Middle East Journal of Agriculture Research
ISSN 2077-4605
Volume : 06 | Issue : 04 | Oct.-Dec. | 2017
Pages:1089-1097

Growth, yield of faba bean (*Vicia faba* L.), Genotypes with respect to ascorbic acid treatment under various water regimes
I-Growth and yield

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Received: 15 July 2017 / Accepted: 20 Sept. 2017 / Publication date: 27 Nov. 2017

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 the plant height, root length, number of branches/plant and stem, leaves and whole plant dry weight gave the highest values when plants irrigated by 75% ETc in comparable with these of 50 or 100% ETc treatments. However, root dry weight decreased with 75% and 50% ETc water of irrigation treatments. The lowest values of all growth were observed when plants irrigated with 50% of the ETc, corresponding to100% and 75% ETc. On the other hand, Giza 3 variety was the superior in growth criteria i.e. root length, plant height, number of branches and root, stem leaves and whole plant dry weight, while Giza 716, later and Nobaria 1 lied in between. Also, all growth and yield of faba bean was increased by ascorbic acid sprayed via leaves increased significantly (at 5% level) compared with plants received fresh water only. Generally, it be concluded that faba bean (Giza 3) is more tolerant to water deficit with ascorbic acid as foliar application treatment under water stress.

Key words: Ascorbic acid, varieties, water regime, growth, faba bean, yield.

Introduction

Beans (*Vicia faba* L.) are considered the first legume crop in the arable area of Egypt. Total yield in consumed as green and dry seeds in human feed because the plants has high levels of protein (18%), carbohydrates (58%), vitamins and other minerals. In addition to the improvement of soil texture and its fertility, the plant seeds are considered as a valuable source for energy and proteins.

Drought is considered as one of the major abiotic stress which most of the developing countries suffer from its damages in agriculture, considerable losses were resulted from the adverse effect such as head cold, drought and salinity.Also, drought stress affecting most of the physiological processes in plants photosynthesis affected through stomatal closure and gas exchange caused drought Graham and Ranalli (1997), Hussein *et al*., (2012) and (2013).

Duc *et al*., (1999) stated that under the water deficit condition protein content of faba beans tented to increase and these results compensated with the data obtained by Alghamdi (2009).

Some management practices, like irrigation, can contribute to the increase grain yield under water stress conditions, thus the development of tolerant cultivars becomes an efficient and economical of production strategy (Zlatev and Stoyanov 2005). Also drought tolerance implies the ability to sustain reasonable yield under moderate water stress and not the ability to survive over prolonged and sereve water stress period. (Molina *et al*., 2001; Emam *et al*., 2010 and Hussein *et al*., 2015).

Water stress is one of the most signficiant parameters affecting plant growth, seed yield and quality and photosynthesis productivity for most crops. Ouda *et al*., (2010) described that 20% of full irrigation supply could be saved with approximately yield reduction of 7% Thus, Alderfasi and Alghamdi (2010) reported that irrigation water with 75% of soil water holding capacity resulted in

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higher plant height, large number of plant branches, number of pods/plant, 100 seed weight, seed yield/plant and seed yield/ha.

El-Dakroury (2008) added that increasing of the irrigation treatments from 60 to 100% of ETc (Evapotranspiration), significantly increased the growth criteria, i.e. plant height, number of branches, leaves and pods/plant, leaves area and dry weight of both stem and total plant. Genotypic differences in grain weight are manily correlated with differences in grain growth rates, the large seeded genotypes have the largest individual grain growth rate. (Munier and Ney (1995).

Ascorbic acid is an important primary in plants that functions as an antioxidant, an enzyme cofactor and a cell signaling modulator in a wid array of crucial physio-logical processes, including biosynthesis of the cell wall. Secondary metabolites and phytohormones, stress tolerance, ploto protection, cell division and growth (Wolucka *et al*. 2005).

Additionally, Ascorbic acid and its use in allevation adverse effects of abiotic stress of crops were reported by: Bakry *et al*., (2012) and Mekki, *et al*., (2015). The nutritional value of faba bean was attributed to its high protein content with a range of 27-34%. Hossain and Mortuza (2006) noticed that, depending on the genotypes, the protein comprised of globulins (79%),a lbumins (7%) and glutelins (6%)

The object of this study was therefore to assess the effect of three different irrigation water regime and evaluate the effect of ascorbic acid treatment on productivity of three genotypes of faba bean.

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 growth and yield 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 CaCO3, EC and pH were determined according to Black *et al.* (1982).

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

Particle size distribution							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	

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 *symbiotic* 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 species, 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 oven at 70°C and ground. All collected data were subjected to the proper statistical analysis as described by Snedecor and Cochram (1982).

Results and Discussion

Growth-water regime:

Regardless of faba bean varieties and Ascorbic acid treatments, the data in Table (2) demonstrated that the effect of irrigation regimes on the growth parameters under study. Data in Table (2) showed that a significant effect at of level of water stress on all plant characters i.e. plant height, root length, dry weight of stem, roots and leaves, No. of Pod and No. of Branches.

Table 2: Effect of water regimes, variety type, and ascorbic acid treatment combination on growth parameters of faba bean.

Water regime (W)	Variety type (V)	Ascorbic acid (A)	Plant height, cm	Root Length, cm	Dry weight of, gm			No. of pod /plant	No. of branches
					Stem	Root	Leaves		
100% of Etc (1350 m^3/fed.)	Giza 3	Zero	64.00	18.33	8.72	3.66	5.78	6.33	3.00
		200 ppm	83.67	20.00	13.33	5.27	10.41	12.33	5.67
	Nubaria 1	Zero	72.00	14.33	9.58	3.07	5.49	7.33	3.33
		200 ppm	65.00	18.00	10.41	4.36	9.60	12.00	5.00
	Giza 716	Zero	60.00	13.67	9.00	1.92	4.31	6.67	2.67
		200 ppm	66.33	19.00	10.09	3.74	9.20	10.33	4.33
Mean			68.55	17.22	10.18	3.67	7.46	9.16	4.00
75% of Etc (1015 m^3/fed.)	Giza 3	Zero	73.67	15.67	8.03	3.31	7.47	8.00	3.67
		200 ppm	82.00	20.00	26.93	5.37	11.15	13.33	5.00
	Nubaria 1	Zero	63.33	14.67	8.75	2.32	7.23	6.00	2.67
		200 ppm	76.33	20.00	20.05	4.34	9.90	13.33	5.33
	Giza 716	Zero	63.33	15.67	6.20	3.30	6.08	5.33	3.67
		200 ppm	64.67	18.00	18.82	4.10	8.88	10.67	4.00
Mean			70.49	17.33	14.79	3.79	9.53	9.44	4.05
50% of Etc (675 m^3/fed.)	Giza 3	Zero	48.00	11.67	5.25	1.84	2.16	3.67	1.00
		200 ppm	65.00	15.00	10.82	3.16	5.46	6.00	2.00
	Nubaria 1	Zero	46.33	10.67	5.29	1.04	1.86	3.00	1.33
		200 ppm	56.00	13.67	9.14	3.13	5.15	5.67	2.00
	Giza 716	Zero	46.67	9.00	5.49	1.34	1.53	3.00	1.00
		200 ppm	50.00	13.67	7.56	2.05	3.01	4.00	2.00
Mean			52.00	12.28	7.25	2.09	3.19	4.22	1.55
Variety type	Giza 3		69.39	16.77	12.18	3.76	7.07	8.27	3.39
	Nubaria 1		63.16	15.22	10.53	3.04	6.53	7.88	3.28
	Giza 716		58.50	14.83	9.52	2.74	5.50	6.66	2.94
Ascorbic acid	Zero		59.66	13.74	7.36	2.42	4.65	5.44	2.48
	200 ppm		67.70	17.48	14.12	3.94	8.08	9.74	3.92
L.S.D. at 5% level for W			0.21	0.009	0.026	0.51	0.46	0.13	0.58
L.S.D. at 5% level for V			0.13	0.014	0.019	0.15	0.18	0.10	0.02
L.S.D. at 5% level for A			0.11	0.006	0.012	0.24	0.19	0.08	0.21
L.S.D. at 5% level for W X V X A			0.33	N.S	0.036	N.S	0.56	0.23	0.63

However, faba bean plant irrigated with 75% water stress gave the highest values, these mean value were (70.49 cm) for plant height, root length (17.33cm), No. of branches (4.05), No. pod/plant (9.44) and dry weight (stem, root and leaves) were (14.79, 3.79 and 9.53 gm) respectively. Since there was no significant difference between 100 and 75% water stress level in root weight and number of branches. 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, efficient water conduction (Emam and Seghatoleslami *et al*., 2005), rustication in transpiration (Tradieu, 2005) and water storage and desiccation tolerance (Larcher, 2001). Furthermore, Alderfasi and Alghamdi (2010) reported that irrigation water with 75% of soil water holding capacity resulted in higher plant height, large number of plant branches, number of pods/plant, 100 seed weight and seed yield/plant.

Varietal difference:

Main effects of faba bean varieties on growth parameters i.e. plant height, root length, dry weight of stem, root and leaves and No. of branches, respectively. The obtained data indicated that variety Giza 3 surpassed those of Nubaria 1 and Giza 176 in all the studied growth and growth characters. Table (2) illustrated that the mean values of vegetative growth parameters of variety Giza 3 i.e., (69.39 cm) for plant height, root length (16.77), dry weight for stem and root leaves (12.18, 3.76, 7.07 gm), No. of pod/plant (8.27) and (3.39) for No. of branches. This must be due to the differential expressively of certain genes during autogenetic processes and of each cultivar to the environmental conditions which is expressed in form of branches no./plant (Tayel and Sabreen, 2011).

In this respect, the result of Singer *et al*., (2001), on two snap bean cultivars (Giza 3 and Bronco) showed that plant highest, number of leaves, chlorophyll content, number of flowers and their set percent of both cultivars were significantly affected by water stress. They concluded that irrigation with 75 and 100% of field capacity, were most preferable for Bronco and Giza3, respectively. On the other hand, statistical analysis revealed significant difference within the genotypes variations in these traits among different genotypes can be attributed to both genetic and environmental factors (Musallam *et al*., 2004).

Ascorbic acid:

Data in Table (2) revealed that application of 200 ppm ascorbic acid as foliar application had a favourable effect on growth parameters of feba bean plants. The highest values of plant heights, root length, No of branches, No. of pod/plant and dry weight of stem, root and leaves were recorded with plant treated with 200 ppm ascorbic acid addition compared with control. These values were (67.70) cm, (17.48) cm (9.74) and (14.12, 3.94, 8.08 gm), respectively. In this connection, Smirnoff (1996) who also pointed out that cell wall ascorbate and cell wall localized ascorbate oxidase has been implicated in control of growth, high ascorbate oxidase activity is associated with rapidly expanding cells. Accordingly, these increments in growth parameters by ascorbic acid (Azza *et al*., 2011).

Interaction effect on growth parameters:

The interaction effect between water, varieties and ascorbic acid treatments were significant on plant height, number of branches and pod, as well as dry weight of stem, leaves and whole plant except root length and dry weight of root. The longest plants were observed with ascorbic treatment of Giza 3 variety under 100% ETc irrigation treatment. The shortest plants were shown in plants of Nubaria 1 variety without ascorbic spraying and with the lesser quantity of water (Table 2). Mekki and Ashraf (2012) observed with the three different methods of ascorbic acid application (Soaking, spraying and through soil) rooting medium was more effective in alleviating the adversities of drought in wheat. Also, Amin, *et al*., (2009) concluded that exogenous application of ASA stimulates total leaf area, photosynthetic pigments and growth under drought stress. This results agreement with (Singer *et al*., 2001) on two snap bean cultivars (Giza 3 and Bronco) showed that plant highest number of leaves, chlorophyll content, number of flowers and their set percent of both cultivars were significantly affected by water stress.

Generally, it can be noted that the highest mean value of growth parameters were obtained in the interactions between ETc 75% water stress of Giza 3 and ascorbic acid addition.

Yield-water regime:

Data in Table (3) & Fig. (1) showed that a significant effect of level of water stress on yield plant. Faba bean plant irrigated with 75% water stress gave the highest mean value of grain yield (2.23 Mkg/fed.) and (3.79 Mkg/fed.) for straw yield, these results may be due to plants are capable to development an extensive root system which enables them to extracts water from deeper water soil layers, which in turn increased their adaplability to grow in inadequate soil moisture content and reflected on root plasticity improvement under water stress conditions, this resulted agreement with, El-Sarag, Eman, (2013) and Suralta (2011). While the lowest values of yield were obtained when plants irrigated with 50% water stress, this reduction may be due to the in cell division and expansion in leaves which is turn reduce photosynthesis surface of sugar plant cultivars (El-Sarag, Eman, 2013), Also, this reduction may be attributed that flower radiation interruption as lower number and leaf area per plants under low arailable soil water content (Korshid and Rajabi, 2014).

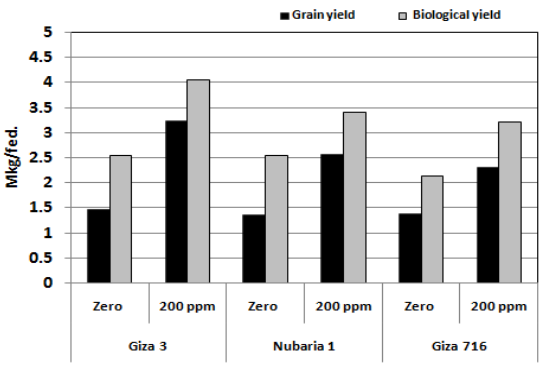
Table 3: Effect of the water regimes, variety type, and ascorbic acid treatment combination on yield and its attributes of faba bean.

Water regime (W)	Variety type (V)	Ascorbic acid (A)	Grain yield, Mkg/fed.	Straw yield, Mkg/fed.
100% of Etc (1350 m3/fed.)	Giza 3	Zero	1.47	2.54
		200 ppm	3.23	4.06
	Nubaria 1	Zero	1.37	2.54
		200 ppm	2.56	3.41
	Giza 716	Zero	1.39	2.13
		200 ppm	2.31	3.22
Mean			2.05	2.98
75% of Etc (1015 m3/fed.)	Giza 3	Zero	1.57	2.63
		200 ppm	3.25	6.08
	Nubaria 1	Zero	1.61	2.61
		200 ppm	2.69	4.80
	Giza 716	Zero	1.76	2.28
		200 ppm	2.52	4.34
Mean			2.23	3.79
50% of Etc (675 m3/fed.)	Giza 3	Zero	1.37	2.36
		200 ppm	2.37	2.97
	Nubaria 1	Zero	1.20	2.22
		200 ppm	2.00	2.66
	Giza 716	Zero	1.00	1.50
		200 ppm	1.50	2.09
Mean			1.57	2.30
Variety type		Giza 3	2.21	3.44
		Nubaria 1	1.90	3.04
		Giza 716	1.74	2.59
Ascorbic acid		Zero	1.41	2.31
		200 ppm	2.49	3.73
L.S.D. at 5% level for W			0.018	0.023
L.S.D. at 5% level for V			0.008	0.018
L.S.D. at 5% level for A			0.010	0.011
L.S.D. at 5% level for W X V X A			0.030	0.034

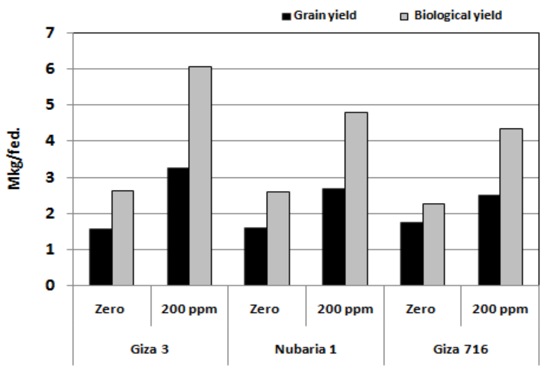
Variety yield:

Data in Table (3) and Fig. (1) showed that grain yield, and straw yield of Giza 3 were higher than Nobaria 1 or Giza 716. The highest mean value of grain yield was (2.21 Mkg/fed.) it obtained by Giza 3. This genotype showed higher pod dry weight values indicated that genotypes with less vegetative growth might be more different in yield per plant, as being noted by Emam (1985) and

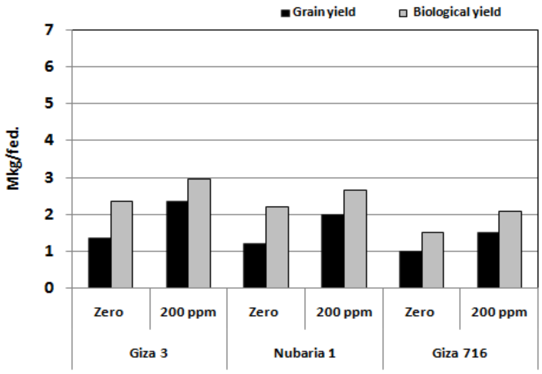
Emam *et al*., (2010), variation in these trails among different genotypes can be attributed to both genetic and its environmental factors (Musallam *et al*., 2004). While the lowest value (1.74 Mkg/fed.) obtained with Giza 716 these results attributed to genotypic differences in grain weight are mainly correlated with differences in grain growth rates. The large-seeded genotypes have the largest individual grain growth rate (Egli *et al*., 1981 and Munier and Ney, 1995).



100% of Etc (1350 m3/fed.)



75% of Etc (1015 m3/fed.)



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

Fig 1: Grain yield and straw yield under the effect of water regimes, variety, and ascorbic acid foliar, Mkg/fed.

Ascorbic acid:

Data in Table (3) and Fig. (1) revealed that application of 200 ppm ascorbic acid as a foliar application had a favourable effect on faba bean yield, the highest mean value of grain and straw yield (2.49 and 3.73 Mkg/fed.). were obtained with plants treated with 200 ppm ascorbic acid as compared with the control plants. These results may be due to sprayed ascorbic acid influencing many physiological process respiration activities cell division and many enzymes activities as reported by Zewail (2007). Also, Gad *et al*., (2012) indicated that foliar spray with ascorbic acid at 200 ppm increased grain yield, pod yield and 1000-grain of peas.

Interaction effect on yield:

In interactive effects of water regime, varieties and ascorbic acid treatment (3) & Fig (1). The highest value of grain yield was (3.25 Mkg/fed) its obtained by Giza 3 under 75% ETc and ascorbic acid addition. Application of ascorbic acid via leaves improved yield of faba bean under 75% of Giza 3. ETc. This was true for the three varieties. These increment were more under 75% ETc. These results may bed due to that genetic engineering of crops for abiotic stress tolerance could be done through its oxidative defense. According to Chaves *et al*., (2002) who stated that, in addition to dry matter accumulation partition vegetative biomass to reproductive organs and this affected yield under drought condition. Mekki and M. Ashraf, (2012) revealed that ascorbic acid induced enhancement of growth and yield of cotton grown under drought condition. Ascorbic acid increasing yield and its component through its importance in oxidation-reduction. Hamada (2000) Mohsen *et al*., (2011) and Rung-Hue *et al*., (2006) mentioned that varieties differences in chlorophyll content which affecting photosynthesis and intern affect in growth and yield which were detected in wheat, barley and maize (Alghamdi, 2009).

Conclusion

Many trails were done by many ways to overcome the negative drought on crops an important way is use the best performing cultivars among the genetic material tested in Giza 3 and extensive faba bean farming in the region as a results of its capacity to give high yield under various water regime. Treatment with ascorbic acid as foliar application treatment with done and increasing of growth parameters and yield of faba bean was obtained.

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