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STUDIES ON THE CORRELATION BETWEEN RESISTANCE AGAINST *OROBANCHE* AND THE TOLERANCE TO ALINITY IN SOME *Vicia faba* CULTIVARS.

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ABSTRACT

The present work aimed to study the correlation between resistance against *Orobanche* and the tolerance to salinity in some parasitized *Vicia faba* resistant cultivars, i.e. Giza 429 and Giza 843, as well as the partially resistant Giza 674 cultivar in comparison with the susceptible Giza 3 one, through the evaluation of their growth, chemical composition and productivity when irrigated with different levels of sea water (5% and 10% as continual irrigation as well as 10% and 20% as alternately irrigation, E.C. 2.5, 5.0, 5.0 and 10.0 ds/m, respectively), in addition to the fresh water irrigation in the control treatment in the first pot experiment season; 1999/2000, or when irrigated with the same levels of salinity in the presence of *Orobanche* parasitism in the second one; 2000/2001. The obtained data in both growing seasons represent a strong supportive evidence on the highly degree of the physiological tolerance not only to salt stress but also to the double stresses (salinity + *Orobanche* infection), which characterized both *Orobanche*-resistant cultivars; Giza 429 and Giza 843 that enable both of them to be adapted to even the double stresses, thus, could complete its life cycle till harvest, and produced its seed yield under such conditions without applying any specific treatments that induce such adaptation. Meanwhile, the non-adapted Giza 674 and Giza 3 cultivars were not able to do so under the same conditions. The recorded results with both resistant cultivars disclosed that this physiological tolerance brought about in both of them by creating more negative osmotic potentials (Osmotic Adjustment) through the accumulation of much more quantities of inorganic osmotica, i.e. N, P, K^+, Ca^{+2}, Mg^{+2} and the lowest quantities of Na^+ and lower Na^+/Ca^{+2} ratio as well as high K^+/Na^+ ratio, this in addition to the considerable accumulation of organic protective osmolytes, i.e. sugars (especially non-reducing ones), proline, free amino acids and protein in their roots and shoots, which greatly exceeded either that in the stressed plants of the other two cultivars or even the non-stressed control plants in several cases. Such accumulation increased proportionally with increasing salinity level as an adaptable mechanism with enable both cultivars to adjust the rate between the protective and toxic intermediates of metabolism in favor of more tolerance to stress. Since, the accumulating of much more quantities of sugars (as osmolytes) in their roots might enable plants to keep better water relation under stress conditions, by increasing the ability of their roots to extract more water even from the saline soil solution. Moreover, the calculating of Relative Seed Yield % [RSY] and Stress Susceptibility Index % [SI] values for the tested cultivars offered another strong evidence on the high tolerance to salinity, as did against *Orobanche* infection, which characterizing both Giza 429 and Giza 843 cultivars. In the meantime, the highly significant values of correlation coefficient for both mentioned cultivars strongly confirmed the highly significant positive correlation between *Orobanche* resistance and salt tolerance in both *Orobanche*-resistant cultivars, which was the main interesting point in the present investigation. Nevertheless, the all applied stress treatments resulted in a highly significant reduction in the yield components of both resistant cultivars in spite of their superiority as regards growth, dry weights and chemical composition in comparison with the other two cultivars. Therefore, the obtained data in the present study which represents an attempt towards the obtaining salt-tolerance Egyptian faba bean cultivars, suggested the possibility of successful cultivation of Giza 429 and Giza 843 cultivars in the newly reclaimed areas and irrigated continual with sea water up to 10 % or alternately up to 20%, even in the presence of *Orobanche* infection. In the meantime, a special attention must be directed towards the increasing their tolerance to salinity through the applying of specific physiological treatments in order to approach their optimal productivity under such saline conditions.

INTRODUCTION

There is increasing interest in faba bean (*Vicia faba L.*) as the most important leguminous food winter crop, because its superiority as the most available cheap source of substituted protein and consequently, as a main popular diet for most of the Egyptian people. Unfortunately, it is one of the major hosts of *Orobanche crenata* Forsk; the attractive-looking, but deadly parasite, thus, its infestation severely affects faba bean productivity (Ahmaed, 1981, Salem *et al.*,1989, Salem *et al.*,1991 and Ibrahim, 1997). Accordingly, the total production from this crop in Egypt is still insufficient to cover the local consumption. Thus, there is a great need to overcome this gap between the local production and the consumption demand. Therefore, improvement of faba bean yield in Egypt depends, to a great extent, on the control of *Orobanche* parasitism through the agronomic practices, chemical control with glyphosate and other herbicides (Ahmaed, 1981, Salem *et al.*,1989) and selection of *Orobanche*- resistant Egyptian cultivars (i.e. Giza 429 and Giza 843), or different physiological treatments including, applying plant growth regulators on the parasitized host and the presowing seed irradiation treatment with gamma rays or fast neutrons (El Shihy *et al.*, 1994), in addition to the expansion of its cultivation in the newly reclaimed areas which represents the great hope in increasing our cultivated land and consequently the economic production of this crop. On the other hand, the susceptibility of faba bean plants to salinity (Abd-Alla, 1992, Sharma, 1995a and Molia-Doila, *et al.*, 1998) will restricts or even prevents its cultivation in such newly reclaimed area in which the use of the saline water or even the diluted sea water becomes the only source of irrigation. This mandated a demand for production of salt-tolerant Egyptian faba bean cultivars for the cultivation in such areas. In this regard, Ibrahim (1997) disclosed that, the plants of the *Orobanche*-resistant Egyptian cultivars; Giza 429 kept their shoot apex without wilting symptoms till the harvest which reflects a good internal nutritional status as well as water relation in the infected Giza 429 plants, unlike the other two cultivars; Giza 402 (partially resistant) and the susceptible Giza 2 one. He attributed this results due to the accumulation of IAA in the shoot tip associated with another accumulation of cytokinins as well as sugars in its roots as compared with either to two other cultivars or its *Orobanche* tissues during the later stage of growth which enable Giza 429 roots to keep better performance against *Orobanche* infection and gives some sort of resistance against wilting. Such mechanism is well known as an "Osmotic Adjustment" which can be accomplished by creating more negative osmotic potentials through the accumulation of the organic osmolytes (e.g., sugars) within the root cell as an adaptable mechanism against either biotic or abiotic stress. Since sugars as osmolytes enable plants to keep better water relations under stress conditions by increasing the ability of their roots to extract more water from even the saline soil solution. Therefore, the present study represents an attempt towards the obtaining salt-tolerant Egyptian faba bean cultivars. Accordingly, it was the interest of this study to investigate the correlation between resistance against *Orobanche* and the tolerance to salinity in some parasitized *Vicia faba* resistant cultivars, i.e. Giza 429 and Giza 843, as well as the partially resistant Giza 674 in comparison with the susceptible Giza 3 one, through the evaluation of their growth, chemical composition and productivity when grown under either only salt stress or the combination of salinity and *Orobanche* parasitism.

MATERIALS AND METHODS

The present work was conducted in the wire green house of the Plant Physiology Division, Faculty of Agriculture, Cairo University, Giza, Egypt, including the preliminary experiment (was designed during 1998/1999 season, to define the most appropriate range of salinity which can be experimentally applied in the main experiment). The main experiment was conducted during two successive growing seasons; 1999/2000 and 2000/2001. In both seasons four *Vicia faba* cultivars were chosen in relation to *Orobanche* parasitism, i.e. the *Orobanche*-resistant Giza 429 and Giza 843 cultivars, the partially resistant Giza 674 in comparison with the susceptible Giza 3 cultivar. The applied salinity levels were designed depending on the obtained data in the preliminary experiment which were, 5% and 10% sea water (as continual irrigation) as well as 10% and 20% sea water (as alternately irrigation), in addition to fresh water irrigation (in the control treatment). The only exception is that in the second season (2000/2001) faba bean plants treated with the same four salinity levels in the association with *Orobanche* infection (double stresses). Therefore, the pot experiment in the first season included 5 treatments, meanwhile, in the second season included 6 treatments with four replications. Seeds of *Vicia faba* cultivars were obtained from the Department of Seed Legumes Research, Ministry of Agriculture, Giza, Egypt, meanwhile, *Orobanche crenata* seeds were obtained from the Weed Control Section of the same Ministry. In both seasons, 480 pots of 30 cm in diameter were filled with an equal quantities from the mixture of 2:1 clay and fine sand and prefertilized with 2.4 g superphosphate, 1.2 g potassium sulphate and 0.60 g calcium nitrate, before sowing in both seasons, a samples from the used soil, tap water as well as sea water were chemically analyzed according to the standard procedures (Jackson, 1973). It important to mentioned that before seed sowing in the second season (2000/2001), pots of each cultivar were divided into two groups; 20 pots were kept free from *Orobanche* infection (healthy treatment) and the rest 100 pots were infected with 1g of *Orobanche* seeds mixed with the soil of each pot assigned for infected treatments for each cultivar, since, healthy and infected treatments were conducted for each cultivar. Seeds of *Vicia faba* cultivars were sown on 15th Nov 1999 and 14th Nov 2000 in the first and second seasons respectively. The pots were irrigated with fresh water (0.38 ds/m) until the complete germination, then the plants were later thinned to leave three plants / pot. Afterwards, the pots were irrigated either with fresh water (in the control treatment) or with the diluted sea water; 5% and 10% as continual irrigation or 10% and 20% as alternately irrigation (E.C. 2.5, 5.0, 5.0 and 10.0 ds/m, respectively). Sea water (50.0 ds/m) was obtained from Mediterranean sea, Alexandria region. (1 ds/m = 1 mmoh/cm = approximately 640 ppm). During both experimental seasons, two samples were collected after 63 and 93 days from sowing. At each sampling date in both growing seasons, the plant height, the length of the main roots, number of leaves, branches and pods /plant as well as the dry weights of shoots, roots and pods were determined, in addition the number of tubers and spikes/host plant as well as the dry weight of *Orobanche* g/plant were estimated (in the second season only). At harvest, after 146 and 145 days from sowing in the first and second seasons, respectively, the yield components, i.e. number of pods / plant, number of seeds / pod, seed yield (g) / plant, pod yield (g) / plant and 100- seed weight (g). Also, the Relative Seed Yield [RSY] was estimated as follows:

$$\underset{\text{(Seed Yield)}}{\text{RSY \%}} = \frac{\text{The seed yield (g/plant) under salinity level}}{\text{The seed yield (g/plant) under control treatment}} \text{X100}$$

Also, Stress Susceptibility Index [SI] was estimated according to Fischer and Maurer (1978). $\underset{\text{(Seed Yield)}}{\text{SI \%}} = \frac{[1-(yij / yic)]}{[1-(y\text{-}j / y\text{-}c)]} \text{X100}$

where;

Yij = Seed Yield (g/plant) of the ith cultivar grown under Jth saline level, Yic= Seed Yield (g/plant) of the same cultivar grown under the control treatment, Y-j = The mean value of seed yield (g/plant) of all cultivars grown under the Jth saline level, Y-c= The mean value of seed yield (g/plant) of all cultivars grown under the control treatment.

Moreover, the correlation between *Orobanche* resistance and salt tolerance in Giza 429 and Giza 843 cultivars was also statistically analyzed. Data of growth characters and yield components were statistically analyzed and the means were compared using the least significant difference test [L.S.D.] values at 5 % and 1% levels [Gomez and Gomez, 1984].

Chemical analyses:

The roots and shoots as well as produced seeds were chemically analyzed in order to determine their chemical constituents. For reducing, non-reducing and total sugars the hot ethanol extract was used and the sugars constituents were determined by using phosphomolybdic acid method according to (A.O.A.C., 1975). Total free amino acids were determined colorimetrically in fresh materials by using ninhydrin reagent, as described by (Moore and Stein, 1954). Free proline concentration was measured calorimetrically in extraction of fresh materials according to Bates *et al.* (1973). The total nitrogen was determined in dry materials by using the modified- micro-Kjeldahel method as described by Peach and Tracy (1956). Crude protein was calculated by multiplying N % by the factor 6.25. Determination of K, P, Na, Ca and Mg were carried out on the ground dry material. The samples were digested in a mixture of sulphoric acid, salicylic acid and hydrogen peroxide according to Linder (1944). Phosphorus was determined sepectrophotometrically by using stannous chloride reduced molybdophosphoric blue color method according to (A.O.A.C., 1975). Potassium and Sodium were determined photometrically using Jen way flame photometer. Standard curves for both elements were constructed using solutions of KCl and NaCl. Calcium, and Magnesium were determined using the Atomic Absorption Spectrophotometer.

RESULTS AND DISCUSSION

It is worthy to point out that the obtained results in the both collected samples in each growing season exhibited the same trend. Therefore, the tabulated and discussed data of the various determinations in the present study represent the results recorded at the second sampling date, i.e. 93 days after sowing.

Important notes on the host-parasite relationship under saline conditions during the second growing season of the main experiment:

During the second season; 2000/2001 it was observed that flowering occurred under saline conditions, 12, 10, 9 and 9 days ealier than that under the non-stressed conditions (control treatment) for Giza 3, Giza 674, Giza 843 and Giza 429 cultivars, respectively. Moreover, the increasing resistance of faba bean cultivars against the *Orobanche* infection, was accompanied by late flowering and consequently late germination and invasion of *Orobanche* on the roots of the resistant host plants, even under saline conditions, i.e. flowering was occurred under saline conditions 4, 7 and 10 days ealier in the susceptible Giza 3 plants than in the partially resistant Giza 674 and the resistant Giza 843 and Giza 429 cultivars, respectively. The late germination and invasion of *Orobanche* on the resistant host roots, i.e. Giza 429 and Giza 843 cultivars in the present investigation (depending on the flowering stage) might mitigate its injurious effects on the host plants, as previously evidenced by Ibrahim (1997), who insured that the most *Orobanche*-resistant Giza 429 cultivar, did not suffer from the apical wilting of its shoot apex throughout the growth period till harvesting. This could be explained as due to capability of the host plants of competing, to a great extent, with the parasite's newly established powerful sink, thus, could sustain the growth of its active apex and greatly maintained its dominance. In the present study, the small swelling tubercles of *Orobanche* were found in the first sample (63 days after sowing) attached only to the infected roots irrigated with the fresh water (control treatment). The late germination and invasion of *Orobanche* under saline conditions till 63 days after sowing may represents the "salinity effect" as another factor (beside the flowering stage of the host) that affect the time of *Orobanche* germination on the infected host roots. At the second sampling date, i.e. 93 days after sowing, the swelling tubercles of *Orobanche* were found attached only to the infected roots either irrigated continually by 5 % or by 10 % sea water as alternately irrigation in addition to the control treatment (fresh water irrigation), meanwhile no *Orobanche* infection at all, at the two higher levels of salinity, i.e. continual irrigation by 10 % sea water and alternately irrigation by 20 % sea water. This strongly indicate that these higher levels of salinity caused a complete inhibition of *Orobanche* germination on the infected roots. Thus, it could be hypothesised that *Orobanche* plants were severely affected as the salinity level increased in the root medium if compared to the host plant under the experimental conditions of the present study. The inhibitory effects of salinity on the further growth of *Orobanche* even after its penetration on the infected roots, were evidenced, mainly from the complete inhibition of the *Orobanche* shoot growth due to the all applied levels of salinity, consequently, no emergence of *Orobanche* spikes above the ground surface were recorded under the all applied treatments in the second season, except the control treatment (plants irrigated with fresh water) throughout the growth period till harvesting. More support for these recorded observations is found in the obtained results in this study, when the highly significant lower values as regards number of tubers/host plant and dry weight of *Orobanche* (g)/host plant were recorded with the infected plants grown under the all levels of salinity, especially the resistant Giza 429 and Giza 843 cultivar plants, as compared with infected control plants irrigated with fresh water.

1-Growth characters:

Comparing the effects of different stress treatments on the all studied growth characters of 93days-old *Vicia faba* cultivar plants (Table 1) it could clearly noticed that the all studied growth parameters showed a gradual highly significant reduction in response to increasing salinity levels, to reach its maximum values in the plants alternately irrigated with 20% sea water if compared with the fresh water irrigation (the control treatment) in the first season. Nevertheless, the superiority of both Giza 429 and Giza 843 cultivars in this regard, could be realized when comparing the mean values of each cultivar under the all salinity levels. The data clearly revealed that the highest mean values were recorded by Giza 429 and Giza 843 as regards plant height, root length and number of leaves/plant which highly significantly exceeded the respective values of Giza 3 cultivars. On the other hand, the lowest mean value of number of branches/plant was recorded by Giza 429 followed by Giza 843 compared with the other two cultivars. In this concern, it is well known that, increasing branches production especially after 93 days from sowing is mainly due to the activation of the lateral buds, which in turn, would be explained as due to the inhibition of the apical dominance. On the other hand, the highest mean value regarding number of pods/plant was recorded by Giza 843 cultivars. In the second season, *Orobanche* parasitism resulted in significant reduction in the plant height and root length and number of pod/plant of the all infected cultivars except Giza 429, and highly significant reduction in number of leaves/plant as well as significantly decreased the production of branches on Giza 429 cultivar.

Table (1): Average plant height, main root length (cm), number of leaves, branches and pods/plant of 93 days-old *Vicia faba* plants (Giza 3, Giza 429, Giza 674 and Giza 843 cultivars) as affected by different stress treatments in the first and second seasons; 1999/2000 and 2000/2001 seasons.

Cultivars / Treatments	G 3	G 429	G 674	G 843	MeanS	G.3	G 429	G 674	G 843	MeanS	G 3	G 429	G 674	G 843	MeanS	G.3	G 429	G 674	G 843	MeanS	G 3	G 429	G 674	G 843	MeanS
	Plant height					Root length					Number of leaves					Number of branches					Number of pods				
	First season																								
Fresh water (control)	54.33	64 66	61 66	62 00	60 66	35 00	37 00	36 00	37 66	36 42	37 00	36 00	38 00	36 00	36.75	2 30	2.00	2.60	2 30	2 30	4.70	6 00	4 10	6.00	5 20
5% sea water (CI)	34 00	42.66	40 00	40 33	39 25	22.00	28 33	28 67	29 00	27 00	15 60	28 00	25 00	23 00	22.90	1.30	0 60	1 60	1.60	1.27	0.67	3.00	4.67	3 11	2.86
10% sea water (CI)	26 00	37 33	31 66	32 33	31 83	16 33	26 00	24 67	26 67	23 42	12 30	17 30	15 00	15 30	14.97	1.00	0 30	1.00	0 60	0.72	1.00	1.42	1 67	1.29	1.35
10% sea water (AI)	30 00	41 00	38 00	39 00	37 00	18 67	28 67	27 00	28 66	25.75	15 30	18 60	17 00	21 00	17.97	1.30	0.60	1 30	1 00	1.05	0.67	1 67	2.67	3.33	2.09
20% sea water (AI)	21 00	29 66	24 66	26 00	25 33	15 66	20 00	16.67	19.66	18 00	9 00	12 30	9 00	11 00	10 32	0.60	0.60	0.60	0 60	0.60	1.00	2 53	3 33	3.33	2 55
Mean C	33 07	43 06	39 20	39 93	-	21 53	28.00	26 60	28 33	-	17 84	22 44	20 80	21 26	-	1.30	0 82	1.42	1 22	-	1 61	2 92	3.29	3 41	-
L S D values at		5%		1%			5%		1%			5%		1%			5%		1%			5%		1%	
Cultivar		4 86		8.94			3 27		6.01			3.48		6.39			NS		NS			2.05		NS	
Salinity		4 74		7.87			3.19		5.30			3.39		5.63			0.69		1 14			2.01		3 31	
C X S		NS		NS			NS		NS			NS		NS			NS		NS			NS		NS	
	Second season																								
H + fresh water (control)	55 60	63.60	61.30	62 30	60 70	35 00	35 60	36 30	37 30	36 05	38 00	36 60	38 30	36 60	37.38	2.00	2.60	2.30	2.00	2.23	4.00	6.60	4.30	6.30	5 30
I + fresh water (control)	50.00	61.33	57 67	58 67	56 92	32 00	34 67	32 66	34.33	33.42	30 00	31 00	30 00	30 60	30.40	2.33	2.00	2.00	2.00	2.08	2.33	6.00	3.27	3 00	3.65
I + 5% sea water (CI)	27 66	38.66	34 67	36 33	34 33	19 00	29 67	26 33	28 00	25 75	15 30	20 60	18 00	18 00	17.97	1.33	1.30	1 00	1 00	1 16	1 33	2 67	1 35	1 33	1 67
I + 10% sea water (CI)	20 33	30 00	26 00	28 33	26 17	15 33	22 00	19 33	20 66	19 33	10 00	15 30	12 60	14 00	12.97	1.00	-	-	0 33	0.33	0.67	1 77	0.67	0 74	0.96
I + 10% sea water (AI)	27 00	35.33	32 67	33 33	32.08	17 67	25.00	32 66	24 33	24 91	11 00	17 60	16 60	17 30	15.62	1.00	0.67	1.60	1.00	1.07	0.67	1.93	1.30	1.90	1.45
I + 20% sea water (AI)	18.00	25.67	19 66	20 34	20 92	12.33	19 00	16.66	16.66	16.16	10 00	12 60	10 00	11.60	11.05	0.67	-	-	-	0.17	0.33	0.33	1.63	2 30	1.15
Mean C	33.10	42.43	38.66	39.88	-	21 89	27 66	27.32	26.88	-	19 05	22 28	20 92	21 35	-	1.39	1.09	1.15	1 06	-	1.56	3.22	2.09	2.60	-
L.S D. values at:		5%		1%			5%		1%			5%		1%			5%		1%			5%		1%	
Cultivar		2.43		4.46			2.45		4.49			2.32		4.26			0.39		0.71			0.23		0.61	
Salinity		2 37		3 93			2.39		3.96			2.26		3.75			0.38		0.63			0 34		0 55	
C X S		NS		NS			NS		NS			NS		NS			NS		NS			0 62		0.91	

CI= Continual Irrigation AI= Alternately Irrigation (two times with diluted sea water followed by once with fresh water) H= Healthy I= Infected

Similar results were previously reported by Ahmed (1981), Salem *et al.* (1989), Salem *et al.* (1991) and Ibrahim (1997) with faba bean. The significant or highly significant reduction in the all studied growth characters was more pronounced when the *Orobanche* infection was associated with salinity levels in the double stress treatments (Table1). Nevertheless, the superiority of both resistant cultivars: Giza 429 and Giza 843 was strongly confirmed even under the double stress treatments as evidenced from the highly significant increments recorded by their mean values over the respective ones of Giza 3 cultivar in the all parameter except number of branches/plant, suggesting a good correlation between *Orobanche* resistance and salt tolerance in both cultivars. Decreasing growth parameters by increasing the salinity level of irrigation water was previously reported by Aly (1987), Sharma and Garg (1985), Botella *et al.* (1997) and De-Pascale and Barbieri (1997). As shown in Table 2 the dry matter accumulation in the stressed roots, shoots, pods and the whole cultivar plants was highly significant decreased at the all applied levels of salinity and attained its maximum at the highest level of salinity, however, at that level a marked increases in the accumulation of dry matter in stressed Giza 429 and Giza 843 organs as well as the whole plants were recorded over the respective accumulation in Giza 3 and Giza 674 cultivars, except Giza 429 pods. On the other hand, the same conclusion could be drawn when comparing the mean values of each cultivars regardless the salinity level (mean C). Here the mean values of dry matter accumulation in Giza 429 and Giza 843 roots, shoots, pods and the whole plant were highly significantly and significantly exceeded that in Giza 3 respectively. The inhibitory effects of salinity on the dry matter accumulation of stressed faba bean plant organs was previously reported by Aly (1987), Abd-Alla (1992) and Cordovilla *et al.* (1995). The data in Table 2 also revealed that Orobanche parasitism did highly significantly reduced the dry matter accumulation in the all plants organs and the whole plant of different cultivars except the roots and pods of Giza 429 as previously observed with plant height and root length of the same cultivars (Table 1). The inhibitory effects of *Orobanche* infected on dry weights of the infected faba bean plant was previously recorded by Ahmed (1981), Salem *et al.* (1991) and Ibrahim (1997). When the infected plant cultivars were irrigated with the different dilutions of sea water, the dry weights of the different plant parts as well as the whole plants were severely affected. So the double stresses resulted in a highly significant decreases in such dry weights. According to the mean values of each cultivar it could be realize that the mean values of dry weights of Giza 429 roots, shoots, pods and the whole plants highly significant and significant the respective mean value of Giza 3 and Giza 674 respectively, meanwhile, the mean values of Giza 843 significantly exceeded the respective mean value of Giza 3 as regards dry weight of roots and the whole plant only. The obtained results in Table 2 also clearly indicate that, although the all combinations levels of salinity and parasitism resulted in highly significant reductions in the dry matter production of the whole cultivar plants, especially when the infected plants irrigated either continually with 10 % sea water or alternately with 20 % sea water, however, Giza 429 and Giza 843 infected plants were slightly affected by the applied salinity levels if compared to the other two cultivars; Giza 3 and Giza 674. Moreover, the mean values of the *Orobanche*–resistant Giza 429 and Giza 843 cultivars regardless the salinity level recorded a highly significant and significant increases over the respective value of Giza 3 cultivar, respectively.

As for the growth characters of *Orobanche* parasitizing the different cultivars under saline conditions the data in Table 3 clearly revealed that, depending on the differential in the resistance degree against *Orobanche* infection of each cultivar which positively correlated with its salt tolerance, the lowest highly significant values as regards number of tubers, spikes and dry weight of *Orobanche* /host plant under the all salinity levels as well as fresh water irrigation were recorded on the infected roots of Giza 429 followed by Giza 843 cultivars, meanwhile, the highest ones were recorded on Giza 3 followed by Giza 674 infected roots. The data also revealed that salinity exerted its identical detrimental effects in both the host and the parasite, consequently, in addition to the drastic reduction induced by salinity in the number of tubers, spike and dry weight of *Orobanche*/host plant with the all tested cultivars, no above ground growth of the parasite at the all applied levels of salinity was detected. Moreover, the highest two levels of salinity induced a completely inhibited *Orobanche* germination and/or growth on the all infected cultivar roots.

2- Chemical analyses:

The results of sugars analyses in the first season (Table 4) showed that increasing salinity levels caused a gradual increase in reducing, non-reducing and total sugar concentrations in the shoots and roots of different cultivars to reach its maximum values at the highest two levels of salinity, if compared to the control treatments, which strongly indicate a positive correlation between salinity level and sugar accumulating potential, with special referring to the superiority of Giza 429 and Giza 843 plant organs which greatly exceeded the other two cultivars in their sugars concentrations especially at the highest two levels of salinity in addition to increasing non-reducing sugar concentration in their tissues to more than 1.5 folds that of the reducing ones.

The obtained results with Giza 429 and Giza 843 take their supportive evidence from the conclusions of several workers; Santarius (1973) suggested that, sugars as osmolytes enable plants to keep better water relations under stress condition. Simpson (1981) reported that, glycophytes adapt themselves to somewhat saline conditions by lowering osmotic potential through converting starch to sugars. Also, Gnanasiri *et al.* (1990) reported that, osmoregulation in stressed plants was higher with K^+ and sugar. Both of them were found to correlate negative with osmotic potential. Moreover, Ashraf *et al.* (1991) concluded that, sugars and proline accumulation were considered as a suitable screening parameter for salinity tolerance. Recently, Nasir *et al.* (2000) found that, leaves of tolerant sugarcane line showed high degree of osmotic adjustment by accumulation of more K^+, free proline and sugars. In the second season, (Table 4), sugars concentrations. generally, seem to be unaffected by *Orobanche* infection in the shoots with only few exceptions. In contrast, the infected roots showed

Table (2): Average dry weights (g / plant) of the different parts as well as the whole plant of 93 days-old *Vicia faba* plants (Giza 3, Giza 429, Giza 674 and Giza 843 cultivars) as affected by different stress treatments in the first and second seasons; 1999/2000 and 2000/2001 seasons.

Treatments / Cultivars	G.3	G.429	G.674	G.843	MeanS	G.3	G.429	G.674	G.843	MeanS	G.3	G.429	G.674	G.843	MeanS	G.3	G.429	G.674	G.843	MeanS
	Shoots					Roots					Pods					Whole plant				
	First season																			
Fresh water (control)	5.44	6.52	5.71	5.72	5.85	1.63	1.67	1.59	1.63	1.63	0.71	0.95	0.66	0.90	0.81	7.78	9.14	7.96	8.25	8.28
5% sea water (CI)	3.31	5.43	3.84	4.25	4.21	0.35	1.24	0.72	1.11	0.86	0.16	0.20	0.26	0.22	0.21	3.82	6.87	4.82	5.58	5.28
10% sea water (CI)	2.42	4.83	3.34	4.16	3.69	0.49	0.94	0.51	0.79	0.68	0.11	0.10	0.21	0.09	0.13	3.02	5.87	4.06	5.04	4.50
10% sea water (AI)	2.99	4.93	3.83	3.90	3.91	0.56	0.97	0.62	0.81	0.74	0.12	0.18	0.18	0.19	0.17	3.67	6.08	4.63	4.90	4.82
20% sea water (AI)	2.11	3.98	2.67	3.47	3.06	0.44	0.94	0.47	0.79	0.66	0.07	0.01	0.16	0.22	0.12	2.62	4.93	3.30	4.48	3.84
Mean C	3.25	5.14	3.88	4.30	-	0.69	1.15	0.78	1.03	-	0.23	0.29	0.29	0.32	-	4.18	6.58	4.95	5.65	-
L.S.D. values at:		5%		1%			5%		1%			5%		1%			5%		1%	
Cultivar		0.90		1.65			0.23		0.42			0.06		0.09			1.25		2.29	
Salinity		0.87		1.45			0.22		0.37			0.05		0.07			1.21		2.05	
C X S		NS		NS			0.35		NS			NS		NS			NS		NS	
	Second season																			
H + fresh water (control)	5.25	7.01	5.82	5.93	6.00	1.66	1.72	1.69	1.68	1.69	0.63	0.98	0.71	0.94	0.82	7.54	9.71	8.22	8.55	8.51
I + fresh water (control)	4.07	5.42	4.63	5.00	4.78	1.00	1.62	1.27	1.27	1.29	0.16	0.90	0.66	0.21	0.48	5.23	7.94	6.56	6.48	6.55
I + 5% sea water (CI)	2.26	4.83	3.23	4.16	3.62	0.82	1.09	0.58	0.79	0.82	0.14	0.20	0.15	0.12	0.15	3.22	6.12	3.96	5.07	4.59
I + 10% sea water (CI)	1.80	3.48	1.96	2.37	2.41	0.42	0.75	0.42	0.79	0.59	0.10	0.19	0.10	0.01	0.10	2.32	4.42	2.48	3.17	3.10
I + 10% sea water (AI)	2.17	4.28	3.06	3.55	3.27	0.50	0.96	0.49	0.57	0.63	0.10	0.19	0.13	0.19	0.15	2.77	5.43	3.68	4.31	4.05
I + 20% sea water (AI)	1.62	2.60	1.14	2.38	1.94	0.39	0.69	0.50	0.61	0.55	0.05	0.01	0.14	0.16	0.09	2.06	3.30	1.78	3.15	2.58
Mean C	2.86	4.60	3.31	3.90	-	0.80	1.14	0.83	0.95	-	0.20	0.41	0.32	0.27	-	3.86	6.15	4.45	5.12	-
L.S.D. values at:		5%		1%			5%		1%			5%		1%			5%		1%	
Cultivar		0.67		1.15			0.20		0.36			0.09		0.11			0.80		1.48	
Salinity		0.66		1.10			0.19		0.32			0.08		0.09			0.78		1.30	
C X S		NS		NS			NS		NS			NS		NS			NS		NS	

CI= Continual Irrigation AI= Alternately Irrigation (two times with diluted sea water followed by once with fresh water) H= Healthy I= Infected

Table (3): Growth characters of attached *Orobanche crenata* to 93 days- old *Vicia faba* parasitized plant cultivars grown under different levels of salinity (% sea water) during the second season of the main experiment (2000/2001 season).

Growth characters of *O.crenata*	No. of tubers / host plant					No. of spikes / host plant					Dry weights of *Orobanche* (g)/ host plant				
Cultivars Treatments	G.3	G.429	G.674	G.843	Means	G.3	G.429	G.674	G.843	Means	G.3	G.429	G.674	G.843	Means
I + fresh water (control)	15.30	4.00	7.00	3.66	7.49	3.66	1.33	2.33	1.33	2.16	4.90	1.46	3.56	1.86	2.95
I + 5% sea water (CI)	3.00	0.66	2.33	1.33	1.83	-	-	-	-	-	0.29	0.05	0.22	0.06	0.16
I + 10% sea water (CI)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I + 10% sea water (AI)	4.33	0.66	3.33	1.00	2.33	-	-	-	-	-	0.42	0.09	0.36	0.09	0.24
I + 20% sea water (AI)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean C	4.53	1.06	2.53	1.20	-	-	-	-	-	-	1.12	0.32	0.83	0.40	-
L.S.D. values at:		5%		1%			5%		1%			5%		1%	
Cultivar		0.03		0.05			-		-			0.03		0.06	
Salinity		0.02		0.04			-		-			0.02		0.05	
C X S		0.03		0.07			-		-			0.04		0.07	

CI= Continual Irrigation AI= Alternately Irrigation (two times with diluted sea water followed by once with fresh water) H= Healthy I= Infected

higher values than that of the healthy ones in the different cultivars, especially the considerable increments in non-reducing sugars in infected Giza 429 and Giza 843 roots over that in healthy ones. On the other hand, sugars concentrations in the different shoots and roots showed much higher values under the double stress treatments than those recorded under salt stress in the first season, which confirmed the positive correlation between the magnitude of stress intensity and sugar accumulating potential with special referring to the superiority of Giza 429 and Giza 843 plants which recorded the highest values in this respect as compared with the other two cultivars. The superiority of both resistant cultivars was also evidenced if we consider the concentration of total sugars (mg glucose/g D.W.) at the highest level of double stress in the second season in both shoots and roots of different cultivars which were in their shoots 180.6, 287.4, 194.2 and 274.9 and in their roots were 69.7, 102.6, 73.0 and 96.2 for Giza 3, Giza 429, Giza 674 and Giza 843, respectively. The accumulation of much more sugar in both resistant cultivars especially in their roots, as a mechanism of salt tolerance increased their ability to extract more water from the saline soil solution. Since, plants to maintain a continuous water uptake must decrease the internal water potential, and sugars as well as K^+ contribute to lowering osmotic potential in glycophtes under stress conditions.

The results in Table 5 clearly reveled that the main feature of increasing salinity level is the accumulation of proline as well as the total free amino acids in the stressed tissues. i.e. increasing salinity level caused a highly accumulation of both constituents (as previously did with sugars) in the different parts of the tested cultivars. Such gradual increasing attained its highest values at the highest salinity level (the plant irrigated alternately with 20% sea water) as compared with fresh water irrigation in the first season. At such highest salinity level, proline concentration in the stressed roots of both resistant cultivars Giza 429 and Giza 843 were more than double that the respective values in the roots of Giza 3 and Giza 674 cultivars. The superiority of Giza 429 and Giza 843 could be evidenced by calculating the percentages of increments in free amino acids concentrations in the stressed shoots and roots of both cultivars over the respective values of Giza 3 which were 85.0% and 80.0% for the shoots while 69.0% and 71.6% for the roots, respectively, after 93 days from sowing in the first season. The accumulation of much more quantities of proline as well as free amino acids in both cultivars in this later stages of growth, in additions to the positive correlation between increasing salinity level and both constituents as well as sugars offered strong evidence on the broad and confirmed correlation between *Orobanche* resistance and salt tolerance in both Giza 429 and Giza 843cultivars. In this concern, Strogonov (1970) reported that, the accumulation of non toxic substances such as sucrose, proline, free amino acids and protein which have protective properties are considered to be a protective adaptation. Giovanna *et al.* (1989) found that, the free amino acids of tomato increased in the leaf tissues treated with salt 3.5 times compared with the control. Ashraf *et al.* (1991) reported that, salinity increased solute accumulation (proline and soluble sugars). Good and Zaplackinski (1994) stated that, concentration of free amino acids and proline increased markedly in plants exposure to many biotic or abiotic stress. Sallam (1999) found that, proline, total free amino acids and protease increased in faba bean plants with increasing salinity levels.

Table (4): Reducing sugars (R.S.), non-reducing sugars (N.R.S.) and total sugars (T.S.) concentration (mg glucose/gdry weight) in the shoots and roots of *Vicia faba* plants (Giza 3, Giza 429, Giza 674 and Giza 843 cultivars) as affected by different stress treatments in the first and second seasons; 1999/2000 and 2000/2001 seasons.

Treatments	R.S				N.R.S				T.S			
Cultivars	G3	G429	G674	G843	G3	G429	G674	G843	G3	G429	G674	G843
	First season											
	Shoot											
Fresh water (control)	32.4	52.3	36.1	49.9	45.0	86.9	49.7	85.7	77.4	139.2	85.8	135.6
5% sea water (CI)	42.9	97.2	48.2	96.6	67.1	136.3	68.5	124.1	110.0	233.5	116.7	220.7
10% sea water (CI)	58.8	105.8	51.7	103.2	89.3	147.7	86.3	132.6	148.1	253.5	138.0	235.8
10% sea water (AI)	54.8	99.6	53.2	97.7	77.4	139.6	76.8	105.9	132.2	239.2	130.0	203.6
20% sea water (AI)	59.7	100.1	64.0	99.4	94.6	154.6	91.6	131.3	154.3	254.7	155.6	230.7
	Root											
Fresh water (control)	18.6	26.0	18.4	26.4	16.0	14.3	17.0	14.9	34.6	40.3	35.4	41.3
5% sea water (CI)	25.2	38.6	26.5	37.3	23.3	36.5	24.6	35.5	48.5	75.1	51.1	72.8
10% sea water (CI)	35.1	45.1	37.9	44.2	31.8	43.9	35.0	42.7	66.9	89.0	72.9	86.9
10% sea water (AI)	27.9	42.9	27.5	43.9	25.3	37.1	26.1	36.4	53.2	80.0	53.6	80.3
20% sea water (AI)	29.7	46.2	31.0	46.8	27.3	47.4	29.9	47.1	57.0	93.6	60.9	93.9
	Second season											
H + fresh water (control)	40.6	55.9	48.9	54.1	61.3	123.3	70.6	91.3	101.9	179.2	119.5	145.4
I + fresh water (control)	43.7	56.9	47.5	56.4	59.6	89.6	56.6	87.9	103.3	146.5	104.1	144.3
I + 5% sea water (CI)	55.6	113.7	52.5	114.2	73.3	140.5	79.5	138.2	128.9	254.2	132.0	252.4
I + 10% sea water (CI)	61.4	145.9	54.4	164.1	92.9	156.3	94.6	154.0	154.3	302.2	149.0	318.1
I + 10% sea water (AI)	56.3	117.6	57.7	117.4	109.7	143.9	116.9	140.1	166.0	261.5	174.6	257.5
I + 20% sea water (AI)	64.7	128.0	68.5	129.2	115.9	159.4	125.7	145.7	180.6	287.4	194.2	274.9
	Root											
H + fresh water (control)	17.4	27.2	17.3	27.3	18.1	19.3	16.9	19.8	35.5	46.5	34.2	47.1
I + fresh water (control)	19.0	29.4	19.9	29.1	22.8	39.0	22.4	39.4	41.8	68.4	42.3	68.5
I + 5% sea water (CI)	25.0	31.7	27.6	31.2	29.0	43.6	29.5	41.5	54.0	75.3	57.1	72.7
I + 10% sea water (CI)	27.0	39.2	28.3	38.7	34.3	59.4	37.3	58.2	61.3	98.6	65.6	96.9
I + 10% sea water (AI)	26.0	38.9	27.9	38.4	38.3	55.4	35.2	54.6	64.3	94.3	63.1	93.0
I + 20% sea water (AI)	28.1	39.4	27.9	38.7	41.6	63.2	45.1	57.5	69.7	102.6	73.0	96.2

CI= Continual Irrigation AI= Alternately Irrigation (two times with diluted sea water followed by once with fresh water) H= Healthy I= Infected

The data in Table 5 also reveal that *Orobanche* parasitism reduced the concentrations of both proline and free amino acids in the infected shoots and roots of the all cultivars except Giza 843 shoots. Similar results were previously reported by Ibrahim (1997). Comparing proline and free amino acids concentrations under different double stress treatments (Table 5) in the same second season, one can realize an exact identity to the results of both constituents under salt stress in the first season. Also, the same observation as regards Giza 429 and Giza 843 superiority under salt stress can be also drown under double stress conditions. This can be realized from the percentages of increments in free amino acids concentration in their shoots and roots over the respective concentration in Giza 3 which were at the highest level of double stresses, 84.5% and 81.4% for the shoot while 79.5% and 79.5% in the roots for Giza 429 and Giza 843 respectively.

As previously evidenced, the endogenous concentration of free proline in plants can be used as an indicator for salt tolerance. For each plant, this appears to be an external salt concentrations, above which the plant's proline level sharply rises. This critical point is directly related to the ability of plant to tolerate salt. Thus, measurements of proline concentration can be used to determine salt resistance of plant. Moreover, Meinzer *et al.* (1990) added that, compatible solutes (sugars, proline, amino acids, organic acids and protein) have the role of adjusting the osmotic potential of the cytoplasm to that of the vacuole, thus maintaining an osmotic equilibrium between the two cell compartment. Comparing total crude protein concentrations (Table 6) it could be noticed a gradual decrease in such concentrations associated with increase in salinity level in the irrigation water. The maximum values of such reduction were recorded in the shoots and roots of the plants alternately irrigated with 20% sea water, followed by those irrigated continually by 10% sea water as compared with the fresh water irrigation in the first season.

However, such reduction was to lesser extent with Giza 429 and Giza 843 cultivars as compared with the other two cultivars as evidenced by the comparison of protein concentration in the shoots of both cultivars at the highest level of salinity with the respective values of Giza 3 which were 120.0 and 124.7 compared with 110.4 mg/g dry weight. In this concern, it is well established that plant metabolism, mainly protein synthesis is adversely affected under salinity stress as a result of the decreased synthesis of protein as well as increased activities of hydrolyzed enzymes, as evidenced by Sallam (1999) who mentioned that in faba bean plants, proline, total free amino acids and protease (proteinase) increased with increasing salinity level. On the other hand, it could be observed that *Orobanche* infection also reduced protein concentration in the all infected cultivars especially in their infected roots. However, such reduction due to infection in the roots of Giza 429 and Giza 843 were, 34.1% and 48.0%, compared with 58.3% in the infected of Giza 3 roots. Similar results were reported by Ibrahim (1997).

When the *Orobanche* parasitism was associated with the saline conditions in the multiple stress treatments in the second season (Table 6) the protein concentration in the roots and shoots of the all cultivars showed much lower values than that previously recorded under the salt stress in the first season. Nevertheless, under the highest levels of double stresses the both *Orobanche*-resistant cultivars, i.e. Giza 429 and Giza 843 could accumulate 113.6 and 118.7 mg/g shoot dry weight as well as 96.6 and 75.9 mg/g root dry weight compared with 104.4 and 59.4 in Giza 3 shoots and roots respectively, which clearly confirmed the superiority of both cultivars even under the even stresses in comparison with the susceptible Giza 3 cultivar.

Table (5): Proline and total free amino acids concentration (mg/g fresh weight) in the shoots and roots of 93 day-old *Vicia faba* plants (Giza 3, Giza 429, Giza 674 and Giza 843 cultivars) as affected by different stress treatments in the first and second seasons 1999/2000 and 2000/2001seasons.

Treatments / Cultivars	Proline				Total free amino acids			
	G3	G429	G674	G843	G3	G429	G674	G843
	First season							
	Shoot							
Fresh water (control)	2.5	3.5	2.5	3.1	7.3	5.1	7.0	5.2
5% sea water (CI)	2.9	5.4	3.0	4.9	8.5	13.0	8.8	13.9
10% sea water (CI)	3.9	6.9	4.3	5.9	9.0	15.3	9.2	15.8
10% sea water (AI)	3.5	6.0	3.6	5.1	9.0	13.2	9.0	14.0
20% sea water (AI)	4.5	7.1	4.6	6.8	9.5	17.6	10.1	17.1
	Root							
Fresh water (control)	2.4	3.1	2.4	2.7	5.9	4.3	5.4	4.8
5% sea water (CI)	2.5	5.2	2.3	4.7	4.2	9.2	6.0	9.0
10% sea water (CI)	3.5	6.0	3.5	4.7	6.2	12.3	8.0	11.2
10% sea water (AI)	3.0	5.2	3.2	4.8	5.7	10.8	5.9	10.4
20% sea water (AI)	3.3	6.9	3.3	6.7	8.1	13.7	8.0	13.9
	Second season							
	Shoot							
H + fresh water(control)	2.4	3.6	2.6	3.2	7.3	5.9	6.9	5.3
I + fresh water (control)	2.0	3.2	2.0	3.7	5.6	4.2	5.7	5.3
I + 5% sea water (CI)	2.8	6.5	2.8	6.1	8.6	13.1	7.1	14.0
I + 10% sea water (CI)	4.6	7.0	4.8	6.0	10.1	15.6	11.0	16.0
I + 10% sea water (AI)	3.9	6.6	3.9	6.6	9.0	14.0	8.5	14.1
I + 20% sea water (AI)	4.2	7.0	4.3	6.5	9.7	17.9	9.8	17.6
	Root							
H + fresh water(control)	2.5	3.2	2.6	3.0	5.9	6.2	5.4	6.1
I + fresh water (control)	1.1	2.1	1.1	2.6	3.4	5.0	3.5	5.0
I + 5% sea water (CI)	2.3	5.2	2.4	5.2	4.2	9.2	6.2	9.0
I + 10% sea water (CI)	3.4	6.0	3.5	6.0	6.1	12.7	7.1	12.1
I + 10% sea water (AI)	3.1	5.5	3.1	5.3	5.5	10.9	6.0	10.6
I + 20% sea water (AI)	3.3	6.9	3.3	6.7	7.8	14.0	8.2	14.0

CI= Continual Irrigation AI= Alternately Irrigation (two times with diluted sea water followed by once with fresh water) H= Healthy I= Infected

The results in Table 6 also showed that N, P and K^+ concentrations in the different cultivar plants tended to gradually decreased by increasing salinity level to reach their lowest values at the highest level of salinity, though reduction was to lesser degree in Giza 429 and Giza 843 cultivars compared with the other two ones. This could be realize when comparing K^+ concentration in stressed shoots of Giza 429 and Giza 843 with the respective concentration of Giza 3 and Giza 674 cultivars at the highest level of salinity (20% sea water as alternately irrigation) which where 20.1% and 19.2% mg/g dry weight compared with 13.4 and 13.4 respectively, in the first season. On the other hand, although *Orobanche* parasitism slightly affected nutrient concentrations in the shoot system, it greatly reduced nutrient concentration in the infected roots, except K^+ concentration which seems to be unaffected. Moreover, the double stress treatments induced much more gradual decrease in such concentrations which attained its maximum level at the highest level of double stresses (infected plants irrigated alternately with 20% sea water). However, the superiority of both resistant cultivars was evidenced from the higher values of the nutrient concentration recorded in their organs at the all levels of double stresses as compared with the other two cultivars. In this regard, El-Shakweer and Barakat (1984) showed that N, P and K^+ contents were depressed by increasing salinity. Recently Mer *et al.* (2000) found that high salt concentration in the soil reduced the absorption of N and P by barely and wheat plants.

Table (6): Nitrogen, phosphorus, potassium and crude protein (C.P.) concentration (mg/g dry weight) in the shoots and roots of 93 days-old *Vicia faba* plants (Giza 3, Giza 429, Giza 674 and Giza 843 cultivars) as affected by different stress treatments in the first and second seasons; 1999/2000 and 2000/2001seasons.

Cultivars	G3	G429	G674	G843	G3	G429	G674	G843	G3	G429	G674	G843	G3	G429	G674	G843
Treatment	N				P				K				C.P.			
	First season															
	Shoot															
Fresh water (control)	41.3	44.9	41.9	44.0	5.1	7.0	5.5	6.9	29.7	31.8	30.2	31.7	258.1	280.6	261.9	274.9
5% sea water (CI)	25.9	28.2	25.3	28.3	4.1	4.7	4.2	4.5	17.6	21.3	17.3	20.6	161.9	176.3	157.9	177.1
10% sea water (CI)	24.0	26.1	24.3	26.4	2.2	3.7	2.4	3.6	15.8	19.6	15.2	18.7	150.0	163.1	151.9	165.0
10% sea water (AI)	28.1	30.6	28.2	29.6	3.9	5.6	3.3	5.5	18.2	22.4	19.9	21.3	175.6	191.3	176.2	184.8
20% sea water (AI)	17.7	19.2	17.9	20.0	2.4	2.8	2.6	2.7	13.4	20.1	13.4	19.2	110.4	120.0	111.9	124.7
	Root															
Fresh water (control)	30.8	33.5	31.2	32.3	4.0	4.6	4.2	4.5	25.7	27.5	27.0	26.5	192.6	209.5	195.3	201.9
5% sea water (CI)	19.3	21.0	19.6	21.7	2.7	3.1	2.9	3.2	15.2	18.4	15.5	17.8	120.8	131.4	122.4	135.3
10% sea water (CI)	17.9	19.5	17.2	18.2	2.1	2.4	2.2	2.4	13.7	17.0	13.7	16.2	111.9	121.8	107.3	113.8
10% sea water (AI)	21.0	22.8	21.2	22.3	3.2	3.7	3.3	3.6	15.8	19.4	15.1	18.4	131.1	142.6	132.3	139.4
20% sea water (AI)	13.2	14.3	13.2	13.9	1.5	1.9	1.7	1.8	11.6	17.4	11.3	13.7	82.4	89.6	82.3	86.9
	Second season															
	Shoot															
H + fresh water (control)	40.3	44.2	40.7	43.1	5.5	6.9	5.3	6.7	28.9	32.2	30.6	32.9	251.9	276.3	254.4	269.4
I + fresh water (control)	39.1	42.5	39.6	41.7	5.8	6.6	6.2	6.4	25.1	29.2	26.5	28.0	244.3	265.6	247.6	260.8
I + 5% sea water (CI)	24.5	26.7	24.8	26.9	3.9	4.5	3.2	4.3	16.5	20.2	14.9	19.7	153.2	166.6	155.3	168.2
I + 10% sea water (CI)	22.7	24.7	22.0	24.1	3.0	3.5	3.1	3.4	14.0	18.6	13.2	17.7	141.9	154.4	137.6	150.5
I + 10% sea water (AI)	26.6	28.9	27.0	28.0	4.6	5.3	5.0	5.2	17.4	21.2	17.8	20.2	166.2	180.8	168.4	175.2
I + 20% sea water (AI)	16.7	18.2	16.9	19.0	2.3	2.6	2.2	2.5	11.7	19.0	11.6	15.8	104.4	113.6	105.9	118.7
	Root															
H + fresh water (control)	29.5	33.9	30.2	33.1	3.7	4.9	4.6	4.9	24.6	26.9	26.8	27.1	184.4	211.9	188.8	206.9
I + fresh water (control)	20.4	23.7	21.6	22.8	3.3	3.8	3.5	3.6	24.1	26.2	24.4	26.5	127.7	148.3	131.8	142.3
I + 5% sea water (CI)	14.4	16.4	14.4	15.9	2.2	2.5	2.4	2.4	15.1	19.4	15.3	19.3	89.9	102.6	90.0	99.4
I + 10% sea water (CI)	11.3	15.1	12.9	14.4	1.7	2.0	1.5	1.9	13.9	16.2	14.2	16.2	70.9	94.1	80.6	89.9
I + 10% sea water (AI)	14.1	17.2	14.1	16.4	2.6	3.0	2.8	2.9	11.4	13.8	11.6	13.7	88.3	107.7	88.1	102.4
I + 20% sea water (AI)	9.5	15.5	10.9	12.2	1.3	1.5	1.4	1.4	10.3	11.2	10.4	11.5	59.4	96.6	67.8	75.9

CI= Continual Irrigation   AI= Alternately Irrigation (two times with diluted sea water followed by once with fresh water)   H= Healthy   I= Infected

Although N, P and K^+ were negatively affected by salinity, the complete reverse was true with Ca^{+2}, Mg^{+2} and Na^+, thus, their concentrations showed positive gradual correlation with increasing salinity level to attain its highest level over the non-stressed control in the plant irrigated alternately with 20% sea water. The most interesting finding in the obtained data in Table 7 is that, although the roots and shoots of Giza 429 and Giza 843 cultivars showed much higher Ca^{+2} and Mg^{+2} concentration, they could accumulate the lowest quantities of Na^+ as well as the lowest Na^+/Ca^{+2} ratio in addition to the highest K^+/Na^+ ratio at the highest level of salinity as compared with the other two cultivars. This finding strongly emphasized the superiority of the osmoregulation process in the cells of both cultivars. Since, salt tolerance may related to the ability of plants to exclude Na^+ or avoid Na excess.

Table (7): Sodium, calcium and magnesium concentration (mg / g dry weight) as well as K/Na and Na/Ca ratios in the shoots and roots of 93 days-old *Vicia faba* plants (Giza 3, Giza 429, Giza 674 and Giza 843 cultivars) as affected by different stress treatments in the first and second seasons;1999/2000 and 2000/2001seasons.

Cultivars	G3	G429	G674	G843	G3	G429	G674	G843	G3	G429	G674	G843	G3	G429	G674	G843	G3	G429	G674	G843
Treatments	Na				Ca				Mg				K/Na				Na/Ca			
	First season																			
	Shoot																			
Fresh water (control)	13.1	11.1	13.5	11.8	18.4	17.1	19.7	17.0	7.2	7.1	7.3	6.6	2.27	2.87	2.25	2.70	0.71	0.65	0.68	0.69
5% sea water (CI)	36.8	28.1	32.1	28.9	29.2	35.0	29.6	31.1	10.0	13.3	10.1	11.9	0.48	0.76	0.54	0.71	1.26	0.80	1.09	0.93
10% sea water (CI)	44.6	33.9	38.9	34.1	31.5	39.5	31.3	38.9	12.0	15.9	12.0	14.4	0.35	0.58	0.37	0.55	1.42	0.86	1.24	0.88
10% sea water (AI)	33.5	25.5	29.2	26.1	26.3	30.2	28.7	29.6	8.2	10.0	8.4	10.0	0.54	0.88	0.68	0.82	1.27	0.84	1.02	0.88
20% sea water (AI)	51.7	37.4	45.1	38.9	34.2	41.9	33.5	38.2	14.8	18.8	15.5	17.2	0.26	0.54	0.30	0.49	1.51	0.89	1.34	1.02
	Root																			
Fresh water (control)	11.4	8.8	10.7	11.0	14.7	13.6	15.2	13.5	5.7	5.6	5.9	5.3	2.26	3.12	2.52	2.41	0.77	0.65	0.68	0.81
5% sea water (CI)	31.9	22.4	25.6	23.8	23.3	27.9	21.4	27.8	8.0	10.7	8.1	9.5	0.48	0.82	0.60	0.75	1.37	0.80	1.05	0.86
10% sea water (CI)	38.6	27.1	31.0	28.8	25.1	31.6	25.6	28.7	9.6	12.7	9.4	11.5	0.35	0.63	0.44	0.56	1.54	0.86	1.21	1.01
10% sea water (AI)	29.0	20.3	23.3	21.6	21.0	24.1	21.9	23.7	6.5	8.0	6.7	8.2	0.54	0.95	0.65	0.85	1.18	0.84	1.06	0.91
20% sea water (AI)	44.8	29.8	36.0	31.8	27.3	33.4	28.3	30.5	11.8	15.0	12.4	14.1	0.26	0.58	0.31	0.43	1.64	0.89	1.27	1.05
	Second season																			
	Shoot																			
H + fresh water (control)	13.3	11.0	13.6	11.4	17.9	17.5	19.6	17.6	7.0	6.8	7.5	6.9	2.17	2.93	2.25	2.87	0.74	0.63	0.69	0.65
I + fresh water (control)	13.7	11.7	14.2	11.6	20.1	18.6	21.2	18.4	7.9	8.0	8.0	7.7	1.83	2.49	1.87	2.42	0.68	0.63	0.67	0.63
I + 5% sea water (CI)	38.4	26.4	33.5	26.3	24.4	37.4	26.6	33.3	10.9	14.6	11.9	14.2	0.43	0.77	0.51	0.75	1.57	0.70	1.26	0.79
I + 10% sea water (CI)	46.4	31.5	40.5	31.8	33.8	42.2	35.5	41.3	13.1	17.3	13.9	17.8	0.30	0.59	0.33	0.56	1.37	0.75	1.14	0.77
I + 10% sea water (AI)	34.9	26.7	30.5	28.4	26.4	32.4	26.6	31.7	9.0	11.1	9.1	11.2	0.50	0.79	0.58	0.71	1.32	0.82	1.15	0.90
I + 20% sea water (AI)	53.8	39.1	47.0	41.7	36.6	44.7	37.8	44.5	15.9	20.3	16.6	19.3	0.22	0.49	0.25	0.36	1.47	0.87	1.24	0.94
	Root																			
H + fresh water (control)	11.3	8.8	10.6	10.9	14.6	13.6	15.9	13.9	5.9	5.5	5.9	5.1	2.18	3.06	2.53	2.19	0.77	0.65	0.67	0.78
I + fresh water (control)	11.7	9.4	11.3	10.6	15.9	19.9	16.9	19.7	6.3	5.4	6.4	5.1	2.06	2.80	2.16	2.49	0.73	0.47	0.67	0.54
I + 5% sea water (CI)	32.6	23.4	26.7	24.9	19.0	29.8	21.0	26.5	8.7	11.6	9.5	11.5	0.16	0.83	0.57	0.78	1.71	0.78	1.27	0.94
I + 10% sea water (CI)	39.5	27.3	32.3	26.4	24.9	33.7	25.3	30.5	10.4	13.8	11.1	13.6	0.35	0.59	0.44	0.62	1.58	0.81	1.28	0.96
I + 10% sea water (AI)	29.7	21.3	29.3	22.7	22.7	25.8	22.4	29.3	7.1	8.9	7.3	8.1	0.38	0.69	0.40	0.60	1.31	0.82	1.31	0.77
I + 20% sea water (AI)	45.7	31.1	37.5	31.2	25.2	35.6	26.1	32.4	8.7	10.2	8.3	10.4	0.23	0.36	0.28	0.37	1.81	0.87	1.43	0.96

CI= Continual Irrigation AI= Alternately Irrigation (two times with diluted sea water followed by once with fresh water) H= Healthy I= Infected

On the other hand, in the second season, and regardless few exceptions, it could be stated that although *Orobanche* infection could not affected Na^+, Mg^{+2} and Na^+/Ca^{+2} ratio in the infected roots and shoots, it could slightly increased Ca concentration, meanwhile, K/Na was negatively affected. The data in Table 7 also showed that nutrient concentration as well as ratios were, generally, responded to the double stresses similar to that response recorded under salt stress in the first season. In accord with Giza 429 and Giza 843 cultivars Epstein (1972), stated that, in saline soil the Na^+ / K^+ ratio is very high, thus, the plants, which are tolerant to salinity such as halophytes, must develop a mechanism for preferential uptake of K^+ from mixture rich in Na^+. Gorham and Jones (1990) found that, a high leaf K^+/Na^+ ratio has been associated with wheat salt tolerant. Sharma (1995b) suggested that, salt tolerance is related to the ability of plants to exclude Na^+ or avoid Na^+ excess. On the other hand, Kandeel and Abu-Grab (1992) found that, salinity application tended to increase the contents of Ca^{+2}, Mg^{+2} and Na^+, but decreased that of K^+ content of faba bean plants.

As for the chemical constituents of the produced seeds, and as previously mentioned with the roots and shoots, the recorded data in Table 8 showed that the all salinity levels decreased N, P, K, and crude protein concentrations in the produced seeds by the different cultivars. Such reduction was to lesser extent in Giza 429 and Giza 843 seeds. The most supported evidence for the superiority of both *Orobanche*-resistant cultivars, i.e. Giza 429 and Giza 843 is found in the recorded data in Table 8 which clearly reveal that the plants which have acquired the capacity to complete their life cycle till harvest and produced seeds under the double stresses in the second season were only Giza 429 and Giza 843 plants, unlike the plants of the other two cultivars. As regards the susceptible Giza 3 cultivar, its infected plants were completely dead few days after the second sampling date at the all salinity levels more than 5 % sea water (continual irrigation) while Giza 674 infected plants (partially – *Orobanche* resistant) could complete their life cycle only at 5 % sea water (continual irrigation) and 10 % sea water as alternately irrigation, and could not survived till harvest at the other two levels of salinity (the higher ones). These results offered a strong evidence for the adaptation either to salinity or to double stresses, which characterizing both Giza 429 and Giza 843 cultivars according to Amazallage *et al.* (1990) who considered the plant adapted to salinity when the plant has acquired the capacity to complete its life cycle in a saline environment in which the nonadapted plant is not able to do so. The most interesting finding is that, such adaptation was occurred without applying any specific treatments that induce such adaptation. Accordingly both cultivars could be considered as adapted cultivars to salinity possessing the properties of the physiological tolerance, as previously mentioned, i.e. their adaptation due to their physiological tolerance according to Susan Stavarek and Rains (1983) and Amazallag *et al.* (1990).

The obtained data in Table 8, also indicate that, *Orobanche* parasitism slightly reduced the nutrient and crude protein concentrations in the produced seeds by the infected plants of different cultivars, except that K^+ concentration.

Table (8): Nitrogen, phosphorus, potassium and total crude protein(C.P.) concentration (mg / g dry weight) in *Vicia faba* seeds (Giza 3, Giza429, Giza 674 and Giza 843 cultivars) as affected by different stress treatments in the first and second seasons; 1999/2000 and 2000/2001 seasons.

Cultivars	G3	G429	G674	G843	G3	G429	G674	G843	G3	G429	G674	G843	G3	G429	G674	G843
Treatments	N				P				K				C.P.			
	First season															
Fresh water (control)	19.8	23.8	19.6	23.0	2.9	3.3	3.0	3.2	16.4	20.8	16.6	20.7	123.8	148.9	122.4	143.8
5% sea water (CI)	16.2	17.4	16.4	17.8	2.1	2.4	2.3	2.3	11.3	17.3	14.5	17.5	101.3	108.8	102.3	111.2
10% sea water (CI)	13.6	16.5	15.2	16.9	1.3	2.0	1.6	1.9	9.5	16.5	9.8	16.8	85.0	103.1	94.7	105.8
10% sea water (AI)	13.1	18.8	13.7	18.1	1.4	1.6	1.5	1.6	12.3	17.4	12.5	12.5	81.9	117.5	85.1	113.1
20% sea water (AI)	13.4	14.1	13.3	14.6	1.3	1.5	1.4	1.5	7.8	9.5	7.9	9.9	83.8	88.1	82.8	91.3
	Second season															
H + fresh water (control)	19.9	23.6	19.6	23.5	3.0	3.3	3.1	3.2	16.8	20.4	16.8	20.6	124.1	147.2	122.7	146.6
I + fresh water (control)	17.4	21.9	18.5	21.1	2.1	3.1	2.1	3.1	15.7	19.7	16.0	19.8	108.8	136.9	115.4	132.1
I + 5% sea water (CI)	15.9	16.9	15.6	16.5	2.0	2.1	2.0	2.1	12.9	15.5	12.2	15.2	99.6	105.4	97.8	102.9
I + 10% sea water (CI)	-	16.0	-	15.5	-	1.7	-	1.8	-	10.5	-	10.4	-	99.8	-	96.8
I + 10% sea water (AI)	-	17.0	12.5	17.7	-	1.4	1.4	1.4	-	10.4	9.0	10.1	-	106.4	78.3	110.6
I + 20% sea water (AI)	-	13.7	-	13.5	-	1.5	-	1.6	-	12.2	-	12.3	-	85.4	-	84.4

CI= Continual Irrigation AI= Alternately Irrigation (two times with diluted sea water followed by once with fresh water) H= Healthy I= Infected

As for the effect of double stresses on nutrients and crude protein concentrations in the seeds of Giza 429 and Giza 843 cultivars, the obtained data showed a gradual decrease in the concentration values to reach its maximum at the highest level of double stresses, much more reduction in such constituents in the seeds of other two cultivars were recorded at the only two level of salinity for Giza 674 an only one for Giza 3 seeds as compared with the healthy control seeds. Concerning the effect of salinity treatments on Na^+, Ca^{+2}, Mg^{+2} concentrations as well as K^+/Na^+ and Na^+/Ca^{+2} in the produced seeds by different cultivars in the first season, (Table 9), the results indicated that, while salinity induced general gradual increases, with some fluctuations, in the concentrations of Na^+, Ca^{+2} and Mg^{+2} as well as Na^+/Ca^{+2} ratio, the K^+/Na^+ ratio was adversely affected. In the second season, faba bean seeds produced by the infected plant cultivars showed lower values than these produced by healthy plants as regards Ca^{+2} and Mg^{+2} concentrations, however Na^+ concentration as well as K^+/Na^+ and Na^+/Ca^{+2} seem to be unaffected by *Orobanche* infection. Moreover, and as would be expected due to the effect of double stress treatments, although Na^+ concentration showed higher values in the seeds of stressed Giza 429 and Giza 843 than those produced by healthy plants, their seeds which produced at both highest levels of double stresses showed marked increases in their concentration of Ca^{+2} and Mg^{+2}. On the other hand, K^+/Na^+ and Na^+/Ca^{+2} ratios in the seed of Giza 429 and Giza 843 responded to the double stress treatments in the same way as previously recorded in the first season under salt stress.

Table (9): Sodium, calcium and magnesium concentration (mg / plant) as well as K/Na and Na/Ca ratios in *Vicia faba* seeds (Giza 3, Giza 429, Giza 674 and Giza 843 cultivars) as affected by different stress treatments in the first and second seasons; 1999/2000 and 2000/2001 seasons.

Cultivars	G3	G429	G674	G843	G3	G429	G674	G843	G3	G429	G674	G843	G3	G429	G674	G843	G3	G429	G674	G843
Treatments	Na				Ca				Mg				K/Na				Na/Ca			
	First season																			
Fresh water (control)	1.9	1.6	2.1	1.4	6.5	7.8	6.1	7.7	3.3	5.8	3.6	5.5	8.7	12.7	7.9	14.7	0.29	0.21	0.35	0.18
5% sea water (CI)	3.3	2.1	2.7	3.3	9.6	6.9	8.3	7.6	5.8	7.1	6.2	7.2	4.3	8.2	5.4	5.3	0.35	0.31	0.32	0.43
10% sea water (CI)	3.5	2.9	3.6	3.7	10.3	9.7	10.8	10.3	7.2	6.5	7.1	6.1	2.7	5.7	2.8	4.6	0.34	0.30	0.33	0.35
10% sea water (AI)	2.8	1.9	2.2	2.2	8.7	6.3	9.2	6.4	4.5	3.7	4.5	4.2	4.3	9.0	5.7	5.8	0.33	0.31	0.24	0.33
20% sea water (AI)	2.9	4.0	4.3	4.0	10.6	10.7	12.4	11.0	9.5	6.7	7.9	7.3	2.7	2.4	1.8	2.5	0.27	0.38	0.35	0.37
	Second season																			
H + fresh water (control)	1.9	1.5	2.0	1.4	6.4	7.9	6.2	7.7	3.3	5.4	3.5	5.4	9.0	13.3	8.3	14.5	0.29	0.19	0.32	0.18
I + fresh water (control)	1.7	1.3	2.0	1.1	5.1	6.7	5.7	6.5	2.8	4.5	2.0	4.1	9.5	11.9	8.2	17.2	0.32	0.20	0.34	0.17
I + 5% sea water (CI)	3.4	2.2	2.7	2.4	10.7	7.2	9.2	8.5	5.5	6.7	5.9	6.0	3.8	7.2	4.4	6.4	0.32	0.30	0.30	0.28
I + 10% sea water (CI)	-	3.1	-	3.7	-	10.6	-	11.4	-	7.2	-	6.8	-	3.4	-	2.8	-	0.27	-	0.31
I + 10% sea water (AI)	-	2.0	2.2	2.2	-	6.9	10.2	7.1	-	4.1	5.0	4.7	-	5.3	4.1	4.6	-	0.29	0.22	0.31
I + 20% sea water (AI)	-	4.1	-	4.1	-	11.8	-	11.5	-	7.4	-	7.1	-	3.0	-	3.0	-	0.35	-	0.35

CI= Continual Irrigation AI= Alternately Irrigation (two times with diluted sea water followed by once with fresh water) H= Healthy I= Infected

3- Yield components:

The effect of different stress treatments in both seasons on the yield components of the different faba bean cultivars is shown in Table 10 and 11 as well as Fig. 1 and 2. As shown in Table 10, salinity treatments highly significantly decreased the number of pods/plant, pod yield (g)/plant, seed yield (g)/plant and 100 seeds weight of different cultivars in the first season, while number of seeds/pod was significantly decreased only at both the two highest salinity levels. Nevertheless, generally Giza 429 followed by Giza 843 recorded the highest significant mean values in the all yield components as compared with the other two cultivar (Table 10). Moreover, at the highest level of salinity seed yield of Giza 429 was more than four folds that of either Giza 3 or Giza 674, meanwhile the seed yield of Giza 843 was more than 2 folds that of either Giza 3 or Giza 674 at the same salinity level. Decreasing faba bean seed yield due to increasing salinity has been reported by many workers. In this respect El-Shakweer *et al.* (1982) found that, salinity decreased seed yield of faba bean by 43.8% in the presence of 4000-ppm salts. Rabie *et al.* (1986) mentioned that higher salinity levels inhibited faba bean seed yield and number of pods /plants. Moreover, Sharma (1995a) found that, a 50% reduction in seed yield was observed at 9.51 ds/m. Also De-Pascale and Barbieri (1997) stated that, soil salinity reduced the mean pod weight by 15%, number of pods per plant 48% and seed yield of faba bean by 67%. On the other hand, the all yield components were highly significantly reduced due to *Orobanche* infection in the second season, except number of seeds/pod and weight of 100 seeds which seem to be unaffected.

Table (10):Yield components of *Vicia faba* plants (Giza 3, Giza 429, Giza 674 and Giza 843 cultivars) as affected by different stress treatments in the first and second seasons; 1999/2000 and 2000/2001seasons.

Growth character	No.of pods/ plant					No.of seeds /pod					Pod yield (g) / plant					Seed yield (g) / plant					Weight of 100 seeds (g)				
Cultivars / Treatments	G3	G429	G674	G843	MeanS	G3	G429	G674	G843	MeanS	G3	G429	G674	G843	MeanS	G3	G429	G674	G843	MeanS	G3	G429	G674	G843	MeanS
	First season																								
Fresh water (control)	10.4	11.3	5.9	7.7	8.8	1.9	2.5	2.0	2.0	2.1	16.2	16.2	13.0	11.0	14.1	9.8	10.1	9.9	8.5	9.6	58.0	55.0	52.2	53.2	54.6
5% sea water (CI)	1.1	2.6	2.1	2.1	2.0	1.7	2.2	2.0	2.2	2.0	2.0	2.4	2.2	2.3	2.2	1.5	2.2	1.6	1.8	1.8	31.1	39.3	36.4	38.2	36.3
10% sea water (CI)	1.0	1.9	1.3	1.9	1.5	1.0	2.0	1.6	1.7	1.6	0.7	1.6	1.4	1.4	1.3	0.5	1.4	0.6	1.2	0.9	22.4	30.3	30.2	30.7	28.4
10% sea water (AI)	1.2	1.7	1.5	1.7	1.5	1.7	2.6	1.9	2.5	2.2	1.4	2.5	1.8	2.0	1.9	1.0	1.9	1.3	1.4	1.4	29.9	33.9	32.5	33.3	32.4
20% sea water (AI)	1.2	1.8	1.5	1.6	1.5	1.1	1.7	1.7	1.9	1.6	0.6	1.6	0.7	0.9	1.0	0.3	1.3	0.3	0.7	0.7	20.6	29.3	21.7	22.9	23.6
Mean C	3.0	3.9	2.5	3.0	-	1.5	2.2	1.8	2.0	-	4.2	4.9	3.8	3.5	-	2.6	3.4	2.7	2.7	-	32.5	37.6	34.6	35.7	-
L.S.D. values at:		5%		1%			5%		1%			5%		1%			5%		1%			5%		1%	
Cultivars		0.75		1.37			0.45		0.83			0.81		1.48			0.60		1.11			7.5		NS	
Salinity		0.73		1.21			0.41		0.73			0.79		1.31			0.59		0.98			7.4		12.2	
C X S		1.14		NS			0.70		NS			1.24		1.73			0.92		1.30			11.6		16.2	
	Second season																								
H + fresh water (control)	10.6	10.8	11.2	11.6	11.1	2.1	2.5	2.5	2.4	2.4	16.5	16.5	13.5	12.6	14.8	10.2	10.3	10.0	9.1	9.9	55.6	52.3	53.6	52.9	53.6
I + fresh water (control)	2.4	4.6	2.8	3.4	3.3	2.0	2.2	2.0	2.0	2.1	5.2	6.9	5.5	5.7	5.8	2.5	4.8	2.6	2.8	3.2	42.4	50.1	45.7	47.7	46.5
I + 5% sea water (CI)	1.1	1.8	1.5	1.5	1.5	1.8	1.9	1.8	1.8	1.8	0.8	1.5	0.9	1.1	1.1	0.3	1.0	0.4	0.6	0.6	15.2	35.4	10.6	31.7	20.3
I + 10% sea water (CI)	-	1.6	-	1.3	0.7	-	1.6	-	1.6	0.8	-	1.1	-	0.9	0.5	-	0.7	-	0.5	0.3	-	23.2	-	19.3	10.6
I + 10% sea water (AI)	-	1.6	1.2	1.4	1.1	-	1.6	1.3	1.6	1.1	-	1.2	0.9	0.9	0.7	-	0.7	0.3	0.6	0.4	-	27.5	22.4	24.7	19.1
I + 20% sea water (AI)	-	1.5	-	1.1	0.7	-	1.6	-	1.4	0.8	-	1.0	-	0.5	0.4	-	0.5	-	0.3	0.2	-	20.2	-	10.1	9.6
Mean C	2.4	3.7	2.7	3.4	-	1.0	1.8	1.3	1.8	-	3.7	4.7	3.5	3.6	-	2.2	3.0	2.2	2.3	-	18.9	35.2	25.4	32.4	-
LSD at:		5%		1%			5%		1%			5%		1%			5%		1%			5%		1%	
Cultivars		0.39		0.78			0.37		0.68			0.47		0.87			0.36		0.62			6.4		NS	
Salinity		0.35		0.66			0.34		0.60			0.46		0.77			0.35		0.59			5.6		10.3	
C X S		0.67		0.92			0.57		0.98			0.72		1.02			0.55		0.78			9.3		11.3	

CI= Continual Irrigation AI= Alternately Irrigation (two times with diluted sea water followed by once with fresh water) H= Healthy I= Infected

Table (11): The percentages of relative seed yield |RSY| and stress susceptibility index |SI| of *Vicia faba* cultivars (Giza3, Giza429, Giza674 and Giza 843) as affected by different stress treatments in the first and second seasons: 1999/2000 and 2000/2001seasons.

	Relative Seed Yield |RSY|* (%)				Stress Susceptibility Index |SI|*(%)			
(1999/2000 season)								
Cultivars / Treatments	G3	G429	G674	G843	G3	G429	G674	G843
5%CI	15.0	21.9	16.2	21.3	103.6	95.1	103.2	95.9
10%CI	5.1	13.4	5.6	13.6	104.6	95.5	104.8	95.3
10%AI	10.3	18.8	13.1	17.0	105.6	95.6	102.2	97.6
20%AI	2.8	12.9	3.4	8.2	104.2	93.5	103.5	98.5
(2000/2001 season)								
Cultivars / Treatments	G3	G429	G674	G843	G3	G429	G674	G843
I+F.W.(control)	24.1	47.3	25.7	31.1	111.8	77.7	109.4	95.3
I+5%CI	3.1	9.7	3.7	6.4	102.7	95.7	102.1	99.4
I+10%CI	-	6.6	-	5.7	-	96.5	-	97.2
I+10%AI	-	7.2	2.7	6.9	-	96.9	101.5	91.0
I+20%AI	-	5.2	-	3.4	-	96.8	-	98.7

CI= Continual Irrigation AI= Alternately Irrigation (two times with diluted sea water followed by once with fresh water) H= Healthy I= Infected F.W. = Fresh weight 5, 10, 20 % = 5, 10, 20 % sea water Relative Seed Yield [RSY]*: The relatively higher RSY values indicating the higher degree of salt tolerance. Stress Susceptibility Index [SI]*: The salt-tolerant cultivars which recorded SI values lower than 100%.

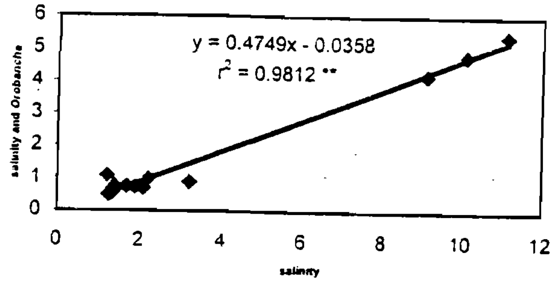

Fig. (1): The correlation between *Orobanche* resistance and salinity tolerance in Giza 429 cultivar.

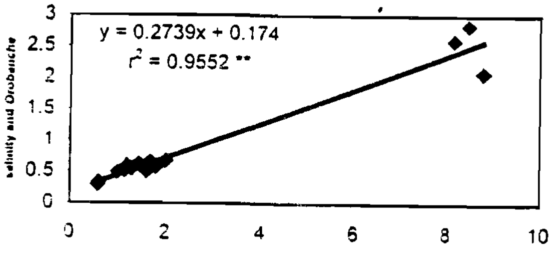

Fig. (2): The correlation between *Orobanche* resistance and salinity tolerance in Giza 843 cultivar. The tabulated r2 value at 5% = 0.514 and 1% = 0.641

In this regard, Edwards (1972) observed that *Orobanche crenata* caused yield loss in broad bean amounted to 50-100 %. Aly (1981) indicated the loss in infected faba bean host seed yield as one tenth of the healthy plants. Salem and El-Ghamrawy (1988) and Salem *et al.* (1989) recorded a significant reduction in the faba bean (Giza 2 cultivar) yield components. Similar results were reported by Salem *et al.* (1991) and Ibrahim (1997).

Moreover, the all yield components of Giza 429 and Giza 843 cultivars were highly significantly reduced at the all applied double stress levels, though to great extent as compared with the reduction induced by only salt stress in the first season. However, at the first (lowest) double stress level Giza 429 seed yield was more than 3 folds that of Giza 3, meanwhile, Giza 843 seed yield was double that of Giza 3 seed yield. Moreover, at the third level of double stresses (infected plants irrigated alternately with 10% sea water) the seed yield of either Giza 429 or Giza 843 was double that of Giza 674 yield. In addition, the relatively much higher values of RSY of Giza 429 and Giza 843 than the respective values of the other two cultivars, (Table 11) strongly confirmed the higher degree of their tolerance to either salinity or to double stresses. Moreover, according to SI values of both cultivars, which were lower than 100%, unlike the other two cultivars which recorded SI values over than 100%, Giza 429 and Giza 843 cultivars can be considered as salt-tolerance or even stress-tolerant cultivars. Also, the highly significant values of correlation coefficient for both cultivars confermed the highly significant positive correlation between *Orobanche* resistance and salt tolerance in both cultivars (Fig. 1 and 2).

Finally, the obtained results in the present study represent a strong supportive evidence on the highly significant positive correlation between *Orobanche* resistance and salt tolerance in both *Orobanche*-resistant cultivars, i.e. Giza 429 and Giza 843 as evidenced not only from RSY, SI and the highly significant values of correlation coefficient for both cultivars but also from their highly adaptation not only to salinity but also to the double stress conditions which strongly was emphasized by continuation their growth and complete their life cycle till harvest and yield production under double stress conditions, nevertheless, without any specific treatment that induces such adaptation, meanwhile, the non-adapted other two cultivars, i.e. Giza 3 and Giza 674 were not able to do so. This adaptation was due mainly to the high degree of physiological tolerance characterizing both cultivars brought about by creating more negative osmotic potentials (Osmotic Adjustment) through the accumulation of much more quantities of inorganic osmotica, i.e. N, P, K^+, Ca^{+2}, Mg^{+2} and lower quantities of Na^+ (through exclude Na or avoid Na excess), as well as higher K^+/Na^+ ratio and lower Na^+/Ca^{+2} ratio, in addition to the considerable accumulation of organic protective osmolytes, i.e. sugar (especially non-reducing ones), proline, free amino acids and protein, in their roots and shoos, which greatly exceeded that in the other two cultivars or even the non-stressed control plants in several cases. Such accumulation increased proportionally with increasing salinity level as an adaptable mechanism or protective adaptation, which enable both cultivars to adjust the rates between the protective and toxic intermediates of metabolism in favor of more tolerance to stresses. Such behavior seems to induce more ability for Giza 429 and Giza 843 plants to continue their growth till harvest under either single or double stresses. Moreover, it is well known that sugars as osmolytes enable plants to keep better water relation under stress conditions (*Orobanche* infection or salt stress) by increasing the ability of their roots to uptake more water from even the saline soil solution. Since sugars and K^+ contribute to the osmotic adjustment, both of them were found to correlate negative with osmotic potential.

Probably, the most interesting feature of the foregoing results is that, they are not only of academic interest, but also of great applied importance. If we consider these results from the economical applied point of view, the obtained results suggested that Giza 429 and Giza 843 cultivars could tolerate the irrigation with the diluted sea water up to 20% as alternately irrigation or up to 10 % when continually irrigated, even in the presence of *Orobanche* infection, thus, both of them can be successfully cultivated in the newly reclaimed Egyptian areas and irrigated with the diluted sea water as previously recommended in the present study. In the meantime, special attention must be directed to more improvement of salinity tolerance and consequently productivity of both cultivars under such saline conditions through a group of specific physiological treatments must be designed and applied wisely, after precise study to approach its optimal effectiveness in inducing more tolerance to salinity and consequently more enhancement of faba bean cultivar productivity. On the other hand, from the academic point of view, both cultivars can be considered, the most suitable faba bean cultivars, today, for the *in vitro* experiments which were directed to the production of salt tolerance line of faba bean plants or the development of salt-tolerant crop genotypes.

REFERENCES

Abd-Alla, M. H. (1992). Nodulation and nitrogen fixation in faba bean (*Vicia faba* L.) plants under salt stress. Symbiosis Rehovot., 12 (3) : 311-319.

Ahmed, A.H.H. (1981). Physiological studies on *Orobanche* parasitism on *Vicia faba*. M.Sc. Thesis, Fac. of Agric., Cairo Univ.

Aly, A. A. (1987).Physiological studies on increasing the tolerance of pepper and broad bean plant to saline water irrigation. Ph. D. Thesis, Cairo Univ., 1987.

Amazallage, G. N.; H. R. Lemer and A. Poljakoff-Mayber (1990). Interaction between mineral nutrients, cytokinen and gibberellin during growth of sorghum at high NaCl salinity. Journal of Experimental Botany, 43 (246): 81-87.

A.O.A.C.(1975). Official methods of analysis of the Association of official analyses chemists, 12th Ed., published by A.O.A.C., Washington D.C.200044.

Ashraf, M. Y.; M. A. Khan and S. S. M. Naqvi (1991). Effect of salinity on seedling growth and solutes accumulation in two wheat genotypes. Rachis, 10 (1) : 30-31.

Bates, L.S.; L.P. Waldem and I.D. Teare (1973). Rapid determination of proline for water stress studies. Plant and Soil, 39: 205.

Botella, M. A.; V. Martinez; M. Nieves and A. Cerda (1997). Effect of salinity on the growth and N uptake by Wheat Seedling. F. plant Nutrition, 20 (6) : 793-804.

Cordovilla, M.P.; A. Ocana.; F. Ligero and C.Lluch (1995). Growth and macronutrient contents of faba bean plants: effects of salinity and nitrate nutrition. Journal of Plant Nutrition., 18 (8): 1611-1628.

De-Pascale, S. and G. Barbieri. (1997). Effects of soil salinity and top removal on growth and yield of broad bean as a green vegetable. Scientia Horticulturae., 71 (3-4): 147-165.

Edward, W.G.H. (1972). Orobanche and other parasite factors, (Pytochemical Society Symposia Series No. 8) London, U K and New York, USA. Acadimic Press, 235-248.

El-Shakweer, M. H. A.; M. A. Farah and M. A. Barakat (1982). Effect of some integrated foliar fertilizers on nodulation, nitrogenase activity, nitrogen content and yield of *Vicia faba* plants in salinized calcareous soil. Research Bull.Fac.of Agric., Ain Shams University. No. 1887. 14 pp.

El-Shakweer, M. H. A. and M. A. Barakat (1984). Nitrogen fixation and phosphorous, potassium and water uptake by faba bean as affected by salinity stresses. Second. Conf., ARC., Giza, 9-11 April, P. 58.

El-Shihy, O. M.; S. M. Salem and M. Khalil (1994). Production of salt tolerant line of (*Vicia faba*) induced by protoplast irradiation with fast neutrons and gamma rays. Egypt. J. Appl. Sci., 9(4): 393-418.

Epstein, E. (1972) Mineral nutrtition of plants. Principles and Perspectives. Than Wiley and Sonc. Inc. New York, London, Sydney, Toronto.

Fischer, R.A. and Maurer (1978). Drought resistance in spring wheat cultivars.1 - grain yield responses. Aust.J.Agric. Res., 29: 897-912.

Giovanna, B. ; M. Rosario ; M. Giovannela; B. Micheele; Maria-Gabrila, P. ; C. Fabrizo and B. Marcello (1989). Characterization of salt tolerant plants derived from a *Lycopersicon esculentum* Mill. Somaclone.J.Plant Physiol., 155: 613-619.

Gnanasiri, S. Premachandra; Hirohumi Saneoka and Shouitsu Ogata (1990). Adaptation of plants to water deficits at high nitrogen levels. Soil Sci. and Plant Nutr., 36(4): 340-352.

Gomez,K.A. and A.A. Gomez (1984) Statistical proceduers for Agricultural Research. 2nd Ed. International Rice Res. Inst. J. Wiley and Sons, New York, U.Y.

Good, A. G. and S. T. Zaplachinski (1994). The effects of drought stress on free amino acid accumulation and protein synthesis in (*Brassica napus*) Physiol. Plant, 90 : 9-14.

Gorham, J. and R. G. Jones (1990). A physiologists's approach to improve the salt tolerance of wheat. Rachis, 9 (2) : 20-24.

Ibrahim, A.S.A. (1997). Physiological studies on *Orobanche* parasitism on *Vicia faba* L.. M.sc. Thesis, Fac. Of Agric., Cairo Univ. Giza, Egypt.

Jackson, M.L. (1973). Soil chemical analysis. Printice-Hall.of India pp.144-197.

Kandeel, Sh. H. and O. S. Abu-Grab. (1992). Influence of salinity and soil texture on mineral content and growth of broad bean plants. Zagazing J. Agric. Res., 19 (2) : 975-981.

Linder,R.C.(1944). Rapid analytical methods for some of the more common inorganic constituents of plant tissues. Plant Physiol.,19(1):76-79.

Meinzer, F. C.; D. A. Grantz; G. Goldstein and N. Z. Saliendra (1990). Leaf water relations and maintenance of gas exchange in coffee cultivars grown in drying soil. Plant Physiol., 94:1781-1787 (C. F. Maersti, 1995).

Mer,R.K.; P.K. Prajith; D.H. Pandya and A.N. Pandey (2000). Effect of salts on germination of seeds and growth of young plants of Hordeum vulgare, Triticum aestivum, Cicer arietinum and Brassica juncea. Joumal-of-Agronomy-and-Crop-Science,185(4): 209-217.

Mola-Doila, Y. A. A.; K. S. Datta; R. Angrish; B. Kumar; J. Dayal and P. Kumari. (1998). Salinity and boron effects on nodulation and carbon and nitrogen contents of nodules of broad bean (*Vicia faba* L.) Indian Journal of Plant Physiology., 3 (4) : 279 : 282.

Moore, S. and W. H. Stein (1954). A modified ninhydren reagent for the photometric determination of amino acids and related compounds.J. Biol. Chem., 211:907-913.

Nasir M.N.; R.H. Qureshi; Muhammad-Aslam and Javaid Akhtar(2000). Comparative studies on two selected sugarcane lines for differences in physiological traits. Workshop proceedings "R&D activities on sugarcane crop in Pakistan", Shakarganj Sugar Research Institute, Jhang, Pakistan, 15-16 September 2000. Pakistan-Sugar-Joumal. 2000, 15: 6, 52-61; 23 ref.

Peach, K. and M.V. Tracy (1956) Modern methodes of plant analysis. Vol.1 Springier – Velay Berlin, 4:643.

Rabie, R. K.; M. K. Matter; A. M. A. Khamis and M. M. Mostafa. (1986). Nitrogen nutrition of broad beans as influenced by soil salinity Japanese Journal of Crop Science, 55 (2): 155-161.

Salem, S.M. and El-Ghamrawy (1988). Host-parasite relationship between Vicia faba and *Orobanche* crenata as affected by foliar application of some growth regulators. Proc.of 2nd Conference of Agriculture Development Research. Ain-Shams Univ., Cairo, Egypt.

Salem, S.M. ; O.M.A. El-Shihy and A.H.Hanafy Ahmed (1989). Comparative studies on the effectiveness of fusillade and glyphosate in controlling *Orobanche crenata* parasitizing *Vicia faba* plants.Bull. Fac.of Agric., Cairo Univ., 40 3 (Dec.) 633-650.

Salem, S.M. ; E.M.Z. Harb and O.M.A. El-Shihy (1991).Host-parasite relationship between Vicia faba and *Orobanche* crenata as affected by fast nutron presowing seed treatments. Bull. Fac.of Agric., Cairo Univ., 42(2) (April) 533-556.

Sallam, H.A.(1999). Effect of some seed-soaking treatments on growth and chemical component on faba bean plants under saline conditions. Annals of Agric.Sci. Cairo, 44(1):159-171.

Santarius, K. A. (1973). The protective effect of sugars on chloroplast membranes during temperature and water stress and its relationship to frost, dessication and heat resistance. Planta, 113 : 105-114.

Sharma, S. K. (1995a). Effects of salinity on growth performance and internal distribution of Na+ , K+ and Cl- in *Vicia faba* L. Indian Journal of Plant Physiology. 38 (1) : 69-72.

Sharma S. K. (1995b). Studies on growth, water relations and distribution of Na+ , K+ and other ions in wheat under short term exposures to salinity. Indian Journal of Plant Physiology, 38 (3): 233-235.

Sharma S. K. and O. P. Garg (1985). Salinity induced changes in plant growth and activities of glutamate dehydrogenase, aspartate and alanine aminotransferases in wheat. Indian Journal of Plant Physiology, 28 (4) : 407-412.

Simpson, G. M. (1981). Water stress on plants. Praeger Special studies, praeger Scientific, U. S. A.

Strogonov, B. P. (1970). Structure and function of plant cells under salinity conditions (In Russian) Nauka Publishing House Moscow.

Susan Stavarek, J. and D.W. Rains (1983). The devekopment of tolerance to mineral stress. Hort.Sci., 19: 377-382.

دراسة الارتباط بين صفتي المقاومة للهالوك وتحمل الملوحة في بعض أصناف الفول البلدي

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أجري هذا البحث بهدف دراسة مدى الارتباط بين صفتي المقاومة للهالوك وتحمل الملوحة في بعض أصناف الفول البلدي المقاومة للهالوك مثل جيزة ٤٢٩ وجيزة ٨٤٣ والمقاومة جزئيا مثل صنف جيزة ٦٧٤ وذلك بالمقارنة مع صنف جيزة ٣ الشديد الحساسية للإصابة بالهالوك وذلك من خلال تقييم نموها وتركيبها الكيميائي وإنتاجيتها في حالة نموها تحت تأثير الري بمستويات مختلفة من ماء البحر (الري المستمر بتركيزي ٥ %و ١٠% و الري المتبادل بتركيزي ١٠% و ٢٠%) بالإضافة إلى الري بماء الصنبور (في معاملة المقارنة). وذلك خلال تجربة الأصص الخاصة بالموسم الأول ١٩٩٩-٢٠٠٠ . أما في الموسم الثاني ٢٠٠٠-٢٠٠١ فقد تم ري نباتات الفول بنفس مستويات الملوحة السابقة , لكن في وجود الإصابة بالهالوك (معاملات الإجهاد المزدوج) . وتؤكد نتائج البحث خلال موسميه الدرجة العالية للتحمل الفسيولوجي لجميع مستويات الإجهاد سواء المنفرد منها او المزدوج والتي تميزت بها نباتات صنفي جيزة ٤٢٩ و جيزة ٨٤٣ والتي جعلتها قادرة على التأقلم الذاتي حتى تحت ظروف الإجهاد المزدوج من الملوحة والإصابة بالهالوك وبالتالي استطاعت استكمال دورة حياتها حتى موعد الحصاد وإنتاج محصولها من البذور دون تطبيق أي من المعاملات الفسيولوجية الخارجية التي تسبب هذا التأقلم , وهذا ما لم تستطعه نباتات صنفي صنف جيزة ٣ و جيزة ٦٧٤ تحت نفس الظروف. وقد أوضحت النتائج ان هذا التحمل الفسيولوجي الذي تميزت به نباتات صنفي جيزة ٤٢٩ و جيزة ٨٤٣ قد تحقق لها من خلال خلق جهد أسموزي اكثر سالبيه داخل أنسجتها (عملية التنظيم الإسموزي) وذلك بتراكم كميات كبيرة متزايدة من عناصر النيتروجين والفوسفور والبوتاسيوم والكالسيوم والمغنيسيوم مع تقليل كمية الصوديوم وكذلك نسبة الصوديوم : الكالسيوم إلى اقل حد ممكن مع الاحتفاظ بنسبة البوتاسيوم : الصوديوم عند أعلى حد ممكن , ذلك بالإضافة إلى تراكم كميات ضخمة من السكريات (خاصة غير المختزلة منها) والبرولين والأحماض

الأمينية الحرة والبروتين في الجذور والمجموع الخضري لهما بدرجة فاقت كثيرا مثيلتها في الصنفين الآخرين تحت نفس ظروف الإجهاد, كما أنها قد فاقت في حالات عديدة مثيلتها في نباتات المقارنة في هذا الصدد, وقد ارتبط هذا التراكم في نباتات صنفي جيزة ٤٢٩ و جيزة ٨٤٣ ارتباطا موجبا بزيادة مستوى ملوحة ماء الري , وذلك كميكانيكية للتأقلم قد مكنتها من ضبط النسبة بين المركبات الواقية والسامة في خلال عمليات التحولات الغذائية داخل خلاياها مما يزيدها تحملا لظروف الإجهاد. من ناحية أخرى فان تراكم كبيرة من السكريات في جذورها قد مكنت نباتات صنفي جيزة ٤٢٩ و جيزة ٨٤٣ من الاحتفاظ داخلها بعلاقات مائية جيدة وميزان مائي موجب تحت ظروف الإجهاد هذه , وذلك بزيادة قدرة جذورها على امتصاص المزيد من الماء من محلول التربة سواء تحت ظروف الملوحة أو الإصابة بالهالوك. علاوة على نلك, فان قيم RSY% و SI% المحسوبة لجميع الأصناف المستخدمة في التجربة, قد أضافت دليلا قويا على درجة التحمل العالية للملوحة (كما هو الحال ضد الإصابة بالهالوك) والتي ميزت صنفي جيزة ٤٢٩ و جيزة ٨٤٣ بعكس الحال في صنفي جيزة ٣ وجيزة ٦٧٤ . والاهم من نلك فقد أكدت المعنوية العالية لقيم معامل الارتباط لصنفي جيزة ٤٢٩ وجيزة ٨٤٣ وجود ارتباط كامل موجب عالي المعنوية بين صفتي المقاومة للهالوك وتحمل الملوحة في هذين الصنفين . من ناحية أخرى , وعلى الرغم من التفوق الواضح لهذين الصنفين في نموهما وتراكم المادة الجافة داخل أعضائهما وتركيبهما الكيميائي , فقد أدت جميع معاملات الإجهاد في موسمي التجربة إلى نقص عالي المعنوية في محصولهما ومكوناته . هذا وتشير نتائج هذا البحث إلى تحمل نباتات صنفي جيزة ٤٢٩ و جيزة ٨٤٣ للري بماء البحر حتى تركيز ١٠% ريا مستمرا أو ٢٠% ريا متبادلا حتى في حالة وجود الإصابة بالهالوك وبالتالي إمكانية زراعتهما بنجاح في الأراضي المستصلحة حديثا وريها بماء البحر في الحدود الموصى بها , وفي نفس الوقت يجب توجيه الجهود إلى زيادة درجة تحملهما للملوحة وبالتالي زيادة إنتاجيتهما تحت ظروفها وذلك من خلال تطبيق مجموعة من المعاملات الفسيولوجية المتخصصة لتحسين صفة تحملها للملوحة وبالتالي تحسين إنتاجيتها والوصول بها إلى حدها الأمثل تحت هذه الظروف .