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Potassium Synergize the Positive Effect of Ascorbic Acid on some Morpho-physiological Parameters of Salt Stressed Faba Bean Cultivars

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THIS WORK was undertaken to evaluate the effect of ascorbic acid (AsA) and potassium (K) on some morpho-physiological parameters of two *Vicia faba* L cultivars (Giza 843 and Giza 716) grown in nutrient solutions containing different concentrations of NaCl (50, 100 and 150mM NaCl) and K (5, 10 and 15mM) for two weeks. In general, under saline conditions, significant reduction in plant biomass and chlorophylls was detected. Seed presoaking in AsA solution resulted in massive increase in growth parameters and chlorophyll contents in both genotypes of stressed and non-stressed plants, but it depended on K concentration, 15mM K was the best. The positive effect of AsA on growth of salt stressed plants was not manifested when K concentration was low (5mM). In both genotypes, carbohydrate and protein contents increased as NaCl increased. Further significant-increase in their contents was detected when seeds were soaked in AsA and plants were cultured under salt stress; it depended on K concentration in the nutrient solution, 15mM K was the best. This type of synergizing between AsA and K on carbohydrate and protein contents was absent under low concentration of K. Sodium increased but K, Mg and Ca contents decreased in both cultivars under salt stress especially when K concentration was low (5mM). Under stressed or unstressed conditions, significant decrease in Na but significant increase in K, Ca and Mg contents due to AsA was detected and it was proportional to K concentration, 15mM K was the best.

Keywords: Ascorbic acid, Organic solutes, Potassium, *Vicia faba*.

Introduction

In Egypt, *V. faba* is the most important legumes where it can be used as daily food for most people, especially for breakfast. Seeds of faba bean contain valuable amounts of proteins (26% -41%), carbohydrates (51%-68%), vitamins B and minerals (Cerning et al., 1975; Picard, 1977). In addition, faba bean contains natural antioxidant such as flavonoids, polyphenols and phenolics. The importance of beans is not only for its nutritional value, but also for its compounds of great medicinal importance such as vicine and convicine (Ray & Georges, 2010). Faba bean cultivation improves soil characteristics where it increases soil nitrogen through N_2 fixation which decreases the dependence on N fertilizer to maximize the yield (Jensen et al.,2010) and avoidance of soil pollution.

In the arid regions in several countries all over the world, crops are cultivated in low quality soils where they suffered from extreme conditions such as temperatures and drought. These conditions result in accumulation of salts due to evaporation and unsuitable irrigation management; they are associated with insufficient leaching of ions leading to soil salinity. Salt-affected soils result in disturbance of osmotic regulation which leads to impair plant metabolism, growth and yield. Plant species are differentially responded to salinity depending on their genetic makeup expressing

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high, moderate or low salt tolerance. Most economically grown plants are glycophytes and cannot tolerate salt stress (Sairam & Tyagi, 2004). In nature, only a few plant species and genotypes are be able to tolerate saline conditions. In general, legumes are considered as either sensitive or moderately tolerant to salinity (Subbarao & Johansen, 1993; Saxena et al., 1993; Delgado et al., 1994). All the developmental stages of plants such as seed germination, seedling growth and vigor, vegetative growth are adversely affected by the presence of high salt concentration (Sairam & Tyagi, 2004).

Ascorbic acid (vitamin C), as one of the most important plant cell antioxidant, is synthesized in mitochondria and transported to other cell compartments. Ascorbic acid plays powerful role in cell membrane protection by direct scavenge of reactive oxygen species (Gill & Tuteja, 2010) which leads to minimize their damages through its synergic effect with other antioxidants. Therefore, it plays an essential role in photosynthesis process and decreases the negative effect of environmental stresses on plant growth through increase the defense mechanisms against oxidative stress (Athar et al., 2008; Azooz & Al-Fredan, 2009). Under stress conditions, it is also active component in plant metabolism where it increases the availability of water and nutrient (Barakat, 2003; Khan et al., 2011). In this concern Azzedine et al. (2011), reported that AsA application mitigated the adverse effect of salt stress on plant growth due to increase leaf area, enhance pigment contents and stimulate proline accumulation.

Regulation of protein synthesis in plants is influenced by K content in the plant growth environment potassium activates nitrate reductase enzyme which catalyzes protein synthesis (Donald, 1998). Hafsi et al. (2010) reported that inhibition of protein synthesis leads to inhibition of overall plant metabolism which leads to considerable decrease in chlorophyll contents and plant biomass. Under salt stress, while AsA acid improved the pigment contents, its positive effect is impaired if the concentration of K is less than appropriate (Azzedine et al., 2011). AsA and K play important role in curbing the negative effects of salt stress on plant metabolism and growth (Davey et al., 2000; Umar et al., 2011; Khan et al., 2011). Consequently, the main aim of this work was to determine the extent of the synergetic effect between the recommended concentration of 100ppm AsA and different concentrations of K in the nutritional medium of plant growth on growth and some physiological phenomena of a pair of faba bean cultivars.

Materials and Methods

Plant materials and growth conditions

Seeds of two faba bean genotypes (Giza 716 and Giza 843) were obtained from Agricultural Institute, Giza, Egypt. Seeds were sterilized and classified into two groups; the first group was soaked in 100ppm of AsA for 8hr; other group was soaked in distilled water for 8hr. Seeds were germinated in pots containing washed sandy soil for three weeks. Then, the obtained plants were transferred to grow in conical flasks containing Hoagland's solutions for two weeks as the following:

1) Hoagland's solution with 10mM KNO_3(K) and one concentration of NaCl (0, 50, 100 or 150mM).
2) Hoagland's solution with 5mM K and one concentration of NaCl (0, 50, 100 or 150mM).
3) Hoagland's solution with 15mM K and one concentration of NaCl (0, 50, 100 or 150mM).
All cultures were kept under lab conditions at 25/20°C day/night. Hoagland's solutions were renewed every two days. Triplicates samples were used for each treatment, three plants for each one. Plants were grown for two weeks under lab conditions and harvested to determine fresh and dry masses, water content, total pigment, carbohydrates, proteins and some ions (Na, Ca, K and Mg). It is worth mentioning, to calculate total pigments, carbohydrates and proteins, carotenoids, soluble carbohydrates and soluble proteins were determined (data not shown), respectively. In addition, preliminary experiments were used to determine the recommended AsA and NaCl concentrations. When ten faba bean cultivars were used, complete inhibition of seed germination of some cultivars was detected using 200mM NaCl. Consequently, 150mM NaCl was used as the highest NaCl concentration. The best results were obtained using 100ppm of AsA.

Chlorophyll measurement

Chlorophyll *a*, chlorophyll *b* and carotenoids were extracted in 85% acetone from the leaf samples, according to the method recommended by Lichtenthaler (1987). Pigments extractwere filtrated and the content of Chl. *a*, Chl. *b* and carotenoids were determined spectrophotometry at the wavelengths of 663, 647 and 470nm.

Estimation of total sugars and total proteins

The total sugars were quantified by the anthrone sulfuric acid method (Fales, 1951). Total sugar contents were calculated as mg g^{-1} DW depending on the organ contents of soluble and insoluble carbohydrates. The soluble proteins were determined according to Lowry et al. (1951). For water-insoluble proteins residue remaining after the extraction of soluble proteins was homogenized with 10ml 1N NaOH for 30min. One ml of this homogenate was mixed with 5ml of alkaline reagent solution without NaOH. Mixture was mixed thoroughly and allowed to stand at room temperature for at least 10min. Then, 0.5ml Folin Ciocalteu reagent was added. After 30min, the extinction was measured against an appropriate blank at 700nm. Total protein content was calculated by summing the contents in the soluble and insoluble protein fractions of the same sample.

Estimation of Na, K, Mg and Ca

Dry tissue (DW= 100mg) of shoots or roots was placed in a 100ml volumetric flask and 10ml of concentrated HNO_3 (65%) were added. The mixture was boiled for 45min to oxidize all oxidizable material. After cooling, 5ml of 70% $HClO_4$ were added and the mixture was boiled gently until the appearance of dense white fumes. After cooling again, 15ml of deionized distilled water were added and the mixture was boiled further to release any fumes. The solution was cooled, filtered and transferred quantitatively to a 25ml volumetric flask. Then, Sodium and potassium were determined using flame photometry according to Williams & Twine (1960). Calcium and magnesium were determined volumetrically as described by Schwarzenbach & Biedermann (1948).

Statistical analysis

The data were statistically analyzed by ANOVA and compared using the least significant difference (LSD) test at 5% (*) and 1% (**) levels (Snedecor & Cochran, 1980). Values in the tables indicate the mean values ±SD based on three independent determinations (n= 3).

Results

Several growth parameters including shoot and root lengths, shoot and root fresh weights and shoot and root dry weights of two broad bean cultivars of *Vicia faba* (Giza 843 and Giza 716) were determined (Tables 1, 2). The studied parameters were decreased by increasing salinity in root medium. Compared to untreated plants (control), percentage of reduction in the shoot length of Giza 716 was higher than that of Giza 843 at 150mM of NaCl. On the other hand, the reduction in root length of Giza 843 was higher than that of Giza 716 under the same concentration of NaCl. Both Giza 716 and Giza 843 cultivars had a clear reduction in shoot fresh and dry weights under the influence of salt stress; they were higher in Giza 843 than Giza 716 at 150mM NaCl. Under stressed and non-stressed conditions, presoaking of *V. faba* seeds in AsA solution resulted in enhancement of all growth parameters in both genotypes, but it depended on K concentration. Ascorbic acid effect was more pronounced in Giza 843 than Giza 716. The positive effect of AsA on plant growth in the saline medium was absent when K concentration was low.

Under salinity stress, percentage of reduction in the Chl. *a* of Giza 843 was higher than that of Giza 176 especially under 150mM NaCl (Tables 3, 4). On the other hand, the reduction in the Chl. *b* of Giza 716 was higher than that of Giza 843 under the same concentration of NaCl. The negative effect of low concentration of K (5mM K) in nutrient solution on Chl. *a* and Chl. *b* contents was detected in both genotypes but the reduction is more pronounced in Giza 716 than Giza 843. Both genotypes showed positive effect of seed pre-soaking in AsA and culturing of plants in nutrient solution containing relatively high concentration of K (15mM) on pigment contents under stress or non-stress conditions.

When NaCl concentrations of nutrient solution were increased, insoluble and total carbohydrate contents of plant organs in both genotypes increased (Tables 5, 6). Further significant-increase in the carbohydrates content of Giza 716 and Giza 843 was detected when seeds were soaked in AsA and plants were cultured under salt stress, but this increase depended on the concentration of K in the nutrient solution, 15mM K was the best in both genotypes. This type of synergizing between AsA and K was more pronounced in Giza 716 than Giza 843. The negative effect of low concentration of K (5mM) in nutrient solution on carbohydrate contents in both genotypes was not modulated by AsA presoaking; the decrease in carbohydrates contents in Giza 843 was higher than Giza 716 especially under the influence of 150mM NaCl.

TABLE 1 . Effect of different concentrations of NaCl (0, 50, 100 and 150mM) on growth parameters of *Vicia faba* (Giza 843) plants treated with or without AsA and different K concentrations of Hoagland's solution as nutrient medium for two weeks.

Treatments		Shoot				Root			
Soaking	**NaCl (mM)**	**Length (cm)**	**Fresh weight (g)**	**Dry weight (g)**	**Water content (%)**	**Length (cm)**	**Fresh weight (g)**	**Dry weight (g)**	**Water content (%)**
Water	0	16.16±.54	4.39±0.68	0.44±0.02	89.90	19.17±0.38	3.50±0.44	0.25±0.02	93.69
	50mM	12.66±.25**	2.81±0.10**	0.28±0.01**	90.01	17.31±0.30**	2.42±0.40**	0.16±0.01	93.32
	100mM	13.00±.20**	2.29±0.10**	0.22±0.01**	90.38	15.20±0.20**	1.34±0.01**	0.12±0.01	91.04
	150mM	10.80±.17**	0.85±0.03**	0.10±0.01**	88.16	9.00±0.20**	1.15±0.04**	0.11±0.02	90.75
AsA 100ppm + 5mM K	50mM	13.22±.44**	3.13±0.02**	0.34±0.02**	89.03	15.46±0.24**	1.63±0.08**	0.17±0.01	89.55
	100mM	13.00±.2**	1.96±0.06**	0.18±0.01**	90.82	13.51±0.32**	1.57±0.03**	0.15±0.01	90.47
	150mM	11.52±.14**	0.68±0.02**	0.09±0.01**	86.32	10.18±0.17**	1.05±0.01**	0.08±0.01*	92.37
AsA 100ppm + 10mM K	0	18.00±.1**	4.80±0.13*	0.48±0.03**	90.08	20.88±0.94**	3.70±0.13	0.29±0.01	92.16
	50mM	16.62±.11	4.34±0.31	0.41±0.03	90.55	18.23±0.25*	2.78±0.09**	0.٢6±0.01	94.25
	100mM	14.35±.42**	3.07±0.02**	0.29±0.01**	90.54	17.17±0.38**	1.74±0.07**	0.20±0.02	91.48
	150mM	12.17±.47**	1.25±0.28**	0.17±0.02**	85.61	11.42±0.24**	1.29±0.09**	0.12±0.02	90.89
AsA 100ppm + 15mM K	0	20.28±.65**	5.26±0.12**	0.55±0.01**	89.92	23.20±0.20**	3.72±0.09	0.54±0.29**	85.50
	50mM	18.43±.38**	4.92±0.04**	0.52±0.04**	89.49	21.53±1.39**	2.85±0.07**	0.25±0.02	91.11
	100mM	16.00±1	3.70±0.15**	0.32±0.02**	91.43	19.04±0.26	1.92±0.05**	0.22±0.02	88.71
	150mM	14.30±61**	1.78±0.10**	0.19±0.01**	89.29	14.13±0.42**	1.40±0.06**	0.14±0.01	89.96
LSD 5%		0.74	0.36	0.02		0.84	0.27	0.12	
LSD 1%		1	0.49	0.03		1.13	0.37	0.16	

- Values are means of three replicates ± standard deviation.
- SD: Statistical significance of differences compared to control; *: Significant at P<0.05, **: Significant at P<0.01.

TABLE 2. Effect of different concentrations of NaCl (0, 50, 100 and 150mM) on growth parameters of *Vicia faba* (Giza 716) plants treated with or without AsA and different K concentrations of Hoagland's solution as nutrient medium for two weeks.

Treatments		Shoot				Root			
Soaking	NaCl (mM)	Length (cm)	Fresh weight (g)	Dry weight (g)	Water content (%)	Length (cm)	Fresh weight (g)	Dry weight (g)	Water content (%)
Water	0	16.90±0.10	2.81±0.10	0.30±0.05	89.47	13.15±0.22	1.90±0.02	0.22±0.02	88.60
	50mM	16.21±1.05	2.08±0.02**	0.24±0.02*	88.31	11.14±0.17**	1.33±0.02**	0.19±0.02	85.50
	100mM	10.00±0.20**	1.77±0.11**	0.16±0.01**	90.91	9.60±0.53**	1.13±0.02**	0.14±0.01	87.58
	150mM	8.31±0.10**	0.71±0.10**	0.09±0.01**	87.34	7.52±0.42**	0.79±0.02**	0.10±0.02	87.68
AsA 100ppm + 5mM K	50mM	17.06±0.22	2.36±0.15	0.27±0.03	88.56	9.50±0.10**	1.26±0.04**	0.18±0.01	85.72
	100mM	9.66±0.15**	1.42±0.09**	0.14±0.01**	90.31	9.23±0.25**	1.03±0.02**	0.15±0.01	85.48
	150mM	7.44±0.37**	0.58±0.08**	0.07±0.01**	88.39	8.56±0.12**	0.50±0.05**	٠,٠٧±١١	32.19
AsA 100ppm + 10mM K	0	17.61±0.35	2.38±0.28**	0.37±0.03**	84.27	13.78±0.69*	1.96±0.05	0.25±0.02	87.38
	50mM	18.76±0.21**	2.29±0.30**	0.32±0.04	85.86	12.28±0.35**	1.58±0.08**	0.20±0.02	87.07
	100mM	12.31±0.30**	1.65±0.23**	0.19±0.01**	88.39	11.33±0.35**	1.37±0.04**	0.19±0.03	86.16
	150mM	10.10±0.36**	0.91±0.04**	0.10±0.02**	89.02	9.36±0.40**	0.72±0.10**	0.13±0.01	81.79
AsA 100ppm + 15mM K	0	21.89±0.84**	3.31±0.28**	0.66±0.04**	79.80	14.98±0.37**	1.96±0.07	0.32±0.03	83.43
	50mM	18.93±0.31**	2.78±0.13**	0.48±0.03**	82.85	16.29±0.34**	1.66±0.03**	0.28±0.02	82.97
	100mM	15.27±0.31**	2.07±0.17**	0.24±0.03**	88.12	14.23±0.25**	1.36±0.06**	0.22±0.02	83.73
	150mM	16.90±0.10**	1.05±0.03**	0.30±0.05*	80.33	12.50±0.50*	1.17±0.06**	0.16±0.01	86.27
LSD 5%		0.74	0.27	0.04		0.62	0.08	0.11	
LSD 1%		1	0.37	0.05		0.83	0.05	0.2	

- Values are means of three replicates ± standard deviation.
- SD: Statistical significance of differences compared to control; *: Significant at P<0.05, **: Significant at P<0.01.

TABLE 3. Effect of different concentrations of NaCl (0, 50, 100 and 150mM) on pigment contents of *Vicia faba* (Giza 716) plants treated with orwithout AsA and different K concentrations of Hoagland's solution as nutrient medium for two weeks.

Treatments		Chl. *a* (mg/g FW)	Chl. *b* (mg/g FW)	Chl. *a/b* ratio	Total pigments (mg/g FW)
Soaking	**NaCl (mM)**				
Water	0	0.847±.055	0.353±.011	2.40±0.19	1.380±0.064
	50mM	0.695±.006**	0.232±.012**	3.00±0.13**	1.040±.021**
	100mM	0.625±.006**	0.217±.004**	2.88±0.08**	0.949±001**
	150mM	0.556±.013**	0.208±.003**	2.68±0.07**	0.866±.008**
AsA 100ppm +5mM K	50mM	0.618±.002**	0.257±.003**	2.40±0.03**	1.063±.006**
	100mM	0.585±.013**	0.173±.007**	3.38±0.09**	0.928±.019**
	150mM	0.435±.018**	0.183±.014**	2.39±0.22	0.770±.038**
AsA 100ppm +10mM K	0	0.915±.005**	0.443±.007**	2.06±0.03**	1.622±.011**
	50mM	0.773±.008**	0.241±.003**	3.21±.06**	1.245±.005**
	100mM	0.654±.016**	0.295±.006**	2.22±0.07	1.145±.014**
	150mM	0.617±.038**	0.230±.015**	2.69±0.07**	.983±.058**
AsA 100ppm +15mM K	0	1.032±.011**	0.423±.041**	2.45±0.03	1.695±.056**
	50mM	0.900±.012**	0.394±.006**	2.28±.03	1.525±.026**
	100mM	0.784±.010**	0.379±.008*	2.09±.16**	1.395±.007
	150mM	0.654±.009**	0.236±.013**	2.78±.40**	1.027±.046**
LSD 5%		0.03	0.022	0.19	0.05
LSD 1%		0.04	0.03	0.26	0.073

- Values are means of three replicates ± standard deviation.
- SD: Statistical significance of differences compared to control; *: Significant at P<0.05, **: Significant at P<0.01.

TABLE 4. Effect of different concentrations of NaCl (0, 50, 100 and 150mM) on pigment contents of *Vicia faba* (Giza 843) plants treated with or without AsA and different K concentrations of Hoagland's solution as nutrient medium for two weeks.

Treatments		Chl. *a* (mg/g FW)	Chl. *b* (mg/g FW)	Chl. *a/b* ratio	Total pigments (mg/g FW)
Soaking	**NaCl (mM)**				
Water	0	٠.846±.053	0.252±.025	3.39±0.56	1.232±.039
	50mM	٠.674±.007**	0.254±.015	2.66±0.13**	1.036±.022**
	100mM	٠.579±.016**	0.186±.004**	3.11±0.14	٠.863±.013**
	150mM	٠.463±.015**	0.157±.035**	3.05±0.62	.698±.051**
AsA 100ppm +5mM K	50mM	٠.615±.002**	٠.247±.009	2.49±0.09**	1.045±.012**
	100mM	٠.607±.014**	٠.177±.009**	3.43±0.24	٠.937±.007**
	150mM	٠.419±.017**	٠.148±.003**	2.84±0.16*	٠.734±.022**
AsA 100ppm +10mM K	0	٠.972±.038**	0.331±.012**	2.94±0.11	1.509±.047**
	50mM	٠.836±.018	٠.276±.012*	3.03±0.10	1.294±.027
	100mM	٠.780±.010**	٠.195±.006**	4.00±0.13*	1.119±.018**
	150mM	٠.516±.005**	٠.176±.004**	3.32±0.08	٠.789±.016**
AsA 100ppm +15mM K	0	1.150±.044**	٠.403±.015**	2.85±0.17*	1.834±.048**
	50mM	1.024±.022**	٠.294±.006**	3.49±0.14	1.515±.020**
	100mM	٠.995±.006**	٠.215±.017**	4.65±0.33**	1.373±.008**
	150mM	٠.857±.011**	٠.179±.017**	4.81±0.50**	1.145±.020**
LSD 5%		0.04	0.025	0.48	0.047
LSD 1%		0.052	0.34	0.65	0.063

Values are means of three replicates ± standard deviation.
- SD: Statistical significance of differences compared to control; *: Significant at P<0.05, **: Significant at P<0.01.

TABLE 5. Effect of different concentrations of NaCl (0, 50, 100, 150mM) on insoluble and total carbohydrates of *Vicia faba* (Giza 716) plants treated with or without ascorbic acid and different K concentrations of Hoagland's solution as nutrient medium for two weeks [The value are expressed as mg g $^{-1}$ dry weight].

Treatments		Shoot		Root	
Soaking	NaCl (mM)	Insoluble	Total	Insoluble	Total
Water	0	70.80±0.36	122.26±1.54	54.60±0.56	91.16±0.69
	50mM	82.63±1.95**	137.39±2.31**	57.93±2.05**	97.97±1.93**
	100mM	88.73±1.10**	147.89±0.29**	61.33±0.90**	104.99±2.27**
	150mM	93.47±2.16**	160.24±4.15**	65.47±0.55**	117.69±0.63**
AsA 100 ppm + 5mM K	50mM	75.33±1.53**	124.18±2.24	44.03±1.59**	75.20±2.12**
	100mM	79.83±0.76**	133.48±1.76**	49.90±0.61**	83.35±1.28**
	150mM	84.67±1.53**	146.46±2.29**	53.60±2.01	91.11±4.06
AsA 100ppm+ 10mM K	0	75.40±1.44**	134.62±1.04**	57.60±1.15**	100.23±1.68**
	50mM	87.00±1.00**	147.89±1.67**	63.33±1.03**	107.62±1.60**
	100mM	90.37±0.57**	153.64±0.69**	67.27±1.10**	118.11±0.89**
	150mM	95.40±3.33**	167.47±4.10**	71.27±1.10**	133.18±3.03**
AsA 100ppm + 15mM K	0	81.33±0.58**	135.60±2.18**	68.53±0.61**	101.11±3.27**
	50mM	91.07±0.90**	152.93±0.08**	71.57±1.40**	116.55±2.19**
	100mM	96.33±2.52**	162.95±2.38**	76.63±1.76**	131.85±4.06**
	150mM	100.67±1.53**	176.59±1.86**	80.73±0.61**	147.96±1.88**
LSD 5%		2.7	3.68	2.07	3.92
LSD 1%		3.63	4.96	2.79	5.28

- Values are means of three replicates ± standard deviation.
- SD: Statistical significance of differences compared to control; *: Significant at P<0.05, **: Significant at P<0.01.

TABLE 6. Effect of different concentrations of NaCl (0, 50, 100, 150mM) on insoluble and total carbohydrates of *Vicia faba* (Giza 843) plants treated with or without ascorbic acid and different K concentrations of Hoagland's solution as nutrient medium for two weeks [The value are expressed as mg g $^{-1}$ dry weight].

Treatments		Shoot		Root	
Soaking	NaCl (mM)	Insoluble	Total	Insoluble	Total
Water	0	76.13±1.10	130.58±1.66	61.53±0.91	97.71±1.45
	50mM	80.20±1.76**	137.48±2.56**	66.23±1.25**	107.3±1.69**
	100mM	85.50±1.15**	148.91±1.76**	70.27±1.07**	115.60±2.13**
	150mM	88.20±0.62**	170.58±2.97**	74.07±1.60**	127.97±3.08**
AsA 100ppm +5mM K	50mM	65.13±1.01**	108.32±2.24**	52.50±1.81**	78.93±2.98**
	100mM	72.07±0.90**	126.49±1.99*	58.30±1.15**	86.01±0.29**
	150mM	76.08±0.88	138.90±1.37**	61.30±0.82	92.64±4.19**
AsA 100ppm +10mM K	0	80.30±0.82**	139.01±0.92**	78.67±1.53**	119.51±2.77**
	50mM	84.40±0.66**	149.44±1.13**	81.37±0.71**	129.25±0.22**
	100mM	90.17±1.30**	166.13±3.12**	85.13±0.42**	136.68±2.18**
	150mM	94.17±0.76**	180.33±0.65**	87.13±1.21**	142.55±0.64**
AsA 100ppm +15mM K	0	84.33±0.95**	145.06±2.57**	83.80±1.64**	127.72±2.45**
	50mM	87.47±0.90**	156.53±1.46**	88.53±1.06**	139.67±0.98**
	100mM	93.20±1.06**	176.29±1.65**	90.63±0.51**	146.86±2.31**
	150mM	96.07±1.10**	186.80±2.03**	92.63±1.66**	154.05±0.71**
LSD 5%		1.72	3.33	2.04	3.63
LSD 1%		2.32	4.48	2.75	4.89

- Values are means of three replicates ± standard deviation.
- SD: Statistical significance of differences compared to control; *: Significant at P<0.05, **: Significant at P<0.01.

Insoluble and total proteins contents in shoots and roots of both genotypes showed significant increase with the increase of salinity level in the nutrient solutions (Tables 7, 8). Under salt free conditions (control), applications of AsA with 1 or 15mM K contents in Hoagland's solution resulted in massive increase in insoluble and total protein contents in shoots and roots of both genotypes (Giza 716 and Giza 843). When low concentration of K was used, significant reduction in total proteins of shoots of Giza 843 was higher than that of Giza 716 under the influence of 150mM NaCl. On the other side, both cultivars had a significant improvement in protein contents of shoots and roots due to seed pre-soaking in AsA and culturing of plants in nutrient solution containing 1 or 15mM K, 15mM K was the best.

There was an increase in sodium contents in Giza 176 and Giza 843 cultivars when the concentration of NaCl in the culture solution was increased. Giza 716 showed a marked increase in sodium content of roots (179.5%) higher than that shown by Giza 843 (105.35%) under the highest concentration of NaCl (150mM) (Tables 9, 10). On the other side, under these conditions, there was an decrease in K content in both shoots and roots with the increase of NaCl concentration, but the percentage of decrease in roots in Giza 843 (43.4%) was higher that of Giza 716 (36.2%). In addition, 150mM NaCl had a negative effect on the amount of Ca and Mg in both cultivars but it was more pronounced in Giza 716 than Giza 843. Under saline-free conditions, significant decrease in Na but significant increase in K, Ca and Mg contents due to AsA treatment was detected and it was proportional to the concentration of K in nutrient solutions, 15mM K was more pronounced (Tables 9, 10).

Under the low concentration of potassium (5mM) in the nutrient solution, sodium content of both cultivars increased especially when the concentration of NaCl was more than 100mM. Under these conditions both cultivars showed significant decrease in K content, it was more pronounced in Giza 843 (35.1%) than Giza 843 (33.66%). Also, there was a decrease in calcium and magnesium contents in both cultivars, calcium it was higher in roots of Giza 716 (10%) than Giza 843 (15%).

TABLE 7. Effect of different concentrations of NaCl (0, 50, 100, 150mM) on insoluble and total proteins of *Vicia faba* (Giza 716) plants treated with or without ascorbic acid and different K concentrations of Hoagland's solution as nutrient medium for two weeks [The value are expressed as mg g $^{-1}$ dry weight].

Treatments		Shoot		Root	
Soaking	NaCl (mM)	Insoluble	Total	Insoluble	Total
Water	0	86.67±1.53	241.27±5.23	27.23±0.93	62.34±3.31
	50mM	90.70±0.89**	263.61±1.18**	33.07±0.50**	88.03±2.26**
	100mM	93.73±0.25**	296.10±0.98**	34.87±0.81**	102.71±1.77**
	150mM	96.23±1.08**	309.11±1.94**	38.87±1.67**	109.40±1.63**
AsA 100ppm + 5mM K	50mM	76.73±1.42**	182.73±5.70**	20.27±0.67**	47.04±1.49**
	100mM	80.13±1.10**	249.53±0.78**	28.50±0.70**	69.01±1.44**
	150mM	82.93±0.90**	277.13±2.92**	33.00±1.00	86.34±3.88**
AsA 100ppm + 10mM K	0	89.17±1.15**	262.62±1.41**	31.50±1.08**	77.43±2.97**
	50mM	93.70±0.70**	290.84±1.49**	36.50±0.70**	98.41±1.63**
	100mM	97.11±0.94**	305.06±2.00**	40.57±0.32**	111.57±1.27**
	150mM	99.40±1.06**	316.99±1.81**	45.07±1.10**	121.48±1.52**
AsA 100ppm + 15mM K	0	91.77±1.56**	270.10±3.05**	34.43±1.31**	90.19±1.31**
	50mM	96.07±0.78**	297.09±1.87**	40.63±1.19**	108.39±3.21**
	100mM	100.47±1.42**	315.75±4.28**	46.17±1.15**	118.17±0.85**
	150mM	105.67±0.93**	332.01±4.65**	51.37±1.11**	128.37±1.77**
LSD 5%		1.83	5.08	1.67	3.66
LSD 1%		2.46	6.84	2.25	4.93

- Values are means of three replicates ± standard deviation.
- SD: Statistical significance of differences compared to control; *: Significant at P<0.05, **: Significant at P<0.01.

TABLE 8. Effect of different concentrations of NaCl (0, 50, 100, 150mM) on insoluble and total proteins of *Vicia faba* (Giza 843) plants treated with or without ascorbic acid and different K concentrations of Hoagland's solution as nutrient medium for two weeks [The value are expressed as mg g^{-1} dry weight].

Treatments		Shoot		Root	
Soaking	NaCl (mM)	Insoluble	Total	Insoluble	Total
Water	0	94.87±0.81	250.16±0.47	30.90±0.85	70.23±1.36
	50mM	97.30±0.26**	266.54±1.16**	33.63±0.40**	73.53±0.61*
	100mM	101.43±0.67**	291.97±2.53**	36.17±1.01**	80.06±2.44**
	150mM	104.40±2.16**	297.42±4.41**	40.50±0.26**	108.83±0.34**
AsA 100ppm + 5mM K	50mM	87.43±1.17**	218.95±1.44**	22.20±1.11**	51.63±0.26**
	100mM	90.80±0.40**	230.98±1.47**	26.07±1.10**	60.93±0.54**
	150mM	94.47±1.50	247.58±4.99	31.00±1.00	67.76±2.73
AsA 100ppm + 10mM K	0	96.27±1.10	260.0 ±2.80**	34.43±0.93**	78.92±1.83**
	50mM	100.20±0.50**	278.84±1.29**	37.07±1.10**	95.20±1.59**
	100mM	104.63±0.60**	297.37±2.02**	41.43±0.93**	116.23±1.18**
	150mM	113.30±1.15**	310.87±1.86**	45.23±0.68**	131.90±1.42**
AsA 100ppm + 15mM K	0	99.63±0.40**	278.64±1.71**	43.07±2.53**	100.9±1.98*
	50mM	105.60±0.85**	295.22±0.72**	47.40±0.53***	108.45±1.02**
	100mM	111.50±0.70**	312.44±4.19**	51.20±1.11**	126.58±2.91**
	150mM	116.30±1.15**	326.40±1.35**	56.80±1.71**	153.61±4.40**
LSD 5%		1.72	3.33	2.04	3.63
LSD 1%		2.32	4.48	2.75	4.89

- Values are means of three replicates ± standard deviation.
- SD: Statistical significance of differences compared to control; *: Significant at P<0.05, **: Significant at P<0.01.

Under saline condition, the significant reduction in sodium contents due to AsA treatments under 15mM K was higher than those of 10mM K in both cultivars. On the other side, when seeds were soaked in AsA and plants were cultured in nutrient solution containing 10mM K, there was a significant increase in K, calcium and magnesium contents in both cultivars. Generally, the increase of these three ions under the influence 15mM K was higher than their concentrations under the influence of 10mM K.

Discussion

Giza 843 and Giza 716 were chosen to compare and confirm the obtained results due to the application of AsA and K under salt stress. Results indicated that the used two cultivars of faba bean expressed moderate ability to tolerate salinity. In general, legumes are considered as either sensitive or moderately tolerant to salinity (Saxena et al., 1993; Delgado et al., 1994). When both cultivars (Giza 843 and Giza 716) were grown under the influence of different concentrations of NaCl, significant decrease in growth parameters with increase of salinity in root medium was detected. The inhibitory effects of salt stress on growth parameters may be attributed to the negative effects of NaCl on several plant activities such as osmotic adjustment, protein and nucleic acid synthesis, cell wall extensibility, rate of new cell production, hormonal balance, enzyme activities, and photosynthesis (Hernández & Almansa, 2002; Boscaiu et al., 2005; Azooz, 2009; Xu et al., 2011; Galal, 2017).

Under non-stress conditions, presoaking of faba bean seeds in AsA resulted in enhancement of plant growth parameters, but it depended on K concentration of the nutrient solutions. The use of 10 or 15mM K in Hoagland's solution improved significantly the effect of AsA on the estimated parameters in comparison to that of control plants.

TABLE 9. Effect of different concentrations of NaCl (0, 50, 100 and 150mM) on mineral contents of *Vicia faba* (Giza 716) plants treated with or without AsA and different K concentrations of Hoagland's solution as nutrient medium for two weeks [The value are expressed as mg g $^{-1}$ dry weight].

Treatments		Sodium		Potassium		Calcium		Magnesium	
Soaking	NaCl (mM)	Shoot	Root	Shoot	Root	Shoot	Root	Shoot	Root
Water	0	19.17±1.37	13.70±0.26	28.07±0.15	31.70±0.98	14.73±0.64	16.33±0.35	10.33±0.42	13.30±0.36
	50mM	35.73±0.21**	30.97±1.06**	20.63±0.78**	28.97±1.58	13.00±0.89*	14.33±0.58**	8.30±0.36**	10.50±0.44**
	100mM	41.00±0.92**	36.23±0.15**	18.27±0.31**	22.33±0.90*	8.93±0.90**	11.90±0.85**	6.37±0.15**	8.83±0.76**
	150mM	45.63±0.25**	38.30±0.10**	17.17±0.15**	20.20±0.20**	7.40±0.40**	9.73±0.64**	3.40±0.53**	7.00±1.00**
AsA 100ppm + 5mM K	50mM	37.23±0.25**	31.67±0.99**	19.40±0.53**	21.53±0.50**	8.53±0.35**	13.27±0.25**	7.70±0.44**	9.60±0.61
	100mM	42.00±1.00**	38.53±0.31**	17.00±1.00**	17.17±0.15**	7.70±0.10**	11.07±0.12**	5.47±0.25**	7.33±0.42**
	150mM	49.67±0.58**	47.33±1.53**	15.43±0.45**	13.40±15.76**	6.37±0.15**	8.17±0.15**	٣.2±0.26**	6.30±0.36**
AsA 100ppm + 10mM K	0	10.10±0.00**	12.50±1.93*	30.53±0.21**	32.47±1.90	18.00±2.00**	19.33±0.58**	15.00±1.00**	17.40±0.53**
	50mM	27.20±0.95**	28.23±0.06**	23.27±0.23**	26.33±0.58*	15.40±0.53	16.40±0.53	12.53±0.50**	12.40±0.40
	100mM	36.37±0.15**	34.47±0.06**	19.33±0.12**	25.77±0.68*	11.00±1.00**	13.33±0.58**	8.43±0.38**	10.87±1.03**
	150mM	37.27±0.25**	35.17±0.06**	21.00±1.00**	24.10±0.10**	9.00±1.00**	11.63±0.55**	6.47±0.25**	8.73±0.64**
AsA 100ppm + 15mM K	0	8.93±0.59**	10.10±1.11**	31.57±0.67**	33.97±1.91	22.00±0.10**	21.20±0.35**	18.33±1.53**	18.87±0.81**
	50mM	22.43±0.51**	26.50±0.44**	26.23±0.67**	30.47±0.06	17.33±0.58**	17.63±0.55**	16.00±1.00**	16.67±0.58**
	100mM	33.40±1.31**	32.00±0.40**	23.00±1.00**	27.67±2.44	15.90±0.10*	15.60±0.44	14.50±0.53**	14.70±0.20*
	150mM	34.40±1.97**	33.23±0.25**	27.77±0.15	22.10±2.76**	12.70±0.10**	13.23±0.25**	11.77±0.12**	12.07±0.90**
LSD 5%		1.4	1.36	0.98	7.13	1.2	0.81	1.05	1.08
LSD 1%		1.9	1.83	1.32	9.6	1.73	1.10	1.4	1.14

- Values are means of three replicates ± standard deviation.
- SD: Statistical significance of differences compared to control; *: Significant at P<0.05, **: Significant at P<0.01.

TABLE 10. Effect of different concentrations of NaCl (0, 50, 100 and 150mM) on mineral contents of *Vicia faba* (Giza 843) plants treated with or without AsA and different K concentrations of Hoagland's solution as nutrient medium for two weeks [The value are expressed as mg g $^{-1}$ dry weight].

Treatments		Sodium		Potassium		Calcium		Magnesium	
Soaking	**NaCl (mM)**	**Shoot**	**Root**	**Shoot**	**Root**	**Shoot**	**Root**	**Shoot**	**Root**
Water	0	25.73±2.29	21.67±0.58	44.53±1.21	46.30±1.87	12.57±0.51	17.33±0.29	9.33±0.29	14.47±0.42
	50mM	39.53±2.02**	28.43±0.74**	35±0.44**	38.73±0.31**	11.40±0.53**	13.70±0.10**	7.37±0.38**	12.63±0.15**
	100mM	43.53±3.44**	35.40±1.78**	32.60±0.35**	36.33±2.57**	8.47±0.42**	8.20±0.44**	5.23±0.25**	8.20±0.20**
	150mM	51±1.78**	44.50±2.10**	24.07±2.43**	26.20±1.51**	6.57±0.12**	5.03±0.15**	4.43±0.25**	6.20±0.26**
AsA 100ppm + 5mM K	50mM	27.27±1.70**	21.37±0.15**	36.77±2.65**	30.33±0.25*	9.90±0.10**	12.23±0.25**	7.57±0.49**	11.40±0.36*
	100 mM	39.80±0.20**	38.30±1.15**	31.80±0.17**	28.53±1.10**	7.60±0.36**	7.40±0.36**	6.33±0.42**	8.53±0.92**
	150mM	52.90±2.65**	47.20±2.43**	22.20±1.67**	17 ±2.65**	5.93±0.25**	4.07±0.12**	3.23±0.25**	5.27±0.46**
AsA 100ppm + 10mM K	0	18.33±1.07	14±0.95	48.70±2.34**	49.43±1.93**	17.57±0.51**	19.90±0.85**	12.67±0.58**	16.87±0.23**
	50mM	30.67±1.51**	27.57±2.20**	39.67±0.29**	44.60±4**	14.37±0.51**	17.97±0.95	10.77±0.25**	15.40±0.53*
	100mM	44.23±0.68**	32.80±1.93**	36.33±0.95**	40.67±2.27**	12.27±0.51	14.50±0.50**	7.63±0.55**	11.50±0.44**
	150mM	47.90±0.36**	36±1.00**	32.80±0.10**	35.47±0.42**	9.57±0.51**	11.73±1.10**	6±0.40**	7.53±0.50**
AsA 100ppm + 15mM K	0	17.53±0.25**	23.30±0.10**	52.67±1.33**	50.17±1.02**	19.33±0.58**	21.33±0.58**	15.37±0.35**	14.63±0.55
	50mM	35.40±0.10**	22.90±0.10**	41.20±0.70**	47.27±0.64**	17.60±0.53**	19.67±0.58**	13.53±0.50**	12.87±0.81**
	100mM	36.63±1.56**	30.10±0.10**	39.63±0.57**	42.93±0.50**	16.30±0.36**	17.33±0.58	11.17±0.15**	11.90±0.17**
	150mM	46.20±1.31**	38.50±0.10**	34.13±1.40**	38.57±0.15**	13.33±0.58*	15.33±0.58**	9.33±0.58	8.33±0.58**
LSD 5%		2.80	2.2	2.29	2.96	0.75	0.95	0.67	0.81
LSD 1%		3.78	2.96	3.097	3.99	1.014	1.28	0.9	1.09

- Values are means of three replicates ± standard deviation.
- SD: Statistical significance of differences compared to control; *: Significant at P<0.05, **: Significant at P<0.01.

When faba bean cultivars were grown in nutrient solution with low concentration of K (5mM), significant reduction in growth parameters was detected. Significant decrease in plant biomass production was registered when combination of salinity and low concentration of K was applied simultaneously (Degl'Innocenti et al., 2009; Hafsi et al., 2010) irrespective AsA treatments. Application of AsA in combination with 1 or 15mM K in nutrient solution resulted in significant increase in estimated growth parameters; its effect was more pronounced in Giza 843 than Giza 716. Many studies reported that AsA as well as K when used in optimal concentration exhibited beneficial effect on growth and yield under saline conditions (Azooz, 2004; Khan et al., 2006; Bassuony et al., 2008; Ekmekçi & Karaman, 2012; Azooz et al., 2013; Amjad et al., 2014). They indicated that, AsA could accelerate cell divisionand enlargement and induce improvement of membrane integrity, which may has contributed in reducing ion leakage, and consequently improving growth. Also, AsA affects many physiological processes including the regulation of growth, availability of water and nutrient, differentiations and metabolism of plants under saline conditions (Barakat, 2003). Potassium application in high concentration was relatively effective in alleviating NaCl stress (El-Lethy et al., 2013).

Salinity stress caused a considerable decrease in chlorophylls contents in both cultivars compared to control plants. Under 150mM NaCl, reduction in Chl. *a* content of Giza 843 was higher than that of Giza 176. On the other hand, the reduction in the Chl. *b* content of Giza 716 (41%) was higher than that of Giza 843. The negative effects of salinity on photosynthetic pigments were described in other reports (El-Tayeb, 2005; Faheed, 2012; AbdElgawad et al., 2016; Wang et al., 2017).

Under control conditions, when 10mM K was used, the value of Chl. *a* and Chl. *b* increased. Further increase in their contents was registered when the concentration of K was increased up to 15mM. The detected increase in photosynthetic efficiency under the influence of AsA application was attributed to the significant increase in Chl. *a* and Chl. *b* contents and inhibiting chlorophyllase activity; chlorophylls degrading enzyme (Fang et al., 1998).

Under low concentration of K and different concentrations of NaCl, AsA resulted in reduction in the synthesis of Chl. *a* and Chl. *b*. Hafsi et al. (2010) reported that a considerable decrease in whole plant biomass and chlorophyll contents was registered when plants were subjected to salinity stress in combination with K-deficiency. Both cultivars showed positive effect of seed pre-soaking in AsA on photosynthetic pigments (Chl. *a* & Chl. *b*) when plants were grown under salt stress in combination with 1 or 15mM K in the nutrient solution. Chlorophyll degradation could be due to the action of free oxygen radicals (Sakaki et al., 1983) but AsA is one constitutes of the defense mechanism against these radicals (Cadenas & Sies, 1985) and it takes place in darkness (Sarkar & Choudhuri, 1981). Degradation of chlorophyll increased when AsA was applied under light condition (Pjon, 1981; Feierabend & Winkelhüsener, 1982). Then, AsA can play its role on chlorophylls as antioxidant or prooxidant effect (Bonet et al., 1996; Yen et al., 1997) and it depending on internal and external conditions (Kitts, 1997). On the other side, under light conditions, AsA improved growth parameters of plants grown under salt stress by increasing chlorophyll contents and photosynthetic capacity (Bastam et al., 2013; Billah et al., 2017). Consequently, antioxidant effects of AsA are higher than prooxidant effects when faba bean cultivars were treated with AsA and sufficient K in nutrient solutions.

Under non stress conditions (control), AsA treatments resulted in increase in the carbohydrate contents. This increase was more pronounced under the influence of 15mM K than 10mM K content of the nutrient solutions. Sufficient K and AsA were important factors to increase of carbohydrates in faba bran cultivars as was detected in other plants (Chow et al., 1990; Smirnoff, 1996, 2018). Underlow concentration of K, the activity of ribulose- 1,5- bisphosphate carboxylase was inhibited and the rate of net photosynthesis was decreased (Cakmak, 2005). Consequently, under low K concentration, AsA resulted in significant reduction in total carbohydrate contents compared with the corresponding plants that exposed to the same concentration of NaCl in Giza 716 and Giza 843. Increasing the concentration of K in Hoagland's solution as growth mediumto 10mM, AsA resulted in a significant increase in total carbohydrates content of shoots and root in both faba bean cultivars. This positive effect of AsA on both cultivars was synergized

by the application of high K content (15mM) in nutrient solution. This type of synergizing was more pronounced in Giza 716 than Giza 843. Potassium plays an important role in regulating the stomatal movement, stimulate CO_2 assimilation, and increased AsA and GSH contents (Chow et al., 1990; Marschner, 2002; Cakmak, 2005; Umar et al., 2011).

Under salt stress, AsA did not control the negative effect of low concentration of K on protein content of both faba bean cultivars. In sugarcane, exogenous application of AsA significantly alleviated the adverse effects of salt stress on growth and metabolites but it led to decrease of protein contents (Ejaz et al., 2012). On the other side, both cultivars showed positive effect of seed pre-soaking in AsA and culturing of plants in nutrient solution containing 10mM K and different concentrations of NaCl. Further-significant improvement in protein fractions was detected when AsA-treated plants of both cultivars were subjected to high concentration of K (1.5 M). Under salt stress, both K and AsA play important role to control the negative effects of salt stress on plant metabolism and growth (Davey et al., 2000; Umar et al., 2011; Khan et al., 2011, Smirnoff, 1996, 2018). In faba bean cultivars, enhancement in protein synthesis under the influence of AsA depended on K concentration. Potassium is necessary for the activation of some enzymes that catalyze the protein synthesis (Donald, 1998).

Accumulation of soluble factions of carbohydrates and nitrogen compounds were considered as sign for the ability of certain genotype to tolerate salt stress; further increase in these components were detected when AsA was used (Ekmekçi & Karaman, 2012; Ejaz et al., 2012; Bastam et al., 2013; Billah et al., 2017). The accumulation of total sugars and proteins in response to salinity stress were documented in this work and others (Zhao et al., 2016; Passamani et al., 2017; Jini & Joseph, 2017), it may be due to the accumulation soluble fractions (El-Tayeb, 2005) and significant up-accumulation or down-accumulation of metabolites (Wu etal., 2013).

Sodium contents of Giza 176 or Giza 843 cultivars increased with the increase of NaCl concentrations. Also, increase in Na contents of both cultivars were detected when AsA treated plants were subjected to salt stress and low concentration of K, especially in Giza 716. The effect of K and Na on uptake of each other was reported (Zheng et al., 2008). Under the influence of 10mM K of the nutrient solution, AsA expressed significant reduction in Na content of roots and shoots. Further reduction in Na contents was detected when 15mM K was used. It was important to rise the endogenous K content via external K supply to increase salinity tolerate during germination (Collins et al., 2008) and vegetative growth (Cakmak, 2005).

There was significant decrease in K content in shoots and roots with increase of NaCl concentrations. Further decrease in K contents of both cultivars was detected when AsA treated plants were subjected to different concentrations of NaCl in combination with low concentration of K. On the other side, AsA resulted in increase of K contents of both cultivars when stressed plants were subjected to 10mM K of Hoagland's solutions. The highest values of K were detected when 15mM K was used. High concentration of NaCl in growth medium reduced the uptake of K^+ ions (Alpaslan & Gunes, 2001; Faheed, 2012; Noreen et al., 2017), it was reversed when sufficient K content of nutrient solution (15mM K) was used, and it was synergized in AsA treated plants.

Progressive decrease in both Ca and Mg in both cultivars with the increase of NaCl concentrations was detected. Further decrease in Ca and Mg contents were recorded under the influence of salt stress and low concentration of K. On the other side, positive effect of AsA on Ca and Mg contents were detected when salt stressed plants were cultured under the influence of 1 or 15mM K content of the nutrient solution. In other studies, El-Tayeb (1991) and El-Bassiony (2005) reported that AsA caused reduction of Na accumulation but increase the contents of K, Ca and Mg under salt stress.

Conclusion

The use of two faba bean cultivars showed that each cultivar was slightly affected in a certain way under the influence of salinity. The study also found that seeds presoaking in AsA increased the capacity of the used cultivars to tolerate relatively high concentrations of salinity, but this was related to the concentration of K in growth solution. Although the application of low concentration of K in combination with salinity in growth medium

eliminated the positive effect of ascorbic acid on plant growth and metabolism, sufficient K contentof nutrient solution increased the ability of faba bean cultivars to tolerate salinity.

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تعزيز البوتاسيوم للدور الإيجابى لحمض الأسكوربيك على النمو وبعض القياسات الفسيولوجيه لأصناف الفول البلدى تحت الإجهاد الملحى

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اجريت هذه الدراسة لتقييم تأثير كل من حمض الأسكوربيك والبوتاسيوم على النمو وبعض الأنشطه الفسيولوجية لصنفين من أصناف الفول البلدى(جيزة 843 و جيزة 716) النامیه فى محلول مغذى يحتوى على تركيزات مختلفة من كلوريد الصوديوم (50، 100، 150 ملى مول) والبوتاسيوم (5, 10, 15 ملى مول) لمدة اسبوعين وقد أسفرت الدراسة عن النتائج التالية:

عند معاملة كلا الصنفين بتركيزات مختلفة من كلوريد الصوديوم لوحظ انخفاض شديد فى الوزن الأخضر والجاف وكذلك المحتوى الصبغى. بينما ادى نقع البذور فى حمض الأسكوربيك لتحسن ملحوظ فى الوزن الأخضر والجاف والمحتوى الصبغى لكلا الصنفين سواء كانت معرضه أو غير معرضه للإجهاد الملحى ولكن هذا التأثير الإيجابى لحمض الأسكوربيك كان يعتمد على تركيز البوتاسيوم فى المحلول المغذى وقد وجد أن أفضل تركيز للبوتاسيوم هو (15 ملى مول). فى حين أن هذا التأثيرالإيجابى لم يظهر على النباتات المعرضه للملوحه فى وجود التركيز المنخفض للبوتاسيوم (5 ملى مول).

أبدى كلا الصنفين زيادة واضحة فى محتوى الكربوهيدرات والبروتين بزيادة تركيز كلوريد الصوديوم فى المحلول المغذى وقد تحسن هذا المحتوى عند نقع البذور فى حمض الأسكوربيك وهذا التحسن يعتمد على تركيز البوتاسيوم فى وسط النمو ووجد أن افضل تركيز للبوتاسيوم هو (15 ملى مول).

أما بالنسبه لتراكم العناصر فى الصنفين وجد زيادة فى تزكيز أيون الصوديوم ونقص فى تركيز كل من أيون البوتاسيوم والكالسيوم والماغنسيوم بزيادة تركيزكلوريد الصوديوم فى المحلول المغذى وخاصة عند التركيز المنخفض من البوتاسيوم (5 ملى مول). فى حالة نقع البذور فى حمض الأسكوربيك ادى ذلك إلى نقص فى أيون الصوديوم وزيادة فى كل من أيون البوتاسيوم والكالسيوم والماغنسيوم وهذا التأثير لحمض الأسكوربيك على تراكم الأيونات كان اكثر وضوحا فى وجود التركيز المرتفع من البوتاسيوم (15 ملى مول) فى المحلول المغذى. مما سبق يمكن القول أن البوتاسيوم يقوم بدور فعال فى إظهار وتعزيز التأثير الإيجابى لحمض الأسكوربيك لمقاومة أصناف الفول البلدى للتأثير السلبى للملوحة.