoculated plants. Saleh *et al* (2000) reported that inoculation with *Rhizobium* increased faba bean seed yield compared with uninoculated treatments. Contrarily, in the second season, all characters studied were significantly increased in the case of control treatment than the *Rhizobium* inoculation treatments except, 100-seed weight and no. of branches/plant that were Significantly increased with inoculation by strain ARC 200 and ARC 201 (no. of branches/plant).

Mean performance of genotypes

Wide range and significant differences were observed between genotypes for various traits recorded in both seasons as shown in Table (4), suggesting the presence of significant genetic variability. Darwish *et al* (2003), his studied genotypes reported varied in the magnitude of relative performance of various traits. In the first season, promising lines no. 15, 12, 8 and 10, were superior for plant dry weight than the other lines and check varieties. For number of pods and seeds/plant, promising lines no. 13, 12, 15 and 8 gave the highest mean values. For seed yield/plant, superior and significant values were recorded by promising lines no. 15, 12, 13, 10 and 8. On the other hand, variety no. 5 and line no. 13 gave higher no. of branches/plant, while varieties no. 5 and 1 gave the highest mean values for 100-seed weight. In the second season, promising lines no. 15 and 8 were superior for plant dry weight. line no. 13 and variety no. 5 for no. of branches/plant, promising lines, no. 15, 13, 8 and 12 for no. of pods and seeds/plant, lines no. 15, 8, 13 and 12 for seed yield/plant and variety no. 5 for 100-seed weight these genotypes had significantly higher mean values for these traits than the other lines and check varieties.

From these results, it could be concluded that the following promising lines no. 15, 8, 13 and 12 may have prospects in faba bean breeding for improving seed yield and its important components. Generally, seed yield/plant superiority for each of these lines may be attributed to high potentiality of more than one of the yield attributes. Darwish *et al* (2003) reported that faba bean genotypes varied in performance and traits were differently reacted in saline - affected soil. In addition Omar (2003) revealed highly significant differences between his studied faba bean genotypes for yield and its attributes. These data agreed with those reported by El-Hosary *et al* (2002).

Table4. Mean performance of sixteen faba bean genotypes during 2003/2004 and 2004/2005 season.

Character	Sk. 2	G. 40	G. 429	G. 3	N. 1	G. 843	G. 716	L. 248	L. 258	L. 244	L. 252	L. 278	L. 332	L. 336	L. 285	L. 163	LSD 0.05
First season (2003/2004)																	
Plant dry weight (g)	26.2	30.5	33.6	35.5	29.5	27.3	22.3	37.5	36.3	37.1	32.4	39.5	36.5	30.7	43.3	25.0	6.2
branches/plant	6.6	5.0	5.6	5.0	7.6	5.1	5.3	5.5	6.0	5.6	6.8	6.1	7.2	5.3	6.2	5.1	0.4
pods/plant	5.2	10.2	10.2	7.2	4.8	6.9	4.1	9.6	8.5	9.9	7.0	12.9	13.0	9.6	10.4	6.2	1.5
seeds/plant	12.5	24.5	23.3	17.5	12.2	16.1	10.1	22.0	20.2	22.8	16.4	27.7	30.7	22.2	25.9	15.3	4.1
Seed yield/plant (g)	12.2	16.3	16.7	14.8	12.4	13.2	8.9	17.3	16.2	18.2	13.5	20.1	18.7	15.5	20.8	12.2	3.3
100-seed weight (g)	94.3	66.1	71.9	83.8	98.0	82.7	86.8	76.4	80.9	79.2	82.8	74.4	60.9	68.2	81.8	78.9	4.0
Second season (2004/2005)																	
Plant dry weight (g)	15.0	18.6	18.2	16.8	19.1	21.5	15.3	27.8	18.7	21.3	23.0	23.9	23.0	23.9	30.0	23.8	2.8
branches/plant	5.8	4.3	4.4	4.4	6.3	5.0	4.8	5.1	5.1	4.7	5.3	4.9	6.3	5.4	5.4	5.1	0.3
pods/plant	3.3	6.6	5.7	4.4	3.4	5.4	3.6	7.6	5.0	5.9	6.1	7.8	7.8	6.9	8.6	6.4	0.6
seeds/plant	7.4	14.7	11.1	9.0	8.4	11.6	7.9	16.8	10.1	12.0	13.5	16.1	18.0	15.2	19.1	14.0	1.8
Seed yield/plant (g)	5.8	8.6	7.6	6.5	7.3	8.9	6.2	12.7	7.6	8.7	9.5	10.4	10.5	10.3	14.2	9.9	1.3
100-seed weight (g)	78.4	57.4	68.4	72.4	86.4	75.0	78.2	75.7	75.2	72.3	69.2	65.1	59.2	67.6	74.7	72.8	3.3

'he interaction between soil salinity and *Rhizobium* inoculation

Data in Table (5) revealed that the effect of interaction between soil alinity levels and *Rhizobium* inoculation. Treatments significantly affected ll traits except, 100-seed weight in first season. Nassef *et al* (2005) ecorded significant differences in seed and straw yields when plants were noculated with *Rhizobium*. Generally, *Rhizobium* inoculation treatments ignificantly exceeded all traits studied under normal soil conditions ompared to soil salinity conditions. These increases could be due to the ole of *R. legumin.* for increasing the growth due to N2-fixation by faba bean plants (Abdel-Wahab and Said 2004). Cordovilla *et al* (1999) recorded hat *R. legumin.* strain GRA 19 formed ineffective and effective symbiosis with faba bean under saline and non-saline conditions. Inhibition of nodulation in legumes under salt stress is due to a large extent, to the inability of *Rhizobium* to survive in the growth medium (Zahran and Sprent 1986).

Table 5. Response of faba bean plants to normal and saline soils and *Rhizobium* inoculation for recorded traits during 2003/2004 and 2004/2005 seasons.

Character	First season (2003/2004)									Second season (2004/2005)								
	Normal soil				Saline soil					Normal soil				Saline soil				
	Rhizobium inoculation								LSD	* *Rhizobium* inoculation								LSD
	R-1	R-2	R-3	R-4	R-1	R-2	R-3	R-4	0.05	R-1	R-2	R-3	R-4	R-1	R-2	R-3	R-4	0.05
Plant dry weight (g)	45.1	46.8	41.0	37.7	20.3	22.5	25.0	23.3	2.7	26.8	19.4	20.8	20.7	21.8	24.7	15.1	20.6	1.5
Branches/plant	6.2	6.5	6.5	6.4	5.4	5.2	5.5	5.3	0.2	5.5	5.0	5.8	5.3	4.9	5.4	4.4	4.8	0.2
Pods/plant	10.6	10.0	11.3	10.9	5.3	6.2	6.8	6.8	0.7	7.4	4.9	5.5	5.5	6.2	7.3	4.4	6.2	0.5
Seeds/plant	26.2	26.4	26.8	25.1	11.7	13.5	15.5	14.4	1.7	16.0	10.7	11.8	11.9	13.6	15.8	9.8	13.0	1.0
Seed yield/ plant (g)	21.0	20.4	20.6	18.3	9.5	10.5	12.2	10.9	1.4	11.4	8.2	8.0	8.9	9.1	11.0	6.7	8.9	0.7
100-seed weight (g)	81.2	80.1	77.7	76.8	83.0	79.7	79.6	75.5	NS	72.7	77.4	69.8	76.3	67.2	71.4	69.2	70.0	3.0

* *Rizobium* inoculation : - R1-Control R2-F.b.ARC200 R3-F.b.ARC201 R4-F.b. TCARDA (ARC) 448

The interaction between soil salinity and genotypes

The interaction between soil salinity levels and faba bean genotypes was significant for all traits studied in both seasons (Table 6). The variability among these genotypes increases the chance of selecting salt tolerant genotypes. Differences among varieties may be due to the differences in number of nodules formed and consequently nitrogen fixation. Singh *et al* (1992) reported dry matter accumulation to be different between faba bean varieties. Generally, results indicated that most genotypes were superior under normal soil conditions for most traits

Table 6. Response of sixteen faba bean genotypes to normal and saline soils for all traits recorded during 2003/2004 and 2004/2005 seasons.

Character	Soil	Sk. 2	G. 40	G. 429	G. 3	N. 1	G. 843	G. 716	L. 248	L. 258	L. 244	L. 252	L. 278	L. 332	L. 336	L. 285	L. 163	LSD 0.05
First season (2003/2004)																		
Plant dry weight (g)	N	35.8	38.9	44.9	38.9	39.8	35.2	30.8	51.3	50.0	47.5	44.5	50.7	44.6	48.9	53.4	27.2	8.7
	S	16.5	22.1	22.3	32.0	19.3	19.5	13.9	23.8	22.7	26.8	20.3	28.3	28.4	12.5	33.2	22.9	
Branches/plant	N	7.3	5.0	6.6	5.1	8.4	5.5	6.1	6.3	6.3	6.0	7.5	6.6	8.0	5.5	6.9	5.3	0.6
	S	5.9	5.0	4.6	4.9	6.9	4.6	4.5	4.8	5.8	5.1	6.0	5.5	6.4	5.1	5.5	4.9	
Pods/plant	N	6.4	12.5	13.2	7.9	5.8	8.2	5.2	12.3	11.3	12.0	9.4	17.4	15.4	14.5	12.7	6.8	2.2
	S	4.1	8.0	7.3	6.5	3.8	5.7	3.1	6.9	5.7	7.8	4.6	8.4	10.6	4.7	8.2	5.6	
Seeds/plant	N	16.2	31.9	31.5	18.8	15.1	20.3	13.4	29.9	28.4	29.1	22.8	37.1	37.8	35.3	33.3	17.2	5.7
	S	8.8	17.0	15.1	16.2	9.4	11.8	6.9	14.2	12.1	16.4	10.0	18.3	23.6	9.0	18.5	13.4	
Seed yield/plant (g)	N	16.5	21.2	22.6	15.7	15.9	16.6	11.8	23.5	22.6	22.5	18.4	26.3	22.7	25.1	26.1	13.5	4.7
	S	7.9	11.3	10.8	13.8	8.9	9.7	5.9	11.1	9.9	13.8	8.6	14.0	14.6	5.9	15.5	10.8	
100-seed weight (g)	N	100.8	66.0	71.5	82.5	101.8	83.2	88.1	77.0	80.0	76.2	80.5	70.6	60.2	70.3	78.7	75.4	5.7
	S	87.8	66.2	72.3	85.0	94.2	82.2	85.5	75.8	81.8	82.1	85.0	78.1	61.6	66.1	84.9	82.4	
Second season (2004/2005)																		
Plant dry weight (g)	N	16.4	18.5	19.3	19.5	18.6	19.7	17.5	29.1	22.0	22.1	25.1	23.4	23.5	24.7	31.5	20.3	3.9
	S	13.7	18.8	17.0	14.1	19.7	23.4	13.1	26.5	15.4	20.5	20.9	24.5	22.5	23.1	28.4	27.3	
Branches/plant	N	6.4	4.6	4.9	4.2	7.2	5.5	4.8	5.6	5.4	5.2	5.7	4.8	6.4	5.3	5.4	5.3	0.4
	S	5.1	4.0	4.0	4.7	5.3	4.5	4.8	4.6	4.8	4.2	5.0	5.0	6.3	5.6	5.4	4.9	
Pods/plant	N	3.4	6.1	5.3	4.7	3.0	4.7	4.2	7.6	5.7	5.6	6.3	8.1	7.6	7.0	8.8	5.2	1.1
	S	3.2	7.1	6.1	4.0	3.9	6.2	3.1	7.5	4.3	6.3	6.0	7.6	8.1	6.8	8.7	7.7	
Seeds/plant	N	7.7	14.5	10.8	10.1	7.3	10.4	8.5	16.6	11.2	11.9	13.5	16.4	18.1	15.0	19.0	10.4	2.5
	S	7.1	15.0	11.4	7.9	9.5	13.1	7.2	17.1	9.0	12.2	13.5	15.8	17.8	15.5	19.3	17.6	
Seed yield/plant (g)	N	6.1	8.9	8.1	7.4	6.1	8.3	7.2	13.0	8.2	8.8	9.5	10.7	10.5	10.4	14.8	8.0	1.8
	S	5.6	8.2	7.2	5.6	8.5	9.4	5.3	12.3	6.9	8.6	9.5	10.1	10.5	10.1	13.5	11.8	
100-seed weight (g)	N	78.9	60.8	75.0	72.6	84.8	79.1	83.4	79.4	74.8	74.1	71.5	64.8	59.3	69.4	79.7	77.3	4.7
	S	78.0	54.0	61.9	72.3	88.0	71.0	73.0	72.0	75.6	70.6	66.9	65.5	[illegible]	[illegible]	[illegible]	[illegible]	

compared to saline soil conditions in both seasons. Some lines (nos. 15, 12, and 13) significantly exceeded the others in seed yield/plant under normal and saline soil conditions. Wide variability among faba bean genotypes regarding salinity tolerance was reported by several workers such as; Darwish *et al* (2003) and Soliman *et al* (2005) who revealed that the investigated genotypes varied in tolerance/susceptibility to salinity from trait to another. But it seems that the most productive genotypes under low salinity conditions are highly susceptible to high salinity. As for the first order interaction between RXG, significant effects were found for all traits.

The second order interaction between soil salinity, *Rhizobium* inoculation and genotypes.

Results in Tables (7&8) revealed that, the response of sixteen faba bean genotypes to soil salinity levels and *Rhizobium* inoculation during 2003/2004 and 2004/2005 seasons caused significant effects for all traits recorded in both seasons. Generally, from the results in Table (7), it is worthy noted that, in the first season, under normal soil conditions, plants inoculated by strain ICARDA 448 showed superiority with one or more from these genotypes no. 14, 13, 12 and 15, respectively, for number of branches, number of pods and seeds/plant and seed yield/plant followed by plants inoculated by strain ARC 200 which had the highest mean values with promising lines no. 13, 14, 15 and 12, respectively, for number of seeds/plant and seed yield/plant. In the second season Table (8), under normal soil conditions, the interaction between, control treatment of *Rhizobium* inoculation with promising lines no. 15, 12, 14 and 8, respectively, significantly exceeded the others in most characters, i.e. plant dry weight, number of pods and seeds/plant and seed yield/plant. Whereas, under saline soil conditions, the interaction between plants inoculated by strain ICARDA 448 with promising lines no. 8, 12 and 15 came in the first rank which recorded highest mean values for number of pods and seeds/plant and seed yield/plant followed by plants inoculated by strain ARC 200 with promising lines no. 13, 11, 15 and 14 for seed yield/plant, number of pods and seeds/plant.

Correlation and path-coefficient analysis

Values of phenotypic correlation coefficient estimated over all years, *Rhizobium* inoculation and genotypes between seed yield/plant and some agronomic traits of faba bean under normal and saline soil conditions are presented in Table (9). Results showed that positive and highly significant correlation was found between seed yield/plant and each of plant dry weight and number of pods and seeds/plant under normal and saline soil conditions. Meanwhile, highly significant positive correlation between all possible pairs for all traits of phenotypic level under normal and saline soil conditions,

Table 7. Response of sixteen faba bean genotypes to normal and saline soils and *Rhizobium* inoculation for recorded traits during 2003/2004 season.

Character	Soil	Rizobium	First season (2003/2004)																LSD 0.05
			Sk. 2	G. 40	G. 429	G. 3	N. 1	G. 843	G. 716	L. 248	L. 258	L. 244	L. 252	L. 278	L. 332	L. 336	L. 285	L. 163	
		R1	42.9	37.2	44.7	56.3	55.4	50	25.2	87.0	37.1	72.0	44.7	38.2	28.7	34.2	37.4	29.8	
	Normal	R2	29.5	42.3	41.2	27.9	43.5	31.1	44.1	58.0	55.3	34.4	50.5	63	55.1	65.5	62.2	45.3	
		R3	43.4	48.6	50.2	44.7	43.1	32.5	29.9	24.0	50.9	47.2	54.8	46.7	34.8	34.8	60.3	10.3	
Plant dry weight		R4	27.4	27.6	43.4	26.8	17.0	27.2	23.9	36.0	56.5	36.4	27.9	55	59.7	61.0	35.3	23.3	17.5
		R1	15.2	18.9	15.3	22.7	16.8	11.6	14.3	19.6	11.8	25.7	22.3	23.5	29.1	9.1	42.4	27.2	
	Salinity	R2	18.4	31.5	20.8	49.0	13.3	18.6	11.3	18.6	13.2	19.6	21.4	34.3	23.2	18.0	31.4	17.3	
		R3	10.1	20.0	31.9	29.8	30.7	18.5	14.0	19.5	32.4	35.7	18.4	37.2	34.9	8.7	23.3	34.6	
		R4	22.3	18.1	21.3	26.6	16.5	29.2	15.9	37.6	33.5	26.0	19.0	18.1	26.4	14.2	35.8	12.5	
		R1	7.0	4.0	7.0	5.5	8.0	6.0	5.5	7.0	7.0	6.0	5.0	6.0	8.0	5.0	7.0	5.0	
	Normal	R2	8.0	5.5	6.0	5.0	8.0	5.5	6.5	7.5	5.5	6.0	8.0	8.0	7.5	5.5	6.5	5.5	
		R3	7.0	5.0	7.5	4.0	9.5	5.0	7.0	5.0	5.5	6.0	10.0	7.0	7.5	5.0	7.0	5.5	
Branches/plant		R4	7.0	5.5	6.0	6.0	8.0	5.5	5.5	5.5	7.0	6.0	7.0	5.5	9.0	6.5	7.0	5.0	1.2
		R1	7.5	6.0	4.5	4.5	7.0	4.0	5.5	4.5	5.5	6.0	5.5	5.5	6.5	4.0	5.0	5.0	
	Salinity	R2	5.0	5.0	5.5	4.5	6.5	4.0	5.0	3.5	5.5	4.5	5.5	5.5	7.0	6.0	5.0	5.5	
		R3	5.5	5.0	4.5	5.5	6.5	5.5	3.5	6.0	6.5	6.0	6.5	5.5	6.0	4.5	6.0	4.5	
		R4	5.5	4.0	4.0	5.0	7.5	5.0	4.0	5.0	5.5	4.0	6.5	5.5	6.0	6.0	6.0	4.5	
		R1	6.8	10.8	14.5	8.8	8.2	12.5	4.8	20.2	8.5	17.2	8.8	12.4	9.9	11.9	7.6	6.5	
	Normal	R2	4.5	13.9	10.5	5.8	47	4.4	5.7	12.1	8.7	7.5	9.1	16.5	16.6	15.8	13.0	10.7	
		R3	8.7	16.4	13.4	11.4	7.3	8.1	6.5	7.3	12.2	13.8	13.5	17.5	13.7	12.2	15.6	2.8	
Pods/plant		R4	5.5	9.0	14.2	5.4	3.0	7.8	3.6	9.7	15.8	9.5	6.2	23.3	21.5	17.9	14.5	7.0	4.4
		R1	3.8	6.7	5.3	4.6	3.2	3.3	2.9	5.6	4.0	6.9	4.3	7.4	9.0	3.8	8.0	6.6	
	Salinity	R2	4.1	10.9	6.7	8.2	2.7	5.9	2.8	5.7	4.1	6.0	5.0	9.6	8.3	6.1	9.1	4.2	
		R3	2.9	7.0	10.1	6.4	5.9	5.5	3.1	4.8	7.9	9.4	5.1	9.9	13.8	3.5	6.4	7.6	
		R4	5.4	7.2	7.2	6.7	3.4	7.9	3.7	11.4	6.8	8.9	3.8	6.9	11.1	5.2	9.3	3.9	

Table 7. Cont.

Character	Soil	Rizobium	Sk. 2	G. 40	G. 429	G. 3	N. 1	G. 843	G. 716	L. 248	L. 258	L. 244	L. 252	L. 278	L. 332	L. 336	L. 285	L. 163	LSD 0.05
			First season (2003/2004)																
		R1	17.7	29.3	32.3	21.1	22.6	34.7	11.7	50.4	23.3	44.2	23.5	25.3	22.4	26.1	18.7	16.1	
	Normal	R2	12.9	35.1	27.0	14.7	9.9	9.1	15	28.4	19.5	17.7	24.4	42.9	46.8	46.3	43.3	29.3	
		R3	21.7	41.2	33.5	25.7	2.9	20.7	17.3	18.1	31.1	30.3	29.1	40.0	30.7	24.0	38.7	6.0	
Seeds/plant		R4	12.4	22.0	33.2	13.8	6.9	16.7	9.7	22.5	39.7	24.3	14.1	40.2	51.3	44.9	32.6	17.4	11.5
		R1	7.5	16.2	10.3	1.9	6.6	7.4	6.9	10.2	6.8	15.8	1.2	16.0	22..0	6.6	18.9	14.5	
	Salinity	R2	9.7	22.6	12.2	26.2	6.5	12.3	5.0	12.3	7.4	11.9	1.5	21.3	19.0	12.0	18.3	9.3	
		R3	5.6	15.7	22.4	13.3	15.5	11.9	7.5	11.2	18.5	2.3	11.5	23.6	30.3	6.7	14.4	19.5	
		R4	12.2	13.5	15.6	14.3	8.9	15.6	8.0	23..0	15.6	17.6	7.7	12.2	23.1	10.6	22.3	10.1	
		R1	18.2	21.0	23.3	18.3	26.2	28.1	10.0	40.8	17.7	36.4	18.3	18.3	13.9	18.6	14.6	12.2	
	Normal	R2	13.0	22.9	19.2	11.9	9.5	8.2	12.8	22.3	17.6	12.9	19.9	32.9	29.4	33.6	35.1	25.0	
		R3	2.1	27.4	24.7	22.3	21.5	16.8	16.0	13.9	26.2	21.3	24.7	26.1	17.8	15.1	30.0	3.8	
Seed yield/plant		R4	12.5	13.6	23.4	1.4	6.4	13.4	8.4	17.1	29.1	19.5	10.7	27.6	30.0	33.3	24.8	13.2	9.3
		R1	7.1	10.6	7.6	10.5	7.3	6.9	6.0	7.1	6.2	13.2	9.4	12.1	13.8	4.2	17.5	12.9	
	Salinity	R2	8.5	13.6	9.2	22.7	5.8	9.8	4.4	9.6	5.8	10.0	9.8	16.2	11.9	8.1	14.9	8.3	
		R3	4.5	11.4	15.8	11.0	14.3	8.9	7.3	9.0	15.5	18.9	8.8	18.8	19.0	4.7	11.8	14.9	
		R4	11.4	9.4	10.6	11.0	8.1	13.2	6.0	18.6	11.9	13.3	6.6	8.9	13.6	6.5	17.8	7.2	
		R1	102.7	71.7	72.9	86.8	117.1	81.1	89.9	81.1	75.2	82.3	79.0	72.4	61.8	70.8	78.8	75.6	
	Normal	R2	96.7	65.3	71.2	81.1	94.2	89.8	84.7	78.0	87.4	72.2	82.1	76.4	62.8	73.2	81.1	850	
		R3	102.6	65.4	72.1	86.5	103.3	81.1	91.2	73.0	84.0	70.2	84.4	65.3	57.6	64.7	77.5	63.6	
100-Seed weight		R4	101.1	61.4	69.8	75.8	92.6	80.8	86.5	75.9	73.4	80.2	76.5	68.2	58.6	72.6	77.5	77.5	
		R1	93.1	62.8	73.8	96.1	107.8	92.5	82.2	69.3	91.9	82.3	87.9	77.7	62.6	63.5	95.2	89.1	11.4
	Salinity	R2	88.3	60.4	76.4	86.0	86.3	78.7	86.3	77.9	77.3	82.5	93.9	78.4	62.6	69.4	79.8	90.2	
		R3	79.3	71.6	70.8	82.5	91.5	75.1	98.5	77.2	84.0	90.4	76.7	82.0	62.6	70.4	82.3	79.0	
		R4	90.6	70.0	68.2	75.5	91.4	82.7	75.1	78.9	74.1	73.1	81.6	74.5	58.5	61.0	82.2	71.4	

Table 8. Response of sixteen faba bean genotypes to normal and saline soils and *Rhizobium* inoculation for recorded traits during 2004/2005 season.

Character	Soil	Rizo bium	First season (2003/2004) Sk. 2	G. 40	G. 429	G. 3	N. 1	G. 843	G. 716	L. 248	L. 258	L. 244	L. 252	L. 278	L. 332	L. 336	L. 285	L. 163	LSD 0.05
Plant dry weight	Normal	R1	12.6	20.3	25.1	27.8	23.2	25.7	24.4	27.1	27.8	22.6	29.7	28.3	30.8	30.9	49.5	22.8	
		R2	22.4	19.1	16.3	12.4	18.2	12.9	21.7	25.2	21.4	15.5	25.0	19.5	20.5	20.9	22.9	217.6	
		R3	12.8	13.9	18.0	20.5	19.4	2.8.8	12.0	31.1	19.4	18.1	25.2	21.8	22.4	23.6	27.8	25.6	
		R4	17.7	20.5	17.8	17.4	13.5	19.2	12.1	33.0	19.2	32.2	20.3	23.9	20.1	23.3	25.8	16.0	
	Salinity	R1	21.4	12.4	23.0	12.5	26.5	24.9	11.2	15.9	19.3	23.9	15.3	23.6	20.6	24.7	34.7	38.7	7.8
		R2	13.6	31.1	23.3	14.4	19.5	33.2	17.2	28.7	12.6	24.3	34.8	17.2	32.5	28.6	31.7	31.9	
		R3	12.6	10.7	7.5	7.5	20.0	2.5	14.2	21.3	9.3	1.5	9.7	24.3	15.4	24.5	21.5	12.8	
		R4	7.2	21.0	14.3	21.8	12.7	15.1	9.7	39.9	20.3	23.4	23.7	32.9	21.6	14.6	25.9	26.1	
Branches/plant	Normal	R1	5.8	4.3	5.0	3.8	8.0	5.8	4.0	5.0	5.8	6.0	7.3	5.0	6.8	5.5	5.5	5.0	
		R2	5.5	5.0	4.8	4.0	6.3	4.8	6.3	6.0	5.5	4.5	5.0	3.8	5.5	4.8	4.0	4.8	
		R3	7.3	4.8	4.8	5.0	7.3	6.0	4.3	6.0	5.0	5.3	6.0	5.3	7.5	6.3	6.5	6.5	
		R4	7.3	4.5	5.0	4.0	7.3	5.5	4.	5.5	5.5	5.0	4.5	5.0	5.8	4.5	5.3	4.8	0.8
	Salinity	R1	5.0	4.0	4.3	4.5	4.5	4.8	4.8	4.5	5.5	4.0	4.5	4.5	6.8	6.5	5.3	5.0	
		R2	5.0	5.0	4.5	5.0	6.3	5.0	4.8	5.0	6.0	4.0	5.8	6.5	6.5	6.0	6.3	4.8	
		R3	5.5	3.0	3.3	4.0	4.5	3.8	5.0	4.3	3.8	4.0	5.5	4.5	5.3	5.0	5.0	4.5	
		R4	4.8	4.0	4.0	5.3	6.0	4.5	4.5	4.5	4.0	4.8	4.3	4.5	6.5	4.8	5.3	5.3	
Pods/plant	Normal	R1	3.4	7.2	7.5	6.5	3.3	6.4	5.9	7.6	7.3	5.0	8.5	11.5	10.3	9.1	13.0	5.7	
		R2	3.6	5.6	3.6	3.2	3.2	3.3	4.7	6.5	4.8	3.2	5.2	6.6	6.0	7.1	5.9	5.3	
		R3	3.2	4.7	5.3	5.0	3.2	4.5	2.2	7.4	6.3	5.6	6.4	5.7	7.7	5.3	9.8	5.0	
		R4	3.3	7.0	4.8	4.0	2.1	4.4	4.0	9.0	4.4	8.6	5.0	8.4	6.3	6.3	6.5	4.7	2.2
	Salinity	R1	5.1	5.2	6.9	3.7	4.7	5.8	3.1	5.0	4.5	6.7	4.8	6.3	7.1	6.9	11.5	12.6	
		R2	2.7	11.0	9.5	4.6	3.4	9.5	3.7	7.8	4.5	7.9	8.5	5.8	12.2	8.5	8.6	8.2	
		R3	2.5	3.4	2.9	2.4	5.4	5.5	3.2	6.0	3.0	3.9	3.4	7.5	4.3	6.8	6.2	3.7	
		R4	2.5	8.7	4.9	5.4	2.2	3.8	2.3	11.2	5.2	6.7	7.4	10.7	8.6	5.0	8.6	6.2	

Table 8. Cont.

Character	Soil	Rizo bium	Sk. 2	G. 40	G. 429	G. 3	N. 1	G. 843	G. 716	L. 248	L. 258	L. 244	L. 252	L. 278	L. 332	L. 336	L. 285	L. 163	LSD 0.05
			First season (2003/2004)																
		R1	7.2	15.1	16.5	13.6	8.3	14.9	13.0	17.7	14.3	9.7	17.2	20.8	25.6	19.8	29.9	11.9	
	Normal	R2	10.0	14.1	9.0	7.3	7.9	8.0	11.1	12.5	8.3	8.4	11.1	14.3	14.6	13.6	13.6	6.8	
		R3	6.8	11.2	7.7	10.3	7.1	10.4	3.9	1.9	13.5	10.9	14.5	12.7	17.9	1! 8	19.6	12.9	
Seeds/plant		R4	6.7	17.6	1.1	9.2	5.8	8.4	6.1	19.3	8.6	18.5	11.2	17.6	14.4	14.8	12.9	10.0	5.0
		R1	12.0	11.6	14.3	8.5	11.1	14.5	5.8	10.5	11.6	16.0	8.8	12.4	17.5	13.9	22.7	26.0	
	Salinity	R2	6.1	24.1	17.2	7.0	7.9	19.1	9.3	16.8	7.8	13.5	21.7	11.9	27.3	19.0	22.0	21.9	
		R3	5.8	8.2	5.2	4.9	13.0	11.3	8.5	12.5	5.4	6.3	8.1	16.4	9.4	18.4	15.0	90	
		R4	4.5	16.0	9.1	11.1	6.0	7.6	5.2	28.5	11.1	12.9	15.5	22.4	17.0	10.6	17.4	13.8	
		R1	5.2	9.7	11.4	10.3	6.9	11.6	11.7	12.9	11.2	6.4	11.4	14.5	13.7	13.8	22.3	9.7	
	Normal	R2	8.8	10.1	7.0	5.3	6.3	5.9	9.0	11.6	6.6	6.9	8.7	9.5	10.2	9.1	1.2	5.4	
		R3	4.1	5.5	5.5	7.6	6.2	8.9	3.3	12.0	9.2	7.7	9.2	7.3	9.2	8.4	14.0	10.2	
Seed yield/plant		R4	6.1	1.2	8.2	6.3	5.1	6.9	4.7	15.7	5.9	14.2	8.9	11.4	9.0	10.3	12.7	6.8	3.6
		R1	9.0	5.3	9.8	4.9	11.2	11.4	4.3	6.0	9.0	10.3	5.2	8.3	.6.0	8.8	16.7	16.6	
	Salinity	R2	4.9	14.3	1.6	5.4	7.7	12.9	6.8	14.2	4.9	8.8	16.7	8.2	17.1	14.1	15.1	14.9	
		R3	5.2	4.7	2.7	3.7	1.1	7.6	6.6	9.9	4.2	4.6	4.8	10.9	5.7	1.9	9.5	6.2	
		R4	3.3	8.6	5.9	5.8	5.0	5.8	3.4	9.2	9.5	10.6	11.1	13.2	9.5	6.8	12.6	9.6	
		R1	72.8	64.1	68.6	75.7	83.1	78.0	89.7	72.8	79.0	64.9	66.1	69.7	53.6	69.7	74.5	81.5	
	Normal	R2	89.7	71.0	77.8	72.8	79.9	7.1	81.3	92.9	80.6	84.3	79.2	66.6	69.6	66.9	74.8	80.4	
		R3	60.6	50.0	72.2	74.0	88.8	85.6	83.9	70.6	67.9	7.7	63.2	56.5	51.3	71.3	71.1	79.4	
100-Seed weight		R4	92.2	58.2	81.3	68.1	87.2	82.5	78.5	81.4	71.8	76.7	77.5	66.3	62.6	69.8	98.4	67.9	9.4
		R1	76.1	45.4	68.8	57.4	99.6	74.3	75.2	57.1	74.3	64.8	59.6	67.1	54.7	63.4	73.9	64.1	
	Salinity	R2	76.7	59.4	61.6	78.0	91.0	67.8	73.8	84.5	63.1	62.7	78.0	69.4	62.5	76.4	69.2	68.2	
		R3	88.2	57.3	52.7	76.9	78.3	68.6	77.4	78.6	78.7	73.0	58.1	66.8	61.2	59.1	63.1	68.7	
		R4	70.9	53.7	64.4	76.6	82.9	73.3	65.7	67.6	86.2	81.8	71.5	58.8	58.5	64.1	72.6	71.8	

Table 9. Values of phenotypic correlation coefficients estimated over all treatments between seed yield/plant and some agronomic traits of faba bean genotypes under normal and saline soils.

Studied characters		x1	x2	x3	x4
Normal soil					
Plant dry weight	(x1)				
Branches/plant	(x2)	-0.043			
Pods/plant	(x3)	0.801 **	-0.136		
Seeds/plant	(x4)	0.814 **	-0.064	0.986 **	
Seed yield/plant	(x5)	0.958 **	-0.096	0.909 **	0.916 **
Saline soil					
Plant dry weight	(x1)				
Branches/plant	(x2)	0.232			
Pods/plant	(x3)	0.812 **	0.055		
Seeds/plant	(x4)	0.825 **	0.092	0.988 **	
Seed yield/plant	(x5)	0.962 **	0.165	0.913 **	0.931 **

indicating that selection practiced for the improvement of any one of a set of correlated characters, would automatically improve the other. The most important relationships was that between seed yield/plant and plant dry weight which gave values of (0.958**) and (0.962**) followed by number of seeds/plant which gave values of (0.916**) and (0.931**) under normal and saline soil conditions, respectively. These results indicated that such traits had a greatest influence on seed yield respective stress environments. These results agreed with those of Saad and El-Kholy (2000) and Abdalla *et al* (2001).

Partitioning of phenotypic correlation coefficient estimated over all years, *Rhizobium* inoculation and genotypes between seed yield/plant and some agronomic traits of faba bean under normal and saline soil conditions are presented in Table (10). The results revealed that the direct effects of plant dry weight and number of seeds/plant on seed yield/plant was positive and high under normal and saline soil conditions. The indirect effects of number of seeds and pods /plant via plant dry weight, number of pods/plant via no. of seeds/plant and plant dry weight via no. of seeds/plant under normal and saline soil conditions, these indirect effects had positive and high values on seed yield/plant. The total contribution could be arranged of phenotypic variation as follows: plant dry weight, number of seeds/plant and number of pods/plant under normal and saline soil conditions.

Table10. Partitioning of phenotypic correlation coefficients between seed yield/plant and some agronomic traits of faba bean genotypes over all treatments under normal and saline soils.

Source of variation	Normal soil	Saline soil
Plant dry weight *vs.* seed yield/plant		
Direct effect	0.631	0.617
Indirect effect via branches/ plant	0.001	-0.005
Indirect effect via pods/plant	0.133	-0.165
Indirect effect via seeds/plant	0.192	0.516
Total correlation	0.958	0.962
Branches/ plant *vs.* seed yield/plant		
Direct effect	-0.031	-0.023
Indirect effect via plant dry weight	-0.027	0.143
Indirect effect via pods/plant	-0.023	-0.011
Indirect effect via seeds/plant	-0.015	0.057
Total correlation	-0.096	0.165
Pods/plant *vs.* seed yield/plant		
Direct effect	0.167	-0.203
Indirect effect via plant dry weight	0.505	0.501
Indirect effect via branches/ plant	0.004	-0.001
Indirect effect via seeds/plant	0.233	0.617
Total correlation	0.909	0.913
Seeds/plant *vs.* seed yield/plant		
Direct effect	0.236	0.625
Indirect effect via plant dry weight	0.514	0.509
Indirect effect via branches/ plant	0.002	-0.002
Indirect effect via pods/plant	0.164	-0.201
Total correlation	0.916	0.931

Coefficient of determination (C.D) and relative importance (RI%) of both, direct and joint effects between seed yield/plant and some agronomic traits of faba bean genotypes over all years, *Rhizobium* inoculation and genotypes under normal and saline soil conditions are presented in Table (11). The main sources of seed yield/plant variation in order of importance were the direct effect of plant dry weight (39.83 and 19.73%) and number of seeds/plant (5.59 and 20.27%) under normal and saline soil conditions and its joint effects with each of number of pods/plant (16.84 and 10.56%) and number of seeds/plant (5.72 and 33.01%) and joint effect between number of pods/plant and number of seeds/plant (7.77 and 13.3%) under normal and saline soil conditions. This pattern of multivariate analysis is in harmony with the finding of other investigators. Farag and Darwish (2005) concluded that

Table 11. Coefficient of determination (CD) and relative importance (RI%) of both, direct and joint effects between seed yield/plant and some agronomic traits at phenotypic correlation coefficient of faba bean genotypes under normal and saline soil.

Source of variation		Normal soil		Saline soil	
		CD	RI%	CD	RI%
Direct effects					
Plant dry weight	X1	0.398	39.829	0.197	19.727
Branches/plant	X2	0.001	0.098	0.000	0.029
Pods/plant	X3	0.028	2.778	0.021	2.145
Seeds/plant	X4	0.056	5.585	0.203	20.272
Indirect effects					
(X1) via (X2)		0.002	0.168	0.003	0.347
(X1) via (X3)		0.168	16.843	0.106	10.561
(X1) via (X4)		0.057	5.715	0.330	33.009
(X2) via (X3)		0.001	0.142	0.000	0.027
(X2) via (X4)		0.001	0.095	0.001	0.139
(X3) via (X4)		0.078	7.767	0.130	13.025
Residual		0.210	20.981	0.007	0.718
Total		1.000	100.000	1.000	100.000

number of seeds per pod, pod weight, and 100-seed weight appeared to yield attributes for which selection can be effective also, Farag (2007) reported that number of seeds per pod, pod weight and 100-seed weight appeared to be the principle yield attributes for indirect selection criteria.

In general conclusion, the results obtained from correlation and path-coefficient analysis studied under normal and saline soil conditions indicated that plant dry weight, number of seeds/plant and number of pods/plant could be used effectively as selection criteria for screening and isolating high yielding genotypes under the environments of the present study.

Conclusion

Five promising mutant lines number 15, 13, 14, 12 and 8, proved superior under normal soil conditions and promising mutant lines number 8, 12 and 15 under saline soil conditions, like wise same five promising lines with strains ICARDA 448 and ARC 200 under normal and salinity soil conditions. Therefore, these mutant lines could be directly used or incorporated in breeding programmes to develop high yielding varieties under normal and saline soil conditions.

REFERENCES

Abdalla, M. M. F. and D. S. Darwish (1996). Investigations on faba bean, *Vicia faba* l. 5-Improving faba bean yield accompanying selection to *Orobanche* tolerance. Proc. 7th Egypt. Argon. Conf., Mansoura, Vol. (1): 171-177.

Abdalla, M. M. F., D.S. Darwish, M.M. El-Hady and E.A. Harty (2001). Investigations on faba beans, *Vicia faba* L. 16- F1 and F2 diallel hybrids with reciprocals among five parents. Egypt. J. Plant Breed. 5: 155-179.

Abdel-Wahab, A. F. and M. S. Said (2004). Response of faba bean to bio and organic fertilization under calcareous soil conditions. Egypt. J. Appl. Sci. 19: 305-329.

Abo El-Soud, A. A., M. A. El-Deeb and Kh. M. El-Yamani (2004). Improving of faba bean production by application of organic compost and rhizobial inoculation under newly reclaimed soil. Egypt. J. Appl. Sci. 19: 333-344.

Alghamdi, S. Salem and Ali A. Khalid (2004). Performance of several newly bred faba bean lines. Egypt. J. Plant Breed. 8: 189-200.

Cordovilla, M. Del P., F. Liger and C. Iluch (1999). Effect of salinity on growth, nodulation and nitrogen assimilation in nodules of faba bean (*Vicia faba* L.). Applied-soil- Ecology 11 (11): 1-7.

Darwish, D. S. and M. M. F. Abdalla (1994). Investigations on faba beans, *Vicia faba* L. 4-Cairo 1 and Cairo 375, two newly developed varieties. Proc. 6th Egypt. Agron. Conf., Al Azhar Univ. Vol. Π: 633-650.

Darwish, D. S., M. M. F. Abdalla, S. A. Mahmoud and T. S. Elmarsafawy (2003). Investigations on faba beans, (*Vicia faba* L). 18- Performance of some breeding material in saline-affected soils. Egypt. J. Plant Breed. 7 (1): 347-361.

Dewey, D. R. and K. M. Lu (1959). A correlation and path coefficient analysis of components of crested wheat grass seed production. Agron. J. 51: 515-518.

Dua, R. B., S. k. sharm and B. Mishr (1989). Response of broad bean (*Vicia faba* L.) and pea (*Pisum sativum*) varieties to salinity. Indian Journal of Agricultural Science.59 (11):729-731.

El-Hosary, A. A. and S. A. Sedhom (1990). Evaluation of some new lines of faba bean (*Vicia faba* L.). Proc. 4th Conf. Agron., Cairo 15-16 Sept. 1: 435-445.

El-Hosary, A. A., S. A. Omar, A. I. Hassan, H. M. El-Naggar and H.A. Wafaa (2002). Diallel crosses for improving faba bean (*Vicia faba* L.) under rainfed conditions. 1-Yield and yield components. Zagazig J. Agric. Res. 29. (1): 17-31.

Farag, S. T. and I. H. Darwish (2005). Types of gene effects of some economic traits in broad bean (*Vicia faba* L.). Egypt. J. Plant Breed. 9(1):77-90.

Farag, S. T. (2007). Relative importance of genetic variance for improving broad bean (*Vicia faba* L.). Egypt. J. Plant Breed. 11 (1): 301-315.

Fehr, W. R. (1987). Principles of Cultivar Development. Theory and Technique. Macmillan Publishing Company. A Division of Macmillan, Inc. New York, London: 80-96.

Hussein, A. H. A., S. A. saleh, M. A. El-Deeb and W. Kadry (1997). Effect of *Rhizobium* inoculation, phosphorus and potassium fertilization on growth, nodulation and yield of faba bean cultivated in the newly reclaimed soils of middle Egypt. Bull. Fac. Agric. Univ. Cairo 48: 201-214.

Mekhemar, G. A. A., M. Shaaban, A. A. Ragab and A. M. M. Biomy (2005). Response of faba bean to inoculation with *Rhizobium* leguminosarum bv.Viceae and plant growth promoting rhizobacteria under newly reclaimed soils. Egypt. J.Appl. Sci. 20:126-144.

Melesse, T. and K. Caesar (1992). Stomatal and non-stomatal effects of salinity on photosynthesis in faba beans (*Vicia faba* L.). J. Agron. and Crop Science.168 (5): 345-353.

Nassef, M.A., G.A.A. Mekhemar, Kh. M. El-Yamani, A.A. Ragab and A.A. Abou El-Soud (2005). Influence of Rhizobium inoculation combined with pseudomonas and herbaspirillum on growth, nodulation and yield of faba bean under newly reclaimed soils J. Agric. Sci. Mansoura Univ. 30 (10): 6251-6262.

Omar, S.A. (2003). Breeding faba bean for environmental stress conditions. 1-Selection under water stress, heritability and drought susceptibility index. Egypt. J. Plant Breed. 7 (1): 77-89.

Pessarakli, M. (1991). "Dry matter yield, nitrogen-15 absorption and water uptake by green bean under sodium choloride stress" Crop Sci. 31: 1633-1640.

Saad, A. O. M. and M. A. El-Kholy (2000). Response of some faba bean cultivars to phosphorus and magnesium fertilization. Egypt. J. Agron. Vol. 22: 19-38.

Saleh, A.S., M. A. El-Deeb and A. A. Ragab (2000). Response of faba bean (*Vicia faba* L.) to *Rhizobium* inoculation as affected by nitrogen and phosphorus fertilization. BU. Fac. Agric. Cairo Univ. 51: 17-30.

Singh, S.P., N. P. Singh and R. K. Pandex (1992). Effect of variety and plant density on the pattern of dry matter accumulation in faba bean. FABIS Newsletter 32: 21-24.

Singh, P. K. and B. D. Chaudhary (2004). Biometrical Methods in Quantitative Genetic Analysis. Kalyani publishers. New Delhi-Ludhiana: 39-68.

Snedecor, G.W. and W. G. Cochran (1992). Statistical Methods. 8th Ed. Iowa state Univ. Press, Ames. IOWA, USA.

Soliman, S. S. A, M. S. Eisa, T.A. Ismail, Nadia A. Naguib and Azza F. El-Sayed (2005). Promising mutant lines under saline and normal soil conditions in faba bean (*Vicia faba* L.) Egypt .J. Plant Breed 9 (1): 111-125.

Tanji, K. K. (1990). "The nature and extent of agricultural salinity". In. k. k. Tanji, ed, Agricultural salinity assessment and management". Amer Soc. Civil Engineers. New York.

Yousif, Y. H. and F.A. Salih (1989). Performance of faba bean genotypes under saline alkali soil condition of Soba area, Sudan. FABIS 25:32-35.

Zahran, H.H. and J. I. Sprent (1986). Effects of sodium chloride and polyethylene glycol on root-hair infection and nodulation of *Vicia faba* L. plants by *Rhizobium* leguminosarum. Planta 167: 303-309.

تاثير ملوحة التربة والتلقيح بالريزوبيم على المحصول وبعض الصفات لستة عشر تركيب وراثى من الفول البلدى

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اقيمت اربعة تجارب حقلية خلال موسمين زراعيين فى 2004/2003 و 2005/2004 بمحطة بحوث دمو– التابعة لكلية الزراعة – جامعة الفيوم. وتهدف هذه التجارب دراسة استجابة ستة عشر تركيب وراثى من الفول البلدى (سبعة اصناف تجارية وتسعة سلالات طفرية مبشرة) لتأثير المعاملة باربعة سلالات مختلفة من التلقيح بالريزوبيم تحت ظروف التربة العادية والتربة المتأثرة بالملوحة على المحصول وبعض الصفات الاخرى. ويمكن تلخيص اهم النتائج فيما يلى:-

1- أوضح تحليل التباين لمستويات ملوحة التربة والتلقيح بالريزوبيم والتراكيب الوراثية وكذلك التفاعلات المختلفة لمواد الدراسة وجود تأثيرات معنوية لمعظم الصفات المدروسة فى الموسمين.كما تراوحت درجة التوريث فى المعنى الواسع من منخفضة الى متوسطة لجميع الصفات المسجلة حيث تراوحت من 15.6 و 37.0% للوزن الجاف للنبات الى 62.8 و 58.4 % لوزن المائة بذرة فى الموسمين الاول و الثانى على الترتيب.

2- عند تعريض نباتات الفول البلدى للاجهاد الملحى ظهرت تأثيرات معنوية على جميع الصفات المدروسة خلال الموسمين عدا صفة وزن المائة بذرة فى الموسم الاول وكذلك عدد القرون بالنبات – عدد البذور بالقرن ومحصول البذور بالنبات فى الموسم الثانى. كما حدث نقص معنوى للمحصول والصفات الأخرى بزيادة ملوحة التربة فى الموسمين.

3- حدثت أختلافات معنوية لمعظم الصفات المدروسة عند أستخدام التلقيح بالريزوبيم فى الموسمين.

4- وجدت أختلافات معنوية بين التراكيب الوراثية المستخدمة للصفات المختلفة فى الموسمين – مما يوضح وجود اختلافات وراثية بين هذه التراكيب – كما أوضحت النتائج أن السلالات المبشرة أرقام 15، 12، 13، 14 ، 8 على التوالى هى اكثر التراكيب الوراثية التى يمكن الأستفادة منها فى برامج التربية لتحسين محصول البذرة ومكوناتة.

5- أوضحت النتائج ان تأثير التفاعلات المختلفة بين المعاملات المستخدمة فى الدراسة أدى لحدوث أختلافات معنوية لمعظم الصفات المدروسة فى الموسمين . كما أظهرت النتائج تفوق النباتات الملقحة بالسلالة ICARDA 448 مع واحدة او اكثر من السلالات المبشرة أرقام 15، 13، 14، 12 ، تحت ظروف التربة العادية و الملحية لمحصول البذوربالنبات ومكوناتة.

6- اوضحت النتائج ان معامل التلازم المظهرى موجباً ومعنوياً بين محصول البذور بالنبات وكلاً مــن الــوزن الجاف للنبات ، عدد القرون للنبات ، عدد البذور للنبات تحت ظروف التربة العادية والملحيــة ، بينمــا كــان التلازم غير معنوى بين عدد الأفرع بالنبات وجميع الصفات المدروسة. كما أظهر تحليل معامل المرور تحــت ظروف التربة العادية والملحية أن الوزن الجاف للنبات ، عدد البذور للنبات ، عدد القرون للنبات تعتبر اكثــر الصفات أسهاماً فى المحصول مما يجعل الأنتخاب لهذة الصفات أو أياً منها مجــدياً فــى تحــسين الكفــاءة المحصولية للفول البلدى.

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