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Growth, yield of faba bean (*Vicia faba* L.) Genotypes with respect to ascorbic acid treatment under various water regimes
II- Chemical Composition and Water Use Efficiency (WUE)

Hanan S. Siam[1], Safaa A. Mahmoud[1], A.S. Taalab[1], M.M. Hussein[2] and H. Mehann[2]

[1] *Plant Nutrition Department, National Research Centre, Postal Code 12262, Dokki, Giza, Egypt.*
[2] *Water Relations Department National Research Centre, Postal Code 12262, Dokki, Giza, Egypt.*

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ABSTRACT

Two field experiments were conducted in the experimental station of the National Research Center in Nobaryia region, El-Behara Governorate, Egypt during 2014 and 2015 winter seasons to evaluate the responses of three faba bean varieties (Giza 3, Nubaria 1 and Giza 716) to ascorbic acid application (0 and 200 ppm) under different water regimes (50%, 75% and 100% of the ETc water stress treatments). The results indicated that highest values of in N, P uptake in grain and straw except K uptake in grain. On the other hand, Giza 3 variety was the superior and content of the nitrogen, phosphorus and potassium, while Giza 716, later and Nobaria 1 lied in between. The highest water use efficiency (WUS) values and seed quality (high protein) were accompanying with 75% ETc water of irrigation treatment. Also, all chemical composition of faba bean was increased significantly (at 5% level) by ascorbic acid sprayed via leaves if compared with plants received fresh water only. It could be suggested that faba bean plants irrigated by 75% of the ETc and foliar application with ascorbic acid of Giza 3 variety was more efficient according to the concept of water saving water use efficiency and seed quality as well as seed major macronutrients contents of faba bean plants.

Key words: Water stress, Giza 3, quality, efficiency, grain, macronutrients, protein.

Introduction

In Egypt dry and green bean seeds are used as human food, also it's a permanent component of most animal feeds. It has potential N_2-fixing and exhibit high levels of protein (28-36%) of seed dry marter). Like all legume, it can play important role in improving soil fertility, so it used as break crop between cereals (Mona *et al*., 2011) and Bakry *et al*., (2011) reported that production of faba bean in Egypt is limiting and affected by different factors such as soil fertility and water supply.

Surface fresh water is scarce. If it is used adequately, the problem of water shortage would be alleviated Egypt is characterized by high temperatures, high evapotranspiration and low rainfalt. We wanted to find an effective way to use the brackish water in winter wheat production, they water deficiency promotes biochemical changes in plants as accumulation of organic compounds (Costa *et al*., 2008) and promotes strong decrease in stomatal conductance (Lobato *et al*., 2009).

Many trails were done by many ways to overcome the negative effect drought on crops, an important way is the use of fertilizer on improving growth and yield under the abiotic stresses Graciano, *et al*., (2005) and Zhu, *et al*., (2009).Also, Siam *et al.,* 2017. Indicated that the highest values of the whole plant dry weight obtained the highest values when plants irrigated by 75% ETc in comparable with these of 50 or 100% ETc treatments. Al-Suhaibani (2009) pointed that, the decrease in yield and yield component associated with increasing soil water deficit and high crude protein and carbohydrate percent in seeds were affected by low water applied levels. Also, Ghassemi *et al*., (2009) reported that, superiority of well watered (I.) irrigation after 70%mm evaporation plants in growth and grain filling duration resulted in production of comparatively more and large grains and consequently higher grain yield per unit area. Also, Hirich *et al*., (2012) stated that adding half of the required water supply enhanced crop productivity. In addition, irrigation during vegetative growth using half of the required water supply showed higher yield productivity than applying the full irrigation.

Corresponding Author: Hanan S. Siam, Plant Nutrition Department, National Research Centre, Postal Code 12262, Dokki, Giza, Egypt. E-mail: drhanansiam@yahoo.com

Recent genetic and breeding efforts has resulted in an improved faba bean adapted to environmental stresses, high yield protein in content and seed free from major anti nutritional factors (Duranti and Cristina 1997 and Alghamdi 2009). Furthermore, common bean cultivars and line has reported to respond differently to soil moisture stress during the flowering period, depending on the severity of water stress Boutraa and Sanders (2001).

Ascorbic acid (Vitamin C) acts as coenzyme reaction by which carbohydrates, fats and protein and metabolized Vitamin C led to increase nucleic acid content especially RNA. Smirnoff and Wheeler (Smimoff and Wheeler (2000) reported that ascorbic acid is an abundant component of plants. It reaches a concentration of over 20 mM in chloroplasts and occurs in all cell compartments including cell wall. It has proposed function in photosynthesis, as an enzyme. Moreover, Abd-El-Aziz *et al*., (2009) indicated that application of ascorbic acid significantly increased all growth parameters as well as some chemical constituents.

Application of fertilizers is one of the successful ways to increase the ability of crop plants to tolerate the adverse effect of abiotic stresses Karim and Rahman (2015). Therefore, controlled irrigation and fertilization to increase plant yield is of vital importance Ertek (2014).

The main purpose of deficit irrigation is to raise the water use efficiency in plants under low water stress was more than 80%, in mild-stress, 65 to 80% and in very serves stress below 65% (Carter 1982), the water use efficiency (WUE) and to obtained the highest yield per unit water (Vomucka and Pospisilvoa 2003), Also, Topka *et al*., (2011) noticed that, irrigation of sugar beet with drip irrigation methods at 75% level had significant benefits in terms of save irrigation water and large WUE. Water use productivity of yield increase by 75% water quantity (ETc) treatment (Hussein *et al*., 2015).

Moreover, Siam (2016) reveal that water utilization efficiency were 0.70, 0.82 and 0.85, respectively at M_1, M_2 and M_3 (irrigation every 4, 6 and 8 days).

The object of this study was to evaluate the effectiveness of water stresses with ascorbic acid of faba bean varieties on yield, seed chemical composition and WUE to develop a best management of water regime.

Material and Methods

Two field experiment in the experimental station of the National Research Centre in Nobaryia Governorate (North west of Nile Delta) during 2014 and 2015 winter seasons to investigate the effect of ascorbic acid application as antioxidant material and water regime on yield and mineral status of three varieties of faba bean plants grown under different water regimes. Plants sprayed by ascorbic acids in the rate of (0 and 200 ppm) using fresh water as a control and grown under 100, 75 and 50% ETc irrigation regimes. The experiment included 18 treatments, two treatments of ascorbic acid application, three varieties and three irrigation water regimes which the irrigation regime lied in the main plots, three varieties of faba bean in subplots and ascorbic acid were distributed randomizley in the sub-subplots. The design of the experiment was split split plot in six replicates. Seeds of Faba bean (*Vicia faba* L.) varieties: Giza 3, Nubaria 1 and Giza 716 (treated with proper symputic bacteria) were sown at November, 15 during two winter seasons.

Physical and chemical characteristics of the experimental site soil are shown in Table (1). Particle size distribution and moisture of the soil sample, Soil $CaCO_3$, EC and pH were determined according to Black *et al.* (1982).

Plants thinned twice, the 1st after 15 days from sowing and the 2nd two weeks later. Calcium super phosphate (15.5% P_2O_5) and potassium sulphate (48.5 K_2O) in the rate of 200 kg/fed were broadcasting before sowing. Nitrogen fertilizer in the form of ammonium sulphate (20.5% N) in the rate of 15kg N/fed to enhancing saymputic bacteria and face the nutrients needs in the early stage of faba plants in this new cultivated area. Ascorbic acid treatment was applied via leaves in two spcies, the first at 21 days from sowing and the another after two weeks later. Two plants were picked from every sub plot, cleaned, dried in electric offen at 70°C and ground. Digestion and determination of macro and micro nutrients were done using the methods described by: Chapman and Pratt (1961).

Calculating of WUP for grain yield as well as straw yield from the following equation WUP = (Productivity of grain or straw/Irrigation water quantity) = kg/m^3. All collected Data were subjected to the proper statistical analysis as described by Snedecor and Cochram (1982).

Table 1: Some physical chemical properties of El-Nobaria soil.

Particle size distirbution				Field capacity (%)
Sand %(	Silt (%)	Clay (%)	Soil Texture	
70.8	25.6	3.6	Sandy loam	20.1

Chemical properties			
EC dsm^{-1}	pH (1:2.5)	$CaCO_3$ (%)	O.M (%)
0.12	7.9	3.57	0.23

Soluble cations (meq L^{-12})				Soluble anions (meq L^{-1})			
Ca++	Mg++	K^+	Na^+	CO_3^-	HCO_3^-	Cl^-	SO_4^-
2.4	2.0	0.162	1.87	-	1.50	0.65	4.28

Total N (mg/100g)	Available (mg/100g)		Available micronutrients (ppm)			
	P	K	Fe	Mn	Zn	Cu
15.1	13.0	21.0	4.47	2.61	1.44	4.0

Results and Discussion

Mineral Status:

Water regime:

The results demonstrates in Tables (2 & 3) & Fg. (1) indicate that the soil moisture regimes significantly affected on concentration and uptake of N, P, K of faba bean plant (straw and grain). These was no significant difference between 100% and 75% water stress level with respect to concentration of N,P except K in grain. The highest values were obtained with 75% ETc followed by 100% ETc and the lowest values with 50% ETC. The highest mean values were (1.83% , 44.73) for N (0.49 %, 11.87) for P and K (1.58, 34.16 kg/fed.) for concentration and uptake in grain faba bean plant, but NPK concentration in straw was increased significantly by increasing the available of soil moisture regime especially under the 100% ETc treatment, there values were (1.011%, 0.247% and 2.477%), for N, P and K concentration while mineral uptake in grain and straw increased significantly under the 75% water stress except K uptake, while the 75% ETc water treatment increase N,P and K uptake in straw recorded the highest values of uptake in straw yield were 34.52, 8.44 and 80.83 kg/fed. For N, P and K, respectively.

This agreement with those by: Yellamanda and Kuladaivelu, (1992), Tan *et al*., (2015) and Siam et al., (2016a) stated that the higher nutrient content in rice plants under soil moisture M_1 (watering at every 4 day) irrigation interal than the other two soil moisture regimes M_2 (watering at every 6 day irrigation internal) and M_3 (watering at every 8 day irrigation internal). These results may be due to higher mobility of inorganic nitrogen in soil solution and hence facilitated absorption by plant roots, whereas under M_2 and M_3 increased moisture stress might have resulted the plant roots to spend more energy to extract an unit amount of N. Also nitrogen uptake increased with increasing moisture levels due to more root growth, grain yield were higher with higher moisture.

On the other hand, water stress showed a negative effect on plant N, P and K content especially at 50% ETC. Mingzhu and Feike (2014) reported the drought stress had a negative effect on plant (N) (-3.73%) and plant p (9.18) and positive effect on plant N:P. This reduction may be non-abundance soil moisture in root zone and may be refer to the reduction of all mention parameter (Hussein *et al*., 2015).

The poor growth of rice under stress moisture condition was due to reduced root growth which resulted in reduced nutrient uptake. Also, this reduction may be due to the poor growth of rice under stress moisture condition due to reduced root growth which resulted in reduced nutrient uptake (Siam *et al*., 2016a).

Generally, the different increase content among irrigation regimes were significant at the 5%, level. This may be attributed to on or 1) water stress decreased plant photosynthesis and subsequently growth characters, (2) water stress decreased nodules numbers which are the sites for gaseous N fixation symbiotically, (3) leaves wilting and pores closing and (4) leaves and flowers abscission. This

concluded that irrigation with 75 and 100% of field capacity were most preferable for their faba bean plant. This agree with our finding in this work (Balasio *et al*., 2006).

It appears that 75% of field capacity might be a suitable treatment for achieving efficient bean yield, drought response difference, between cultivars may arise from improved water uptake (Emam 1985).

Table 2: Effect of the water regimes, variety type, and ascorbic acid treatment combination on NPK % and uptake of faba bean in grain and straw.

Water regime (W)	Variety type (V)	Ascorbic acid (A)	N% in grain	P% grain	K% grain	N% straw	P% straw	K% straw
100% of Etc (1350 m^3/fed.)	Giza 3	Zero	1.400	0.463	1.520	0.787	0.221	2.300
		200 ppm	2.367	0.637	1.950	1.650	0.465	3.433
	Nubaria 1	Zero	1.100	0.393	1.300	0.700	0.183	2.030
		200 ppm	2.200	0.626	1.800	1.300	0.263	2.900
	Giza 716	Zero	0.883	0.365	1.250	0.650	0.151	1.700
		200 ppm	1.967	0.465	1.650	0.980	0.198	2.500
Mean			1.645	0.492	1.578	1.011	0.247	2.477
75% of Etc (1015 m^3/fed.)	Giza 3	Zero	1.569	0.312	1.000	0.730	0.135	1.500
		200 ppm	2.660	0.832	1.800	1.290	0.333	2.900
	Nubaria 1	Zero	1.150	0.280	0.800	0.650	0.117	1.267
		200 ppm	2.400	0.626	1.600	0.910	0.253	2.400
	Giza 716	Zero	0.900	0.222	0.500	0.527	0.100	1.100
		200 ppm	2.310	0.543	1.400	0.840	0.216	2.200
Mean			1.832	0.469	1.183	0.824	0.192	1.895
50% of Etc (675 m^3/fed.)	Giza 3	Zero	1.200	0.250	0.70	0.62	0.120	1.300
		200 ppm	2.000	0.510	1.400	1.190	0.204	2.600
	Nubaria 1	Zero	1.000	0.230	0.600	0.570	0.110	1.000
		200 ppm	1.540	0.480	1.250	0.877	0.175	2.100
	Giza 716	Zero	1.067	0.200	0.400	0.470	0.103	0.800
		200 ppm	1.200	0.365	1.067	0.777	0.145	1.867
Mean			1.335	0.339	0.903	0.750	0.143	1.611
Variety type	Giza 3		1.866	0.501	1.395	1.044	0.246	2.339
	Nubaria 1		1.565	0.439	1.225	0.834	0.184	1.950
	Giza 716		1.380	0.360	1.044	0.707	0.152	1.694
Ascorbic acid	Zero		1.135	0.302	0.897	0.634	0.138	1.444
	200 ppm		2.072	0.565	1.546	1.090	0.250	2.544
L.S.D. at 5% level for W			0.251	0.087	0.041	0.009	0.040	0.009
L.S.D. at 5% level for V			0.200	0.032	0.032	N.S.	0.031	0.011
L.S.D. at 5% level for A			0.134	0.036	0.025	0.010	0.005	0.006
L.S.D. at 5% level for W X V X A			N.S.	N.S.	N.S.	0.024	0.017	0.018

Ascorbic acid:

Ascorbic acid sprayed via leaves increased significantly (at 5% level) all plant organs on content and uptake of N, P, K compared with control treatment Tables (2&3) & Fig. (2). Data revealed that application of ascorbic acid had a favorable effect on macronutrients content and uptake of faba bean plant. The highest plant content and uptake of N, P, K of all plant organ were recorded with plant treated with ascorbic acid compared with control. The increments on N, P, K content and uptake of grain estimated by (2.1%, 53.82 Kg/fed). for N, (0.56,14.71) for P and K (1.54%, 39.86) kg/fed. Respectively, compared with control. Moreover, the same results recorded with straw yield. These results are in accordance by Talaat (2003) reported that the positive effect of N concentration by ascorbic treatments could be explained the accumulation of nitrate by ascorbic acid foliar application
on root growth which consequently increased nitrate absorption, in this concern, the increase in P concentration by ascorbic application may be attributed to the postulation of Hanafy Ahmed (1996) who mentioned that foliar spray with ascorbic acid might increase the organic acid extracted from the

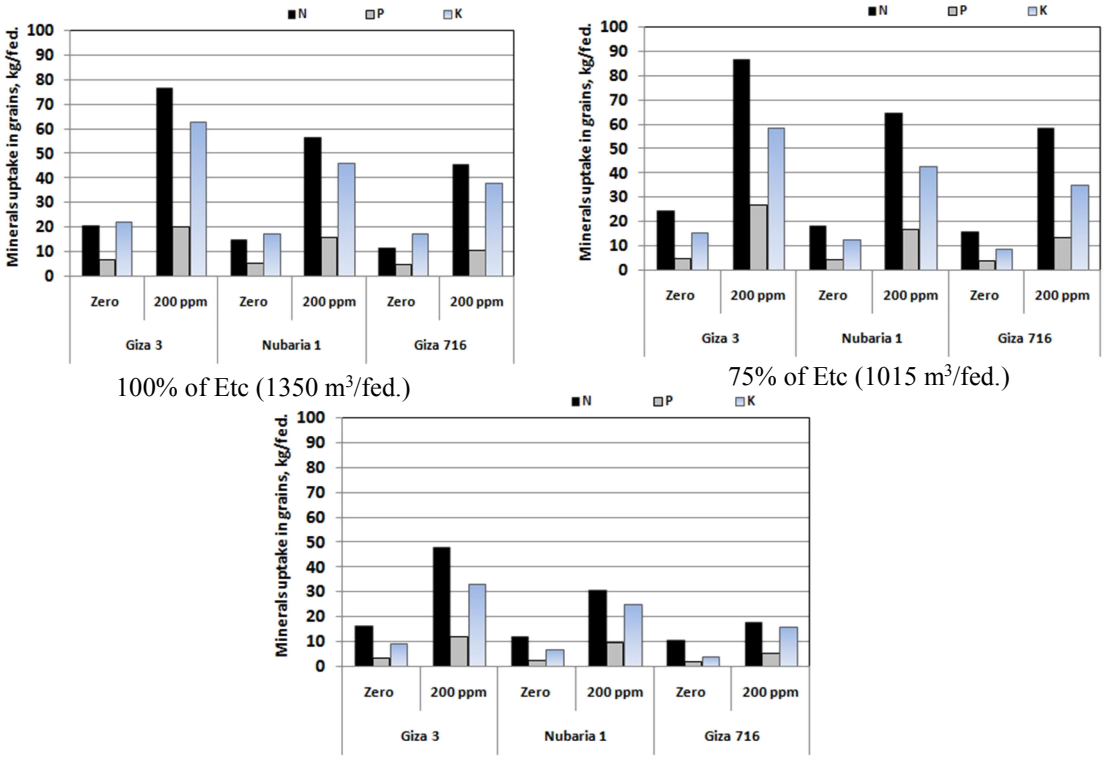
roots in to the soil and consequently increase the solubility of most nutrients which release slowly into the rhizosphere zone where it may be utilized by the plants. In addition, Azza, *et al*., (2011) reported that electrostatic binding of inorganic ions by organic ions such as organic acid is undoubltedly involved in the process of K-ion accumulation. These results are in agreement with Gad *et al*., (2012) and Khafaga *et al*., (2014). Generally, ascorbic acid is synthesized in the higher plants and improves plant growth. It is a product of D-glucose metabolism which affects some nutritional cycle activities in higher plants and plays an important role in the electron transport system (El-Kobisy *et al*., 2005). Several studies have shown that ascorbic acid plays an important role in improving plant tolerance to abiotic stress (Shalata and Neumann, 2001; Al-Hakimi and Hamada, 2001 and Athara *et al*., 2008).

Varieties:

Results in Tables (2&3) & Fig. (2) shows that the concentration and uptake of N,P,K were higher in Giza 3 variety. Also Giza 716 recorded the lowest values of N,P,K content and Nobaria 1 came in between. Resulted revealed that genotypes differed significantly for N,P,K Conc. and uptake. The highest mean value range in N, content in grains extended from (1.38 to 1.86%) for N and (0.36 to 0.50%) for P and K (1.04 to 1.39%), respectively. Generally, the best performing cultivar among the genetic materials in Giza 3, thus cultivar is recommended for commercial and extensive faba bean farming in the region as a result of its capacity of give high protein content under various water regime Alghamdi (2009).

Table 3: Effect of the water regimes, variety type, and ascorbic acid treatment combination on NPK uptake of faba bean grain and straw yields.

Water regime (W)	Variety type (V)	Ascorbic acid (A)	Minerals uptake in grains, kg/fed.			Minerals uptake in straw, kg/fed.		
			N	P	K	N	P	K
100% of Etc (1350 m3/fed.)	Giza 3	Zero	20.51	6.87	22.27	20.05	5.68	58.48
		200 ppm	76.47	20.50	63.05	67.05	18.94	139.44
	Nubaria 1	Zero	15.00	5.45	17.87	17.84	4.65	51.62
		200 ppm	56.38	16.09	46.14	44.39	8.97	98.95
	Giza 716	Zero	11.51	5.14	17.44	13.91	3.22	36.27
		200 ppm	45.35	10.67	38.18	31.62	6.38	80.56
Mean			37.54	10.79	34.16	32.48	7.97	77.56
75% of Etc (1015 m3/fed.)	Giza 3	Zero	24.62	4.96	15.76	19.26	3.55	39.51
		200 ppm	86.52	27.10	58.56	78.49	20.25	176.38
	Nubaria 1	Zero	18.58	4.57	12.94	17.03	3.06	33.13
		200 ppm	64.62	16.90	43.10	43.74	12.15	115.26
	Giza 716	Zero	15.77	3.97	8.86	12.08	2.28	25.14
		200 ppm	58.27	13.75	35.34	36.52	9.38	95.54
Mean			44.73	11.87	29.10	34.52	8.44	80.83
50% of Etc (675 m3/fed.)	Giza 3	Zero	16.50	3.49	9.65	14.69	2.83	30.74
		200 ppm	48.06	12.15	33.24	35.41	6.06	77.28
	Nubaria 1	Zero	12.06	2.82	7.26	12.72	2.44	22.26
		200 ppm	30.73	9.66	25.06	23.39	4.66	55.92
	Giza 716	Zero	10.66	2.06	4.06	7.11	1.54	12.06
		200 ppm	17.96	5.54	16.07	16.30	3.03	39.08
Mean			22.66	5.95	15.89	18.27	3.43	39.56
Variety type	Giza 3		45.45	12.51	33.76	39.16	9.55	86.97
	Nubaria 1		32.90	9.25	25.40	26.52	5.99	62.86
	Giza 716		26.59	6.85	19.99	19.59	4.31	48.11
Ascorbic acid	Zero		16.13	4.37	12.90	14.97	3.25	34.36
	200 ppm		53.82	14.71	39.86	41.88	9.98	97.60
L.S.D. at 5% level for W			4.67	2.28	1.09	1.78	1.42	2.18
L.S.D. at 5% level for V			4.74	0.95	0.45	0.61	1.08	0.77
L.S.D. at 5% level for A			3.43	0.92	0.95	0.85	0.26	1.10
L.S.D. at 5% level for W X V X A			N.S.	2.76	2.85	2.56	0.78	3.31

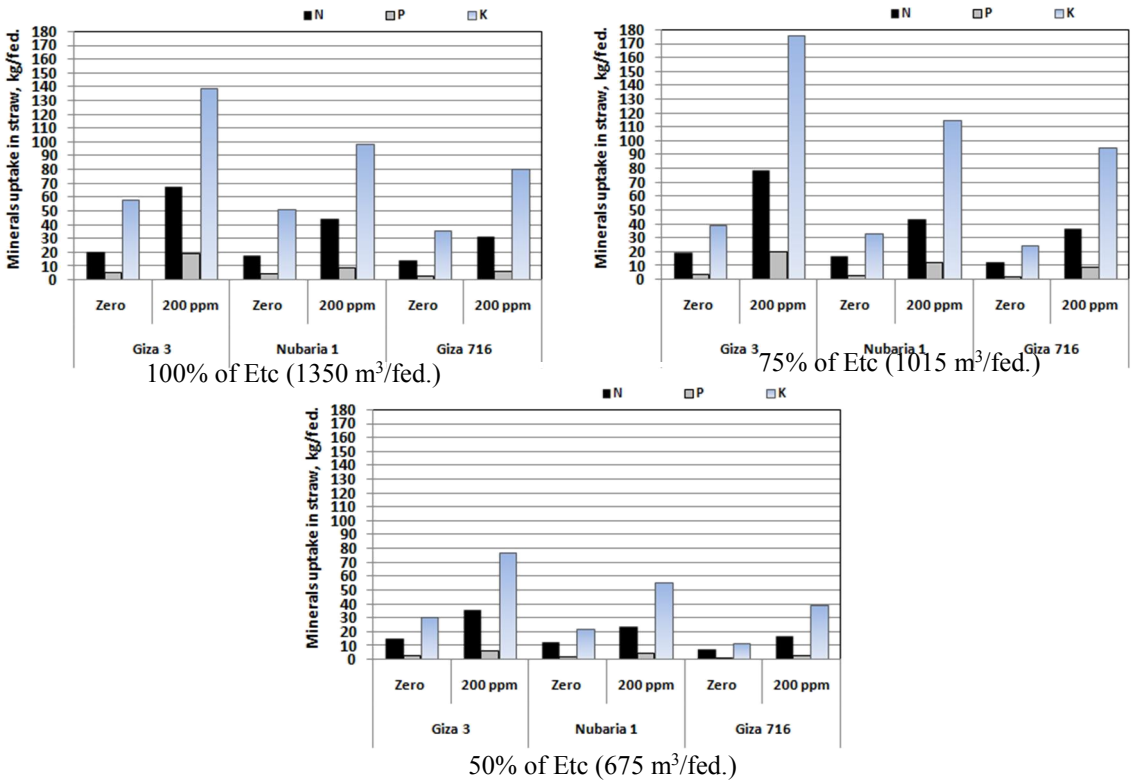


100% of Etc (1350 m^3/fed.)

75% of Etc (1015 m^3/fed.)

50% of Etc (675 m^3/fed.)

Fig. 1: Effect of the water regimes, variety type, and ascorbic acid treatment combination on NPK uptake of faba bean grain and yield.



100% of Etc (1350 m^3/fed.)

75% of Etc (1015 m^3/fed.)

50% of Etc (675 m^3/fed.)

Fig.1: Effect of the water regimes, variety type, and ascorbic acid treatment combination on NPK uptake of faba bean in straw and yield.

This is in agreement with values obtained by Alghamdi (2009) and Tayel and Sabreen (2011). Thus, the differences in the studied parameter were significant at the 5% level, regardless of irrigation regime and ascorbic acid addition this must be related to the differential expressively of certain genes during auto gentic processes and response of each cultivar to the environmental which is expressed in the formal branches No./plant.

Interaction effects:

The interaction effects of water regimes varieties and ascorbic acid treatments were illustrated in tables (2&3) & Fig. (2). All the values of N,P,K content, and uptake that there was significant difference among irrigation and varieties of faba bean.

Generally, the highest values of N,P,K content and uptake of Giza 3 was higher than other varieties under ETc 100% and 75% irrigation water with 200ppm ascorbic acid addition.

Also data in Table (3) clearly indicated that 75%. ETc irrigation treatment of Giza 3 with ascorbic acid addition induced the high uptake of NPK in grain and straw except K uptake in grain, the highest values of K uptake (63.05 kg/fed) under 100% water stress of Giza 3 with ascorbic acid addition in grain.

The highest values of NK content and uptake except P under ETc 75% , was Giza 3 and 200ppm ascorbic acid addition. In this concern, Maathuis (2009) mentioned that many physiological processes such as photosynthesis, fates and protein and enzymes effected by the level of macronutrients which play important roles in its synthesis and activity in plants. Esmaeili, (2011) and Hussein *et al*., (2015) noticed that water stress treatments had significant effect on root yield, growth sugar yield and water used efficiency. This may be related to the effect of water of deficit on water potential, stomata closure and iterance of CO_2 which intern affected photosynthesis which led to alter growth and yield while the lowest value was obtained by Giza 716 without ascorbic acid addition under ETc 50% water regime. This reduction may be attributed to lower radiation interruption as lower number and leaf area per plants under low available soil water content (Albayrak and Yuksel 2009).

The three variable involved in the current investigation (soil moist regimes, varieties and ascorbic acid treatment significantly affected concentration and uptake of N, P, K in straw and grains.

Comparing the effect of treatment ETc 75% at 200 ppm Ascorbic acid with ETc 100% or ETc 50% on N,P,K uptake and concentration by straw and grain of the three varieties, A positive relation occurred between the soil moisture regimes, varieties and ascorbic acid treatments. ETc 75% with Ascorbic spraying in plants of Giza 3 significant increased by grains and straw as compared with ETc 50% with ascorbic acid spraying of the other varieties treatments while the ETc 50% without spraying scobic acid were observed in plants of Giza 167 Tables (2&3)& Fig. (2). Abd-El-Aziz *et al*., (2009) concluded that application of ascorbic acid significantly increased all mineral concentration and uptake.

Generally, the highest values of N and P content with use of ascorbic acid to Giza 3 variety under ETc 100%, on the opposite site. In general the effect of three different water regimes on faba bean has shown that three genetic materials tested can serveas a good resource for protein and another essential nutrients and support any program to alleviate protein malnutrition developing countries. As a result higher level of protein content with decrease water supply to the plant, it is obvious that medium level of irrigate on will give high protein contents in faba bean with acceptable crop yield thus, water can be logically conserved in the region without any significant yield loss.

Protein content:

Data presented in Table (4) indicated that not significant difference among genotypes in protein content of seed under different levels of water treatment significant difference were observed among genotypes when grown under less favorable watering regimes, there is an increasing trend in protein content in seed with less supply of water i.e. seed protein of 75% ETc water regime had more protein content than 100% ETc water treatment .The highest protein content was recorded for Giza 3 seed under 75% ETc with ascorbic acid addition while the lowest was in reported with Giza 716 under 100% ETc water regimes. This results was in contrast with Musallam *et al*., (2004), Liu and

Andersen (2004) and Al-Suhaibani (2009) who found that high crude protein and carbohydrate present in seed were accompanying with low water supply. In addition, Ahmed *et al*., (2008) and Alghamdi (2009) found that water stress increased protein presentage and electrical conductivity.

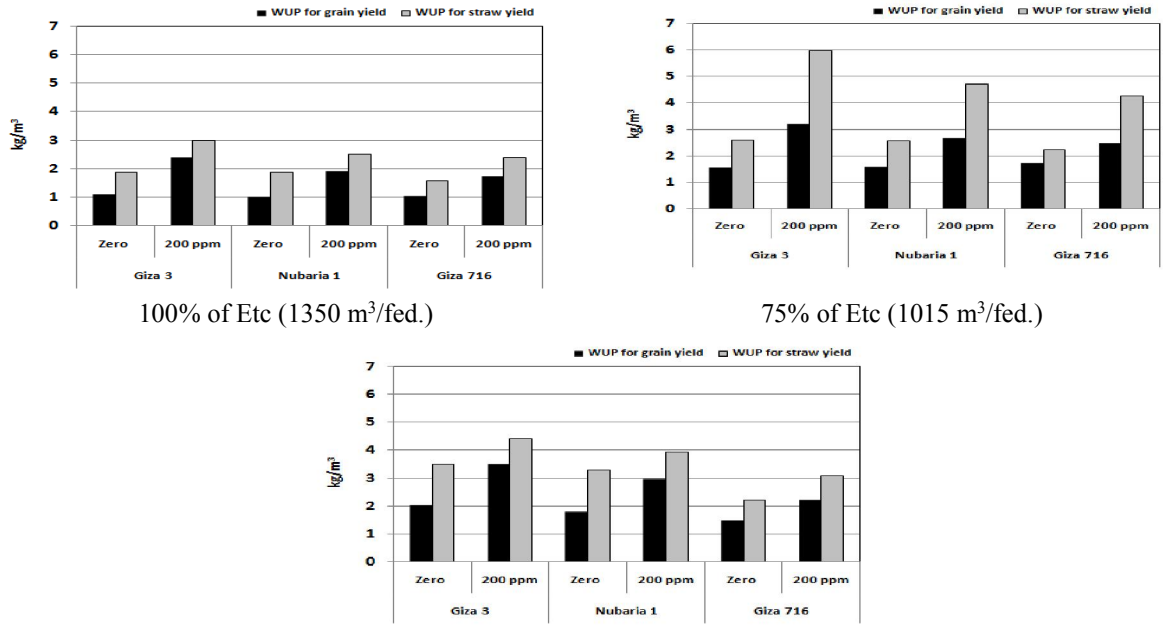
Total protein content varied greatly among the faba bean genotypes. Despite difference that might be due to genotype and location (Salem 2009). In general, the crude protein in seed bean genotypes varied from 5.50% to 16.63% under three irrigation regime it was observed that protein content, this change dependent on the genotypes and environmental condition (Duc, 1999) generally therefore, based on the recommended average human protein intake of 32-50gm by the National Research Council (1974). The tested faba bean genotype could contribute significantly to alleviating the problem of protein malnutrition in the developing countries. While Giza 3 had highest value at 75% ETc and Giza 716 had a lowest value under normal irrigation (100%) ETc.

Water Use Productivity (WUP) for grain and straw yields (kg/m3):

It was observed that there was a significant difference between the grain yield WUP values under the effect of the interaction between the three experimental treatments, on the opposite side there was not significance for straw yield WUP table (4) and Fig. (2). WUP for grain and straw yield were increased by 29.37 and 35.31 % by cultivating Giza 3 variety comparing with Giza 716 variety. Moreover they were increased by 42.4% using 200 ppm ascorbic acid comparing with control treatment.

Table 4: Effect of the water regimes, variety type, and ascorbic acid treatment combination on Protein faba bean straw and grain, as well as water use productivity for grain and straw yields.

Water regime (W)	Variety type (V)	Ascorbic acid (A)	Protein % grain	WUP for grain yield, kg/m^3	WUP for straw yield, kg/m^3
100% of Etc (1350 m^3/fed.)	Giza 3	Zero	8.75	1.08	1.88
		200 ppm	14.8	2.39	3.00
	Nubaria 1	Zero	6.87	1.01	1.88
		200 ppm	13.75	1.89	2.52
	Giza 716	Zero	5.50	1.03	1.57
		200 ppm	12.30	1.71	2.38
Mean			10.28	1.52	2.21
75% of Etc (1015 m^3/fed.)	Giza 3	Zero	9.80	1.54	2.59
		200 ppm	16.63	3.20	5.99
	Nubaria 1	Zero	7.18	1.58	2.57
		200 ppm	15.00	2.65	4.72
	Giza 716	Zero	5.63	1.73	2.24
		200 ppm	14.40	2.48	4.27
Mean			11.50	2.20	3.73
50% of Etc (675 m^3/fed.)	Giza 3	Zero	7.50	2.03	3.49
		200 ppm	12.50	3.51	4.40
	Nubaria 1	Zero	6.25	1.77	3.28
		200 ppm	9.63	2.96	3.94
	Giza 716	Zero	6.66	1.48	2.22
		200 ppm	7.50	2.22	3.09
Mean			8.30	2.33	3.40
Variety type	Giza 3		12.19	2.29	3.56
	Nubaria 1		10.19	1.98	3.15
	Giza 716		8.78	1.77	2.63
Ascorbic acid	Zero		7.76	1.47	2.41
	200 ppm		13.02	2.55	3.81
L.S.D. at 5% level for W			0.78	0.087	0.082
L.S.D. at 5% level for V			0.50	0.016	0.021
L.S.D. at 5% level for A			0.41	0.011	0.016
L.S.D. at 5% level for W X V X A			N.S	0.031	0.048



100% of Etc (1350 m^3/fed.) 75% of Etc (1015 m^3/fed.)

50% of Etc (675 m^3/fed.)

Fig 2: Water Use Productivity of grain yield and straw yield under the effect of water regimes, variety, and ascorbic acid foliar, kg/m^3.

Generally, it was observed that the highest values of WUP for grain yield and straw yield were obtained by irrigating faba bean plants, Giza 3 variety, by 75% of the ETc (1015 m3/fed.) and sprayed by 200 ppm ascorbic acid. On the other hand the lowest values were gained by irrigating Giza 716 variety by 50% of the ETc (675 m3/fed.) and ascorbic acid treatment (zero spraying). So using 75% of the ETc is saving 25% from used irrigation water for the other uses in agricultural in Egypt, these data in the same concern with Mehanna *et al.* (2013, and 2015) and Hussein *et al*., (2015**)**.

Conclusion

Many trails were done by many ways to overcome the negative effect drought on crops an important way is use the best performing varieties among the genetic material tested in Giza 3, that genetic Giza 3 engineering of crops for abiotic stress tolerance could be done through its oxidative defense. Treatment with ascorbic acid as foliar treatment was done and improving yield seed chemical composition and water use efficiency (WUE) under abiotic stresses of three genotypes of faba bean. Furthermore the effect of three different water regimes on faba bean has shown that three genetic materials tested can serve as a good resource for protein and other essential nutrients and support any program to alleviate protein malnutrition, as a result of higher level of protein with decrease in water supply to the plant and it is obvious that medium level of irrigation will give high protein contents in faba bean with acceptable crop yield thus, water can be logically conserved without any significant yield loss. Further, the best performing cultivars among the genetic materials tested in Giza 3, thus this cultivar is reconvened for commercial and extensive faba bean farming in the region as a result of its capacity to give high protein content under various water regime.

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