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Effects of Foliar Spraying with some Antioxidants on Growth, Dry Seed Yield and Chemical Constituents of Common Bean (*Phaseouls vulgaris* L.) Plants Grown under Water Stress Levels

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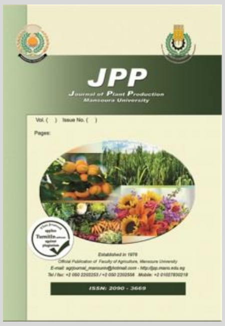

ABSTRACT

The current study was carried out at Qaha Vegetable Research Farm (Qalubia Governorate), Horticulture Research Institute, Agriculture Research Center (A. R. C.), Egypt, during the two successive summer seasons of 2017 and 2018 on common bean cv Nebraska. The aim of this study was to investigate the effect of applied antioxidants (ascorbic acid at 100, 200 mg/L and putrescine at 25, 50 mg/L) under water regimes at three levels i.e. 100%. (control), 75% (moderate stress) and 50% (severe stress) of ETo(Evapotranspiration) respectively of water requirements of common bean plants in the two seasons and their interactions on vegetative growth characteristics, dry seed yield and its components and chemical compositions as well as seed quality. The experimental design was split-plot, the water regimes were arranged in the main plots, while foliar spraying with ascorbic acid and putrescine were adopted in the sub-plots. The obtained results of the treatments showed that foliar spraying with the aqueous solution of putrescine or ascorbic acid at the highest rate of 50 mg/ L or 200 mg/ L respectively under irrigated common bean plants with the moderate water level (75% ETo) markedly increased all of the vegetative growth parameters and dry seed yield and its components. In additions, the same mentioned treatments showed obvious increment in the chemical composition in leaves and dry seeds in both seasons. And led to save a part of the irrigation water (about 25 %) especially under the condition of water stress or drought

Keywords: common bean, putrescine, Ascorbic acid, water stress regimes, Water use efficiency.

INTRODUCTION

Common bean plants *(Phaseolus vulgaris* L.*)* is an important member of Fabaceae family, it is considered one of the most important vegetable crops in Egypt for local market and it has a great importance role for exportation. Common bean also considered a major vegetable crop as a rich source of carbohydrates and protein as well as it is a source of vitamin B complex such as niacin, folic acid, riboflavin and thiamine. Added to that, it is considered as a source of mineral nutrients; phosphorus, potassium, magnesium, iron, copper, zinc, and calcium. Moreover, it is also has main source of fatty acids. Regular consumption of common bean reduces cholesterol levels in the blood. (Rocha and Gallegos, 2007).

Regarding the water regimes, currently, the world is facing many problems of crop production as a result of water deficiency. Among of them, deficit water irrigation which is the most dangerous one. Water is a very limited resource and most of Egypt's water uses are within the agriculture sector that consumes about 84 %. Problems of water scarcity may increase due to the increment of population which rise in living standards and accelerated urbanization which threaten the water supply sector in general and agriculture in particular and lead to both an increment in water consumption and in addition of pollution of water resources. According to forecasts, are especial challenges faces in Egypt nowadays and in the next decades. The demand for irrigation water will continue to increase because of higher domestic and industrial water consumption by the year 2030 may cause a decrease in the volume of fresh water available for agriculture (Abu-Zeid and Hamdy, 2002).

One of the most common irrigation methods in Egypt is furrow irrigation, resulting in high water losses and low irrigation efficiencies especially for using under the old Delta conditions (clay soil). Drip irrigation have been considered to be one of the most important obligatory irrigation systems and increase water consumption efficiency%. which has to be applied in the newly reclaimed desert areas as well as old Delta soils for saving much irrigation water. Drip irrigation systems exhibited the highest values of snap bean vegetative growth, pods yield (kg/ fed.) and water used efficiency, meanwhile furrow irrigation recorded the lowest values in the same concern (El-Noemani *et al.*, 2010). Drought contributes is one of the most factor to reduce the number of flowers, pod setting and poor quality of pods which led to reduction of yield. In this respect, exposure to drought stress causes morphological, physiological, biochemical and molecular changes that negatively affect plant growth and yield. The ability to uptake and allocate nutrients is a key factor in plant tolerance to drought. Common bean is sensitive to drought stress, which can cause yield losses of more than 50 % (Razinger *et al.*, 2010). Increases in reactive oxygen species production in drought-stressed, such as superoxide anion (O_2^-), hydrogen peroxide (H_2O_2) and hydroxyl radical (OH^-) are damageable for cellular structures and macromolecules, associated disturbances in carbohydrate metabolism causing photo inhibition of the photosynthetic apparatus. Moreover, it can directly damage membrane lipids, inactivate metabolic enzymes and damage nucleic acids, leading to cell death. Water deficit leads to oxidative stress in plant cells, due to a higher leakage of electrons

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toward O_2, during the photosynthetic and respiratory processes, leading to enhancement in reactive oxygen species (Sánchez-Rodríguez *et al.*, 2012). El-Tohamy *et al.* (2013) mentioned that water stress levels resulted in a significant decline of leaf water potential, stomatal conductance, photosynthesis rate and all growth, productivity and quality parameters of bean plants. Finding relatively safe tools and treatments to overcome the negative effects of drought stress or improve drought tolerance of sensitive plants could be of great value especially under arid and semi-arid conditions as shortage of water becomes a limiting factor for growth and productivity in such conditions.

On the other way, antioxidants is one of new methods to assist the plant to tolerate any environmental conditions and increased plant growth, cell cycle through plant growth and plant protect of any ROS (Reactive Oxygen Species) and increase photosynthetic pigments thereby increased chlorophyll contents, increased photosynthetic rate, increased productivity by plants Chen and Gallie (2006). Therefore, many compounds have been applied to minimize the harmful effects of drought stress, such as ascorbic acid, putrescine and potassium citrate. These compounds can decrease the adverse effects of drought in crop plants under water stress (El-Shayb, 2010, Gadalla, 2010, Abd-Ellatif, 2012 and Ibrahim, 2012). Also, these antioxidant compounds are well known to be involved in plant adaptation to water stress and may play important roles in plant growth and development (Farooq *et al.,* 2009 and Gadalla, 2010).

Concerning with (putrescine) which consideres as Polyamines like (spermidine and spermine) play an important role in protecting plant against various a biotic stress; they are potent ROS (Reactive Oxygen Species) scavengers and inhibitors of lipid peroxidation. The diamine putrescine can alleviate harmful drought effects in plants grown under water stress by many ways including: polyamines (PAs) may be involved in free radical scavenging (Drolet *et al.,* 1986). Polyamines are regulators of antioxidant enzymes and it is as components of stress-signaling system, it is can modulate functions of RNA, DNA, nucleotide triphosphates, proteins synthesis and protect macromolecules under stress conditions (Kuznetsov and Shevyakova, 2007). High accumulation of polyamines in plants during a biotic stress has been well documented and is correlated with increased tolerance to a biotic stress (Kuznetsov and Shevyakova, 2007 and Ahmad *et al.*, 2012).

Ascorbic acid (AsA) is the major antioxidant in plant known to increase plant growth and cell cycle, through photosynthetic apparatus and plant protect of any ROS (Reactive Oxygen Species) and increased Rubisco subunit, photosynthetic pigments thereby increased chlorophyll contents, photosynthetic rate and increase productivity of plants (Chen and Gallie, 2006). Ascorbic acid also plays an important role in several physiological processes in plants, including growth, differentiation, and metabolism. AsA has a key role in defense against oxidative stress and is particularly abundant in photosynthetic tissues (Smirnoff *et al.,* 2004). Moreover, foliar spraying with ascorbic acid (AsA) as an antioxidant treatment, Smirnof and Wheeler (2000) pointed out that ascorbic acid as an abundant component of plants functions as an antioxidant and an enzyme cofactor. It participates essential factors of processes, including photosynthesis, cell wall growth and cell expansion, resistance to environmental stresses and synthesis of ethylene, gibberellins, anthocyanine and hydroxyl proline. Conklin (2001) suggested that ascorbic acid is an important antioxidant, which reacts not only with H_2O_2 but also, with O_2, OH and lipid hydroperoxidases, which cause reactive oxygen species (ROS) are responsible for various stress-induced damages to macromolecules and ultimately to cellular structure. El-Shiekh *et al.* (2016) declared that foliar application of ascorbic acid at the rate of g/10 L increase in the growth and development of faba bean plants might be due to enhancement of cell division, cell enlargement and influence DNA replication.

The main objectives of this study were to investigate the effect of the appropriate amount of irrigation regime and the best dose of foliar spraying from putrescine or ascorbic acid to enhance growth, dry seed yield and its components, seed quality and water use efficiency as well as chemical properties in order to saving irrigation requirements of common bean plants.

MATERIALS AND METHODS

This field experiment was initiated during the two summer seasons of 2017 and 2018 in a clay loam soil at Qaha Vegetable Research Farm (Qalubia Governorate), Horticulture Research Institute, Agriculture Research Center (A. R. C.), Egypt. The objectives of this study were to investigate the interaction effect between foliar applications by some antioxidants materials [ascorbic acid (AsA) and putrescine (Put)] with different water stress levels i.e., 50, 75 and 100% of Evapotranspiration (ETo) on common bean (*Phaseolus vulgaris* L.) cv. Nebraska on growth, dry seed yield and its components as well as some chemical constituents of seeds.

Water stress levels were calculated as follows:-

Water stress levels	% of ETo	Irrigation water quantity applied m^3/fed
1-WL_1 full irrigation (control)	100%	Irrigation with 3790.5 m^3 water/fed.
2- WL_2 moderate water stress	75%	Irrigation with 2842.8m^3 water/fed.
3- WL_3 severe water stress	50%	Irrigation with 1895.25 m^3 water/fed.

Drip irrigation is a highly efficient method of water application, which is also ideally suited for controlling the placement and supply rate of water-soluble fertilizers. Drip irrigation system was used to apply the levels of water stress (quantity of irrigation water applied) in the experiment.

Samples of soil were randomly collected each year before cultivation at a depth of 0 -30 cm in order to measure the important of physical and chemical properties which determined according to (Jackson, 1973). The soil of the experimental field was clay loam in texture. The physical and chemical analyses of soil are shown in Table (1).

Table 1. Physical and chemical analysis properties of the experiment soil.

PH	E.C (dS/ m)	$CaCO_3$ %	Soluble cations(M/L)				Soluble anions(M/L)				Macro elements(ppm)			Micro elements(ppm)			
			Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	CO_3^{-2}	HCO^{-3}	Cl^{-2}	SO_4^{-2}	N	P	K	Fe	Cu	Zn	Mn
7.9	2.54	3.6	6.03	3.97	16.0	0.19	-	2.4	10.3	13.6	81	6.3	58.8	3.0	6.8	2.18	2.17

This study is in concern with the following of two main topics

A. Water stress levels:-

1- WL1 100% of ETo (control) Irrigation with 3790.5 ^{m3} water/fed.

2- WL2 75% of ETo Irrigation with 2842.8 ^{m3} water/fed.

3- WL3 50 % of ETo Irrigation with 1895.25 ^{m3} water/fed

B. Antioxidants treatments:-

1- Ascorbic acid at 100 mg/L.

2- Ascorbic acid at 200 mg/L.

3- Putrescine at 25 mg/L. 4- Putrescine at 50 mg/L.

The experimental design was split-plot with three replicates. The main plots were devoted for three level of water regimes i.e., 100% of ETo (control), 75% of ETo (moderate stress) and 50% of ETo (severe stress), respectively of water requirements of common bean plants in the two seasons while, foliar spraying with ascorbic acid and putrescine were arranged in the sub -plots. Drip irrigation system was used at the rate of 4 L/ h was spaced at 25 cm intervals to apply at the three levels of water. Total water irrigation (m^3/ fed.) was estimated according to the meteorological data of the Central Laboratory for Agricultural Climate, Agricultural Research Center, Ministry of Agriculture, Giza, Egypt under the condition of Qaha Vegetable Research Farm (Qalubia Governorate). The total irrigation of water requirements for bean plants 3790.5 m^3/fed in the same location of soil were taken from the previous study by (Farag, 2012). The water rate 4 L/h discharge with 6 days intervals (water treatments were applied every 6 days) in the two seasons. The irrigation treatments were started after 30 days from seed sowing. All experimental units were received equal amounts of water until the complete germination (15 days from seed sowing date) then irrigation treatments were started in the both seasons. Foliar application of ascorbic acid (AsA) and putrescine (Put) located randomly distributed in the sub-plots treatments. Plants were sprayed with ascorbic acid at the rate of 100 and 200 mg/L and putrescine were sprayed at the rate of 25 and 50 mg/L. and they were sprayed at three times ; 20, 30 and 40 days from sowing date.

Ascorbic acid was used as a commercial product C6 H8 O6 F. W. 176.1 supplied from Sigma Chemical Company.

Seeds of common bean cv. Nebraska were purchased from Horticulture Research institute, Agricultural Research Center and sown in the 1st week on March of 2017 and 2018. The area of experimental plot was 11.2 m^2. Each plot consisted of 4 dripper lines at 4 m in length and 0.7 m in width, seeds were sown with two seeds/ hill at 5 - 7 cm apart on one side of dripper lines. At 15 days from sowing, plants were thinned leaving one plant/ hill.

The basic fertilizers which as phosphorus fertilizer in the form of calcium super phosphate (15.5 % P_2O_5) at the rate 200 kg/fed., ammonium sulfate 21 % N, $(NH_4)_2SO_4$ at the rate of 150 kg/fed., potassium sulfate (50 % K_2O) at the rate of 50 kg/fed. The other agricultural practices were used according to the recommendations of Egyptian Ministry of Agriculture under the conditions of the experimental region.

The following parameters were recorded:

1- Vegetative growth parameters:

five plants of common bean from each treatment were randomly taken at flowering stage; 50 days from sowing date to measure plant height(cm), number of leaves and branches, leaf area (cm^2) as well as total fresh and dry weight(g) of foliage/ plant (leaves and stems). The plant organs of foliage were dried in an electric forced-air oven at 70 °C till constant weight and then the dry weight/plant was evaluated.

2- Dry seed yield and its components:

At full seed ripening stage i.e. 120 days after sowing), 5 plants from each plot were randomly taken to estimate dry seed yield components i.e. number of dry pods/plant, umber of dry seeds/pod, dry seed weight/pod (g), seed index (100 seeds weight g), shell out and dry seed yield (g/plant), while the total dry seed yield /fed was calculated through dry seed yield per plot. While, shell out of dry pods (%) was calculated using the following equation:

$$\textbf{Shell out of dry pods} = \frac{\textbf{Weight of dry seeds}}{\textbf{Weight of dry pods}} = \times 100$$

Water Use Efficiency:

Water use efficiency (WUE) is an indicator of the efficiency of irrigation in increasing dry seed yield common bean. Water use efficiency (Kg_{yield} / $m^3{}_{water}$) was calculated from the following equation (Rahil and Qanadillo, 2015): Water use efficiency is typically defined as the crop yield (Kg_{yield}/ fed.) divided by the amount of water used ($m^3{}_{water}$/ fed.) for each treatment.

$$\textbf{WUE} = \frac{\textbf{Total pods yield (Kg / fed.)}}{\textbf{Total applied of irrigation water (m}^3\textbf{/ fed.)}} = \textbf{Kg/ m}^3$$

3- Chemical composition:-

Chemical composition in common bean leaves:

The total chlorophyll and the free proline content (mg/ 100 g fresh weight) were measured at flowering date; 50 days after sowing in the fresh leaves (random sample of five fresh leaves from the plants top/ plot), and chlorophyll content was determined according to Nagata and Yamashita (1992). Whereas, proline content in leaves dry matter was determined using acidic ninhydrin according to using spectrophotometer according to the method described by Troll and Lindsley (1955).

Chemical constituents in common bean dry seeds:

Common bean seeds were fractionated and sifting then the fine powder (at 0.2 g) of dry sample was digested in a mixture of sulphuric and perchloric acids according to Piper (1947) to estimate total nitrogen in seeds as wet digestion. Total nitrogen (%) was determined by using the modified "MicroKheldahl" method apparatus of Parnas and Wagner as described by Pergl (1945). Phosphorus (%) was estimated in seeds spectrophotometrically using the chloraostannous reduced molybdophosphoric blue color method in sulphuric acid system as described by King (1951). While, K, Ca, Mg, Fe, Mn, Zn and Cu were analyzed by Perkin-Elmer (1100 B) atomic absorption spectrometer.

4-Seed quality:

Common bean dry seeds were treated by Tobsen fungicide then put in filter paper inside germination incubator at 25 C^0 to determine the germination tests i.e. germination ratio (%), germination rate and seedling length according to ISTA rules (ISTA, 2009) as follows:

$$\textbf{Germination \%} = \frac{\textbf{No. of germinated seeds}}{\textbf{No. of sown seeds.}} \times 100$$

Germination Rate (day):

The germinated seeds were counted every day to determine the germination rate and the total index according to Anjum and Bajwa (2005).

$$\textbf{Germination rate} = \frac{\textbf{(G1 xN1) + (G2 x N2) + ...(Gn x Nn)}}{\textbf{G1 + G2 + ...Gn}}$$

Where,

G = Number of germinated seeds in certain day,

N = number of the certain day.

5-Statistical analysis:

All obtained data of the present study was subjected to the analysis of variance techniques according to the design used by the MSTATC computer software program variance and mean of treatments were compared according to the Least Significant Differences (L. S. D.) test at the 0.05 probability level, method described by (Bricker, 1991).

RESULTS AND DISCUSSION

I- Vegetative growth parameters:-

Data registered in Table (2a) exhibited that there were significant differences in the vegetative growth characters of common bean plants under the three irrigation schedule regimes treatments. The maximum vegetative growth characters were recorded by using the full irrigation (100 % of plants irrigation requirements /fed.) followed by the moderate irrigation regime (75 % of irrigation requirements /fed.) then the severe water stress regime (50 %/ fed.). The decrement in all studied growth parameters significantly gained with increasing water stress levels from 75 % to 50 % of water irrigation /fed. The largest reduction in growth characters of common bean plants were observed under severe water stress (50 % /fed.) during the two seasons of this study, that is may be attributed to the main role of water in increasing the absorption of macro and micro nutrients from the soil and in turn affect plant vegetative growth, water is consider the main constituents in photosynthetic process which consequently affect on the amounts of photosynthetic assimilation required for cells and tissues formation and in turn affect all morphological parameters of growing plants. Many investigations agree with this; Abdul-Jaleel *et al.* (2009) who noticed that water stress inhibits cell enlargement more than cell division might be due either to decreases in cell elongation resulting from the inhibiting effect of water shortage on growth and promoting hormones which, in turn, lead to decreases in cell elongation and eventually growth. Water stress conditions cause a marked inhibition in plant photosynthetic efficiency, mainly due to the closing of stomata and inhibition of enzymes. Also, El-Noemani, *et al.* (2010) mentioned that the reduction in number of branches of common bean plants due to the low soil moisture level which may be due to the reduction in the uptake of nutritional elements that caused reduction in the physiological processes needed for plant growth. Furthermore, Eid (2015) showed that increasing water stress levels (50 and 35%) were significantly decreased plant height and number of branches parameters of snap bean plants comparing with full irrigation level (control) at 60 days after sowing in two growing seasons. Marzouk *et al.* (2016) illustrated that snap bean plants receiving 100 % of the potential evapotranspiration reached to the highest plant height, number of leaves and branches per plant. In this concern, the enhanced production of reactive oxygen species during water stress lead to the progressive oxidative damage and ultimately cell death and growth suppression (Ruiz-Lozano *et al.*, 2012). Moreover, Abdel-Aziz and Geeth (2017) working on snap bean and conducted that the maximum vegetative growth characters were recorded with using the full irrigation (100 % of plants irrigation requirements /fed.) followed by the moderate irrigation stress regime (80 % /fed.) then the severe water stress regime (60 %/ fed.).

Table 2a. Vegetative growth of common bean as affected by water stress levels and applied antioxidants during the two seasons of 2017 and 2018.

Seasons	1st Season						2nd Season					
Treatments	Plant height (cm)	No. of leaves/ plant	No. of branches/ plant	Leaf area (cm^2)	Fresh weight (g/plant)	Dry weight (g/plant)	Plant height (cm)	No. of leaves/ plant	No. of branches/ plant	Leaf area (cm^2)	Fresh weight (g/plant)	Dry weight (g/plant)
Water levels												
100% ETo(cont.)	53.84	18.17	4.83	580.7	67.9	23.5	55.84	19.17	5.22	521.7	70.51	23.00
75% ETo	48.27	16.33	4.60	566.1	55.91	15.69	50.40	17.91	5.07	454.1	58.35	15.69
50% ETo	37.323	15.91	4.08	482.4	44.47	13.22	39.06	15.59	3.79	382.4	45.55	13.23
L.S.D at 0.05	2.24	1.53	N.S	42.35	6.15	4.99	1.50	1.39	.071	4.35	3.34	4.99
Foliar application												
Control (Tap water)	39.19	14.06	3.5	364.9	45.57	13.80	41.19	14.67	3.72	364.9	49.04	13.80
Putrscine (25 mg/L)	48.07	17.23	4.55	444.0	64.98	18.45	49.59	18.21	4.65	444.0	65.33	18.45
Putrscine (50 mg/L)	50.09	18.61	5.07	499.1	66.78	21.30	52.32	19.06	5.28	499.1	67.74	21.30
Ascorbic acid(100mg/L)	48.07	18.72	4.77	478.7	63.20	16.88	50.18	18.82	5.01	478.7	64.88	16.88
Ascorbic acid(200mg/L)	47.44	15.39	4.61	475.2	56.57	16.92	48.89	17.02	4.80	475.2	60.01	16.92
L.S.D at 0.05%	2.02	1.86	1.0	31.84	7.58	2.81	1.86	1.59	0.65	31.68	3.82	2.81

As for foliar spraying with antioxidants, results in the same Table (2a) sharply cleared that the foliar application of putrescine and ascorbic acid treatments created significant ascending effects on growth parameters of common bean plants; plant highest, number of leaves and branches, leaf area as well as fresh and dry weight / plant. Putrescine (Diamine) at the rate of (50 mg/ L) was the most effective treatment as compared with the other rate (25 mg/ L) and all the other treatments, the previous result is true during the both seasons. Such increments in plant growth aspects as a result of using the tested antioxidants may be due to the main role of antioxidants on enzymatic reactions in plant metabolism and its role in catching and binding as well as scavenging of the reactive oxygen species (ROS) which affect on plant metabolism and vigor which consequently increased plant growth. Also, the increasing in plant growth traits as a result of using tested antioxidants may attributed to the increasing of photosynthetic pigments and the absorption of mineral nutrients which affect positively on plant growth. These findings are in accordance with, Eid (2015) on common bean found that vegetative growth characters were significantly increased by adding putrescine at 20 mg/L and and ascorbic acid at 200 mg/L during 2012 season. Hosny *et al.* (2015) assumed that the highest values of plant height, number of leaves per plant as well as fresh and dry weights of shoots on snap bean plants were recorded as a result of spraying plants with 400 mg/L of ascorbic acid compared with the control. Abdel-Aziz and Geeth (2017) mentioned that the foliar application of ascorbic acid treatments created significant ascending effects on growth parameters of snap bean plants i.e. plant height, number of branches and dry weight of foliage/ plant. Ascorbic acid was the most effective treatment at the highest dose (200 mg/ L) as compared with the moderate one (100 mg/ L) and the control. Gharib and Hanafy Ahmed (2005) indicated that spraying pea plants with putrescine at 1 or 2 ppm significantly increased plant height and shoot dry weight.

Regarding to the interaction effect between water regimes and foliar spraying with antioxidants treatments on vegetative growth characteristics, all vegetative growth parameters expressed as plant height, number of leaves, leaf area as well as fresh and dry weight/plant were significantly increased among of two studied factors, such data Table (2b) pointed out that all vegetative growth tested were obtained with the most superior treatment by adding the moderate irrigation regime 75 % from plants irrigation requirements /fed. and foliar spray with Putrescine at the rate of (50 mg/ L). On the contrary, the lowest records of the vegetative growth character obtained with the interaction among of adding the water deficient at 50 % /fed. of water regime and foliar spraying with ascorbic acid at 100 mg/ L as compared with the rest of the other interactions treatment. These results reinforced with, Eid (2015) found that there were significantly increase in number of leaves and branches/plant as well as fresh and dry weight per plant with the interaction between water stress levels (50 and 35%) and foliar application with ascorbic acid at 400 mg/L and putrescine at 20 mg/L compared with control and other treatments during the two growing seasons. Hosny *et al.* (2015) proposed that the highest values of all measured growth parameters were recorded as a result of the interaction between irrigation of snap bean plants with 100 % of pan evapotranspiration and spraying with the highest concentration of ascorbic acid at the dose of 400 mg/L. Moreover, Abdel-Aziz and Geeth (2017) on snap bean showed that there were significant interactions effects among of all studied factors and the tallest plants with more branches and the heaviest dry weight of snap bean plants were obtained with the most superior treatment with the moderate irrigation regime 80 % from plants irrigation requirements /fed. and foliar spray with ascorbic acid especially at the highest rate of 200 mg/ L. Furthermore, Qados (2014) decided that the interaction effects induced significant increases of all growth features of soybean plants with an increasing effect at 80 % and 60 % field capacity with foliar application of ascorbic acid at 100 and 200 mg/ L.

Table 2b.Vegetative growth of common bean as affected by the interaction between water stress levels and applied antioxidants during the two seasons of 2017 and 2018.

Seasons		1st Season						2nd Season					
Treatments		Plant height (cm)	No. of leaves/ plant	No. of branches/ plant	Leaf area (cm^2)	Fresh weight (g/plant)	Dry weight (g/plant)	Plant height (cm)	No. of leaves/ plant	No. of branches/ plant	Leaf area (cm^2)	Fresh weight (g/plant)	Dry weight (g/plant)
100% ETo	Control (Tap water)	45.50	15.16	3.83	369.0	54.6	11.9	47.5	16.5	4.5	379.1	58.2	17.9
	Putrscine (25 mg/L)	50.17	17.33	4.17	441.0	70.4	16.0	52.2	18.3	4.4	444.0	73.3	18.2
	Putrscine (50 mg/L)	49.66	17.83	5.00	505.9	74.4	19.2	2.3.0	18.7	5.5	512.2	75.0	21.1
	Ascorbic acid(100 mg/L)	49.00	18.66	5.33	496.8	68.8	14.9	51.0	19.7	5.8	496.2	69.5	18.5
	Ascorbic (acid 200 mg/L)	47.00	16.00	4.66	457.6	61.4	16.4	49.0	16.6	5.2	470.4	65.8	19.4
75% ETo	Control (Tap water)	40.53	13.30	3.50	382.0	49.3	17.0	42.5	14.5	3.6	341.4	53.2	13.8
	Putrscine (25 mg/L)	54.00	19.17	5.33	534.7	75.5	26.6	56.0	20.0	5.3	517.4	73.4	25.8
	Putrscine (50 mg/L)	59.33	20.33	5.66	582.3	75.8	28.8	61.3	21.2	6.1	595.9	78.5	30.3
	Ascorbic (acid 100 mg/L)	57.33	20.66	4.83	548.6	73.6	22.9	59.3	21.8	5.7	555.0	76.2	26.2
	Ascorbic (acid 200 mg/L)	58.00	17.33	4.83	555.8	65.4	22.1	60.0	18.4	5.3	542.5	68.2	25.1
50% ETo	Control (Tap water)	31.53	13.66	3.17	343.7	32.9	12.5	33.5	13.0	3.0	301.3	35.8	9.3
	Putrscine (25 mg/L)	38.61	15.20	4.16	356.2	49.1	12.7	40.6	16.3	4.2	362.1	47.3	12.3
	Putrscine (50 mg/L)	41.27	17.66	4.56	409..1	50.2	15.9	43.3	17.3	4.3	420.5	49.7	17
	Ascorbic (acid 100 mg/L)	37.80	16.83	4.16	390.8	47.2	12.9	40.2	15.3	3.6	389.5	48.9	15.9
	Ascorbic (acid 200 mg/L)	37.33	16.20	4.33	412.2	42.9	12.2	37.7	16	3.9	395.7	46.0	15.2
L.S.D at 0.05%		3.50	3.12	1.72	56.92	12.66	5.46	3.11	2.84	1.13	56.92	6.43	5.46

2-Dry seed yield and its components:-

Data in Table (3a) showed the effect of water irrigation regimes; 100 %, 75 % and 50 % from plants irrigation requirements/ fed. on dry seed yield and its components measurements such as, number of dry seeds/pod, dry seed weight/pod (g), seed index (100 seeds weight g), shell out and dry seed yield (g/plant) as well as dry seed yield (kg/fed),such data revealed that common bean plants which irrigated with the complete irrigation treatment (100 %/ fed.) lead to the maximum increases on dry seed yield and its components followed with those plant which irrigated with 75 % then 50 % per fed. and led to significantly increased water use efficiency Kg $_{yield}$/ m^3 $_{water}$) as compared with the other treatments. Whereas, the highest water stress level at 50% was the most effective treatment which gave the highest reduction in dry seed yield and its components during the two growing seasons.

These reductions in dry seed yield and its components are mainly related to altered metabolic functions, one of those is reduced synthesis of photosynthesis pigments, these changes in the amount of photosynthetic pigments are closely associated to plant biomass yield (Abdul Jalleel *et al.,* 2009). Also, the reduction in yield and its components due to a decrease in seed set%, which may be attributed to a decrease in the viability of pollen and/or in the receptivity of stigmatic surface or both as reported by (Sakr and El-Metwally, 2009 and Abd-Ellatif, 2012), These results are in line with those obtained by, (El-Tohamy and El-Greadly, 2007; Emam *et al.,* 2010; Abd-Ellatif, 2012 and Philip, 2013) they found that decreasing water level lead to decrease pods yield of snap bean (pod length and diameter, fruit setting%, number of pods/plant and total yield/fed) compared to control plants (100% wl). Eid (2015) who illustrated that water stress level at 35% gave the highest reduction in all yield characteristics of snap bean during 2012 and 2013 as compared with water stress level at 50% and full irrigation level 100% (control).

Table 3a. Dry seed yield and its components of common bean as affected by water stress levels and applied antioxidants during the two seasons of 2017 and 2018.

Seasons	1st Season					2nd Season				
Treatments	**No. of seeds/ pod**	**Seed index 100 seeds wt. (g)**	**Shell out %**	**Dry seed yield (g/plant**	**Dry seed yield (kg/fed)**	**No. of seeds /pod**	**Seed index 100 seeds wt. (g)**	**Shell out %**	**Dry seed yield (g/plant**	**Dry seed yield (kg/fed)**
Water levels 100% ETo (cont.)	4.37	45.84	84.98	26.55	836.8	4.54	46.73	86.19	27.14	842.3
75% ETo	4.0	40.93	84.0	21.30	741.9	4.18	40.22	84.03	22.90	790.6
50% ETo	3.48	34.25	73.48	16.92	644.7	3.62	35.20	83.05	18.38	662.4
L.S.D at 0.05	0.23	1.75	N.S	3.34	62.03	0.16	0.33	2.43	2.49	15.58
foliar application Control (Tap water)	3.62	39.36	82.46	20.45	680.4	3.77	40.08	81.90	20.78	712.2
Putrscine (25 mg/L)	4.03	41.66	84.76	23.17	790.5	4.35	43.62	86.17	24.78	795.6
Putrscine (50 mg/L)	4.36	44.46	86.81	25.32	811.4	4.55	45.60	87.25	27.11	813.3
Ascorbic acid (100 mg/L)	4.05	41.31	84.40	22.77	756.6	4.00	43.23	86.44	23.78	775.1
Ascorbic acid (200 mg/L)	4.15	41.55	84.85	22.88	666.7	4.33	42.71	85.33	24.24	779.3
L.S.D at 0.05	0.38	2.46	2.59	2.90	116.3	0.19	1.52	1.56	2.45	25.47

With regard to foliar application with antioxidants, It is discernible from the data in the same Table (3a) that, the most pronounced effects on dry seed yield of common bean plants, were achieved by the foliar application of putrescine at the rate of 50 mg/L followed by ascorbic acid at the highest rate of 200 mg/ L compared with the other treatments or the control. This positive effect of ascorbic acid on dry seed yield and its components may be attributed to its role as a cofactor for enzymes involved in photosynthesis, hormone biosynthesis and the regeneration of antioxidants (Gallie, 2012). Barky *et al.* (2013). In addition, such increases effects of ascorbic acid on dry seed yield and its components in this results may be attributed to their roles in enhancing many physiological and developmental processes in plant including cell division reproductive organ development, floral initiation and development pollen fertility, flowering and fruit development and ripening leaves senescence and a biotic stress (Alcazar *et al.,* 2010 and Ahmad *et al.,* 2012).

These conclusions are confirmed with the results of those Eid (2015) on snap bean indicated that the highest increment of dry seed yield parameters were existed with adding putrescine at 20 mg/L followed by ascorbic acid at 400 mg/L. Also, Hosny *et al.* (2015) proved that spraying snap bean plants with ascorbic acid at the rate of 400 mg/ L increased seed number, weight of pods, pod length, pod diameter per plant and total yield/ fed. when compared with the control treatment.

Concerning to the interaction effect among different water stress levels and foliar application with antioxidants treatments on dry seed yield and its components on common bean, the results are at Table (3b) further proved that irrigation schedule regime (75 %) from plants irrigation requirements /fed. and foliar spraying with putrescine at 50 mg/L was the best interaction treatment which produced the highest means values over the other two interactions treatments which gave the best characters. On the contrast, the lowest records on yield and its components was obtained with the interaction treatment between water deficient at 50 %/ fed. and foliar spraying with ascorbic acid at 100 mg/ L. Furthermore, the increases in common bean yield and its components and water use efficiency may be due to the role of putrescine in counteracted the harmful effects of water stress especially with the highest dose of 50 mg/ L. In addition, increasing volume applied at 100 % from plants irrigation requirements of plants means, decreasing in the concentration of nutrients in the root zone and also, applied 75 %/ fed. is the best case conditions, these conditions decreased from water stress or drought stress and also, achieved excellent distribution for nutrients inside root zone. While at 50% it can get the lowest water stress but not achieve excellent distribution for nutrients inside root zone because of increasing leaching rate with increasing volume of applied water. This increased in the pod yield can be explained by the significant increases due to the greatest values of the vegetative growth characters as well as the superior pod quality and number of pods/ plant as mention before in Tables (2 and 3) during the two growing seasons. ascorbic acid counteracted the harmful effects of water stress on yield may be attributed to an increase in stomatal conductance and net photosynthetic CO_2-fixation activity under water stress and also, to its role as an antioxidant, a cofactor for enzymes involved in photosynthesis and hormone biosynthesis (Gallie, 2012). These results are further supported by In this respect, Hosny *et al.* (2015) illustrated that there were significant interaction effects between water stress level at 50 % and foliar spraying with ascorbic acid on snap bean plants at 400 mg/L, which gave the highest length, diameter of pods, number and weight of pods/ fed. Moreover, Eid (2015) working on common bean and mentioned that the highest increase of yield characteristics were existed with putrescine at 20 mg/L followed by ascorbic acid at 400 mg/L under water stress level at 50 and 35% when compared with untreated plants and other treatments during the two growing seasons. Qados (2014) found that the interaction effects between water stress and foliar application of ascorbic acid at 200 mg/ L tended to reverse the negative effect of water stress and increased the yield of soybean plants.

Table 3b. Dry seed yield and its components of common bean as affected by the interaction between water stress levels and applied antioxidants during the two seasons of 2017 and 2018.

Seasons / Treatments		1st Season					2nd Season				
		No. of seeds /pod	Seed index 100 seeds wt. (g)	Shell out	Dry seed yield (g/plant)	Dry seed yield (kg/fed)	No. of seeds/ pod	Seed index 100 seeds wt. (g)	Shell out	Dry seed yield (g/plant)	Dry seed yield (kg/fed)
100% ETo	Control (Tap water)	4.0	44.0	84.2	24.3	728.8	4.7	46	83.7	25.1	792
	Putrscine (25 mg/L)	4.4	45.2	85.1	25.6	817.2	4.8	47.7	87.9	27.2	832.7
	Putrscine (50ml/L)	4.4	46.1	86.4	27.2	830	5.0	50	88.5	29.2	847.4
	Ascorbic acid(100ml/L	4.1	44.9	86.1	25.2	798.1	4.9	47	88.1	26.6	815
	Ascorbic acid(200ml/L)	4.4	44.4	85.2	24.3	760.8	4.8	45.4	86.9	26.5	811.1
75% ETo	Control (Tap water)	3.8	42.4	82.5	22.7	713.8	4.1	40.9	80.8	22.1	722.6
	Putrscine (25 mg/L)	4.2	46.7	85.3	26.6	898	4.5	48.8	87.1	28.7	882
	Putrscine (50ml/L)	4.8	50.3	87.3	29.4	919.4	4.9	49.6	89	30.1	900.1
	Ascorbic acid(100ml/L)	4.5	44.6	85.1	26.4	827.1	4.6	47.5	87.3	27	845
	Ascorbic acid(200ml/L)	4.5	45.1	84.6	27.9	825.5	4.6	46.8	86.7	27.9	861.7
50% ETo	Control (Tap water)	3.0	31.7	80.7	14.4	598.6	3.3	33.3	81.2	15.2	617.5
	Putrscine (25 mg/L)	3.4	33.1	83.8	17.3	656.4	3.8	34.3	83.4	18.5	672.1
	Putrscine (50ml/L)	3.8	37	86.7	19.3	684.8	3.8	37.2	84.2	22	692.2
	Ascorbic acid(100ml/L)	3.6	34.3	82	16.7	644.4	3.7	35.1	83.9	17.8	664.9
	Ascorbic acid(200ml/L)	3.6	35.1	84.2	16.9	639.3	3.6	35.9	82.4	18.4	665.1
	L.S.D at 0.05	0.63	4.06	4.93	5.07	189.1	0.33	2.43	2.92	4.21	41.7

3- Chemical composition:-

Chemical composition in common leaves:

Regarding to the results of the chemical composition of common bean leaves presented in the Table (4a) as affected by different water regimes indicated that the highly significant values occurred in common bean leaves received the full irrigation treatment (100 % from plants irrigation requirements /fed.) gave the highest amount of chlorophyll and proline content % achieved in common bean leaves but under the highest severe of water stress (50 %/ fed.) chlorophyll and proline tended to decrease. The accumulation of proline and amino acids in the cytoplasm plays an important role in the osmotic balance of plants and are good indicators of tolerance. Naresh *et al.* (2013) found that the increase of free proline under decrease of water supply in mung bean plants extensively protects cell membrane and protein content in plant leaves suggests an excellent mechanism to mitigate the injurious effect of water stress. Amount of proline was increased under the middle drought stress only because of proline is a key in osmosis regulation. Increasing the amount of proline and sugars in the plants would lead to the resistance against loose water, reduce the membrane damage and accelerate the growth of *Satureja hortensis* plants under stress conditions (Yazdanpanah *et al.*, 2011). In this concern, Furthermore, Abdel-Aziz and Geeth (2017) showed that the highly significant values of proline and chlorophyll content in leaves obtained when snap bean plants received the complete irrigation treatment (100 % from plants irrigation requirements /fed.). On the other side, Qados (2014) showed that the most decrease in the concentration of photosynthetic pigments i.e. total chlorophyll, as a result of drought stress reduced the uptake of nitrogen, phosphorus and potassium content % under the condition of 40 % (field capacity) of soybean plants. Marzouk *et al.* (2016) generalized that subjected the common bean plants to the three water levels (100, 80, and 60 % of the potential evapotranspiration) led to significant increasing in chlorophyll content and fibers content % at full irrigation (100 %) treatment. It was found that the reduction of the previous characters under decreasing water regimes from 80 % to 60 % per fed. and the highest reduction in pod quality pronounces in the level of 60 % per fed.

Table 4a. Chlorophyll and proline content in common bean leaves as affected by water stress levels and applied antioxidants during the two seasons of 2017 and 2018.

Seasons / Treatments	1st Season		2nd Season	
	Total chlorophyll (mg/ 100 g F. W)	Proline content (%)	Total chlorophyll (mg/ 100 g F. W)	Proline content (%)
Water levels100% ETo (cont.)	53.51	0.542	54.58	0556
75% ETo	47.75	0.477	47.48	0.488
50% ETo	35.63	0.364	39.63	0.387
L.S.D at 0.05	3.48	0.12	1.35	0.23
foliar applicationControl (Tap water)	37.69	0.381	38.53	0.392
Putrscine (25 mg/L)	41.77	0.471	42.21	0.486
Putrscine (50 mg/L)	45.98	0.490	47.09	0.510
Ascorbic acid (100 mg/L)	43.17	0.473	43.38	0.481
Ascorbic acid (200 mg/L)	42.89	0.466	43.77	0.483
L.S.D at 0.05	3.53	0.20	2.25	0.21

concerning to the spraying putrescine and ascorbic acid treatments under this investigation on chemical composition of common bean leaves, the results presented in such Table (4a) showed that, foliar spraying with putrescine at the rate of 50 mg/L followed by ascorbic acid at the highest rate of 200 mg/ L. significantly increased chlorophyll and proline content in leaves compared with the other treatments or the control. These results are come to the same conclusion by Gallie (2012) illustrated that ascorbic acid maintains a cation-anion balance in plant tissues by stabilizing cell membranes at high external abiotic stress. In this concern, ascorbic acid can mitigate the adverse effects of drought through increasing the content of IAA and GA_3 which may be involved in protecting the photosynthetic apparatus and consequently increasing the photosynthetic pigments in common bean plants, (Saeidi-Sar *et al.*, 2013). Also, Hosny *et al.* (2015) demonstrated that spraying snap bean plants with ascorbic acid at 400 mg/L increased chlorophyll a, b, carotenoids compared with the control. Moreover, Abdel-Aziz and Geeth (2017) reported that, foliar spraying with the aqueous solution of ascorbic acid lead to significant increases of all chemical composition in the leaves especially, proline and chlorophyll content when ascorbic acid sprayed at the highest rate of 200 mg/ L as compared with the moderate or control.

On the other hand, Eid (2015) on snap bean found that increasing water stress levels from 50 to 35% were decreased concentration of photosynthetic pigments (i.e., chlorophyll a, b and carotenoids) gradually in leaves and green pods of snap bean plants comparing with full irrigation level (100%).

As for the effect of the interactions effect between water regimes and foliar spraying with antioxidants treatments on proline and chlorophyll content in common bean leaves, there were significantly increased effects among of two studied factors, data in Table (4b) indicated that the most superior treatment by adding the moderate irrigation regime 75 % from plants irrigation requirements /fed. and foliar spraying with Putrescine at the rate of (50 mg/ L) significantly increased the total chlorophyll (mg/ 100 g) and proline content in common bean leaves as compared with other studied treatments. These conclusions are agreed with the results of those Khan *et al.* (2011) stated that the positive effects of ascorbic acid in the counteraction of the adverse effects of water stress are the stabilization and protection of the photosynthetic pigments and the photosynthetic apparatus from oxidization. Moreover, ascorbic acid stimulated proline accumulation

n water stressed plants. Increasing the amount of proline and sugars in the plants would lead to the resistance against loose water, protect turgor, Saeidi-Sar *et al.* (2013) found that exogenous supply of ascorbic acid enhanced chlorophyll concentration under the condition of water-stressed in common bean plants. These increases were attributed to the positive effect of ascorbic acid on the root growth, which consequently increased the absorption of different nutrients and alleviated the harmful effects of water stress. Also, its increasing nutrient uptake, elements content such as nitrogen, phosphorous and potassium. Eid (2015) indicated that all the interactions effect between water stress levels and applied treatments were increased the concentration of chlorophyll a, b and carotenoids in both leaves. Hosny *et al.* (2015) concluded that significant increases were obtained on the concentrations of chlorophyll a, b as a result of the interaction between irrigation snap bean plants under water regime levels of 50 and 35 % of pan evapotranspiration and spraying with the highest concentration of ascorbic acid at the dose of 400 mg/L. Also, Abdel-Aziz and Geeth (2017) mentioned that irrigated plants with 80 % from plants irrigation requirements /fed. and spraying ascorbic acid at 200 (mg/ L) increased the total chlorophyll (mg/ 100 g fresh weight).

Table 4b.Chlorophyll and proline content in common bean leaves as affected by the interaction between water stress levels and applied antioxidants during the two seasons of 2017 and 2018.

Seasons		1st Season		2nd Season	
Treatments		Total chlorophyll (mg/ 100 g F. W)	Proline content (%)	Total chlorophyll (mg/ 100 g F. W)	Proline content (%)
100% ETo	Control (Tap water)	41.36	3.88	42.47	3.81
	Putrscine (25 mg/L)	43.96	4.23	45.43	4.38
	Putrscine (50ml/L)	45.23	4.79	47.17	4.73
	Ascorbic acid (100 ml/L)	43.80	4.61	44.46	4.66
	Ascorbic acid (200 ml/L)	43.20	4.56	43.37	4.60
75% ETo	Control (Tap water)	38.90	3.53	39.46	3.44
	Putrscine (25 mg/L)	44.83	5.00	44.86	5.10
	Putrscine (50ml/L)	54.66	5.12	54.33	5.23
	Ascorbic acid (100 ml/L)	49.50	4.44	48.20	4.52
	Ascorbic acid (200 ml/L)	50.83	4.51	50.53	4.48
50% ETo	Control (Tap water)	32.80	3.21	33.66	3.18
	Putrscine (25 mg/L)	36.50	3.68	36.33	3.60
	Putrscine (50ml/L)	38.03	3.76	39.76	3.71
	Ascorbic acid (100 ml/L)	36.20	3.66	37.46	3.56
	Ascorbic acid (200 ml/L)	34.63	3.70	37.43	3.62
L.S.D at 0.05		6.03	0.32	3.76	0.36

Chemical constituents in common bean dry seeds:

The differences between the three levels regimes of water on Chemical constituents in common bean dry seeds are presented in Table (5a), such data showed that macro elements; N, P, K, Mg and Ca and micro elements (Fe, Cu, Zn and Mn) of dry seeds were increased by the full level of water (100%) as compared with other water regimes. Such data also showed that the increment of the all studied elements were significant in both experimental seasons. These results coincided with those reported by Naresh *et al.* (2013), Qados (2014) and Eid (2015) all working on common bean and pointed out that the full level in water led to significant increase in N, P, and K content in seeds. Also, Marzouk *et al.* (2016) generalized that subjected the snap bean plants to the three water levels (100, 80, and 60 % of the potential evapotranspiration) led to significant increasing in pod quality i.e. protein content % at full irrigation (100 %) treatment.

Concerning with the effect of foliar spraying by putrescine and ascorbic acid treatments under this investigation on chemical composition of common bean dry seeds, data Table (5a) showed that, foliar spraying common bean plants with putrescine as the rate of 50 mg/L lead to significant increases of all chemical composition in common bean dry seeds; N, P, K, Mg and Ca and micro elements (Fe, Cu, Zn and Mn) of dry seeds followed by spraying common bean plants ascorbic acid at the rate of 200 mg/L as compared with the other treatments. These results are come to the same conclusion by Gallie (2012) suggested that, one of the main roles of ascorbic acid is to maintain a cation-anion balance in plant tissues by stabilizing cell membranes at high external abiotic stress. In this concern, ascorbic acid can mitigate the adverse effects of drought through increasing the content of IAA and GA_3 and decreasing ABA level, which may be involved in protecting the photosynthetic apparatus and consequently increasing the photosynthetic pigments in common bean plants, (Saeidi-Sar *et al.*, 2013). Hosny *et al.* (2015) demonstrated that spraying common bean plants with ascorbic acid at 400 mg/L increased nitrogen, phosphorus and potassium and crude protein in pods compared with the control.

Table 5a. chemical constituents (%) of common bean seeds as affected by water stress levels and applied antioxidants during the first season 2017.

Seasons	1st Season 2017								
Treatments	N	P	K	Ca	Mg	Fe	Mn	Zn	Cu
Water levels100% ETo (cont.)	4.38	091	1.68	1.87	0.37	6.36	4.13	4.06	4.87
75% ETo	3.56	0.73	1.58	1.77	0.37	6.37	4.09	4.11	4.72
50% ETo	3.02	0.55	1.57	1.51	0.29	6.18	3.87	3.94	4.41
L.S.D at 0.05	0.19	0.15	0.06	0.23	0.05	0.06	0.24	0.06	0.06
foliar application Control (Tap water)	2.87	0.52	1.28	1.44	0.21	578	3.35	3.35	4.13
Putrscine (25 mg/L)	3.33	0.68	1.65	1.68	0.37	6.32	3.82	3.84	4.70
Putrscine (50 mg/L)	3.68	0.76	1.78	1.85	0.46	6.53	4.51	4.43	4.83
Ascorbic acid (100 mg/L)	3.41	0.67	1.66	1.80	0.35	6.44	4.13	4.30	4.56
Ascorbic acid (200 mg/L)	3.32	0.68	1.70	1.80	0.34	6.46	4.35	4.27	4.71
L.S.D at 0.05	0.33	0.1	0.30	0.14	0.07	0.12	0.15	0.1	0.19

Table 5a. chemical constituents (%) of common bean seeds as affected by water stress levels and applied antioxidants during the second season 2018.

Seasons	2nd Season 2018								
Treatments	N	P	K	Ca	Mg	Fe	Mn	Zn	Cu
Water levels 100% ETo (cont.)	4.48	0.75	1.71	1.86	0.40	6.73	43	4.36	4.74
75% ETo	3.54	0.76	1.70	1.87	0.41	6.33	4.13	4.07	4.82
50% ETo	3.36	0.64	1.59	1.69	0.32	6.16	3.96	3.84	4.54
L.S.D at 0.05	0.20	0.03	0.03	0.05	0.02	0.03	0.03	0.17	0.1
foliar application Control (Tap water)	2.74	048	1.36	1.52	0.26	5.65	3.42	3.33	4.17
Putrscine (25 mg/L)	3.40	0.69	1.70	1.82	.038	6.31	3.85	3.86	4.72
Putrscine (50 mg/L)	3.86	0.85	1.80	1.94	0.45	6.54	4.41	4.35	4.97
Ascorbic acid (100 mg/L)	3.77	0.77	1.73	1.89	0.41	6.46	4.36	4.18	4.84
Ascorbic acid (200 mg/L)	3.53	0.81	1.75	1.86	0.39	6.44	4.3	425	4.81
L.S.D at 0.05	0.24	0.04	0.04	0.08	0.02	0.05	0.08	0.1	0.15

Regarding to the effect of the interactions effect between water regimes and foliar spraying with antioxidants treatments application on N, P, K, Mg and Ca and micro elements (Fe, Cu, Zn and Mn) of common bean dry seeds, data in Table (5b) indicated that there were significant interactions among of all the treatments, such results indicated that the superiority combined treatment was by irrigated plants with 75 % from plants irrigation requirements /fed. and received putrescine at the rate of 50 mg/L which increased the total studied elements. i.e. macro and micro elements content % in dry seeds and able to rise the snap bean pods quality. (Gallie, 2012). Saeidi-Sar *et al.* (2013) found that exogenous supply of ascorbic acid enhanced potassium concentration under the condition of water-stressed in common bean plants. These increases were attributed to the positive effect of putrescine on the root growth, which consequently increased the absorption of different nutrients and alleviated the harmful effects of water stress. Also, its increasing nutrient uptake, elements content such as nitrogen, phosphorous and potassium. Hosny *et al.* (2015) concluded that significant increases were obtained on the concentrations of nitrogen, phosphorus, potassium and crude protein in dry seeds content as a result of the interaction between irrigation snap bean plants under water regime levels of 50 and 35 % of pan evapotranspiration and spraying with the highest concentration of ascorbic acid at the dose of 400 mg/L. Reza *et al.* (2013) proved that the interaction between water regime and foliar application putrescine was significant effect to produce the highest total N,P and K content of soybean plants.

Table 5b. Chemical constituents (%) of common bean seeds as affected by the interaction between water stress levels and applied antioxidants during the first season 2017.

Seasons		1st Season 2017								
Treatments		N	P	K	Ca	Mg	Fe	Mn	Zn	Cu
100% ETo	Control (Tap water)	2.66	0.57	1.38	1.64	0.26	5.90	3.47	3.49	4.38
	Putrscine (25 mg/L)	3.33	0.72	1.76	1.85	0.36	6.33	3.89	3.86	4.71
	Putrscine (50ml/L)	3.80	081	1.89	1.89	0.46	6.56	4.52	4.39	4.85
	Ascorbic acid (100ml/L	3.70	0.71	1.76	1.97	0.39	6.50	4.30	4.30	4.68
	Ascorbic acid (200ml/L	3.40	.73	1.81	1.94	0.39	6.50	4.46	4.27	4.77
75% ETo	Control (Tap water)	3.37	0.54	1.30	1.45	0.21	5.81	3.36	3.35	4.10
	Putrscine (25 mg/L)	3.45	0.73	1.67	1.78	0.40	6.41	3.90	3.94	4.83
	Putrscine (50ml/L)	3.93	0.83	1.92	1.97	0.54	6.66	4.60	4.60	5.00
	Ascorbic acid (100ml/L	3.53	0.76	1.74	1.79	0.37	6.43	4.17	4.37	4.82
	Ascorbic acid (200ml/L	3.53	0.73	1.80	1.83	0.33	6.55	4.45	4.33	4.88
50% ETo	Control (Tap water)	3.57	0.44	1.17	1.23	0.15	5.66	3.23	3.20	3.91
	Putrscine (25 mg/L)	3.20	0.58	1.51	1.41	0.33	6.22	3.66	3.73	4.55
	Putrscine (50ml/L)	3.30	0.6	1.54	1.68	0.38	6.36	3.40	4.33	4.64
	Ascorbic acid (100ml/L	3.00	0.55	1.48	1.62	0.31	6.38	3.94	4.24	4.47
	Ascorbic acid (200ml/L	3.03	0.57	1.48	1.60	0.31	6.32	4.14	4.23	4.51
	L.S.D at 0.05	0.54	0.18	0.1	0.26	0.12	0.19	0.29	0.16	0.32

Table 5b. Chemical constituents (%) of common bean seeds as affected by the interaction between water stress levels and applied antioxidants during the second season 2018.

Seasons		2nd Season 2018								
Treatments		N	P	K	Ca	Mg	Fe	Mn	Zn	Cu
100% ETo	Control (Tap water)	2.79	0.54	1.94	1.62	0.32	5.81	3.53	3.48	4.30
	Putrscine (25 mg/L)	3.40	0.72	1.72	1.87	0.38	6.37	3.84	3.90	4.72
	Putrscine (50ml/L)	3.94	0.87	1.82	1.99	0.46	6.55	4.43	4.42	5.00
	Ascorbic acid (100ml/L	3.77	0.8	1.77	1.92	0.42	6.48	4.37	4.24	4.86
	Ascorbic acid (200ml/L	3.50	0.83	1.81	1.90	0.40	6.46	4.32	4.27	4.85
75% ETo	Control (Tap water)	2.70	0.48	1.33	1.51	0.26	5.64	3.41	3.30	4.17
	Putrscine (25 mg/L)	3.50	0.72	1.74	1.85	0.42	6.34	3.98	3.96	4.88
	Putrscine (50ml/L)	3.94	0.92	1.86	2.05	0.52	6.65	4.49	4.53	5.16
	Ascorbic acid (100ml/L	3.89	0.83	1.77	1.97	0.45	6.55	4.41	4.28	4.96
	Ascorbic acid (200ml/L	3.68	0.86	1.79	1.95	0.42	6.51	4.37	4.32	4.92
50% ETo	Control (Tap water)	2.72	0.44	1.28	1.44	0.21	5.50	3.31	3.21	4.03
	Putrscine (25 mg/L)	3.31	0.62	1.63	1.72	0.32	6.22	3.72	3.70	4.57
	Putrscine (50ml/L)	3.71	0.75	1.72	1.79	0.38	6.40	4.31	4.11	4.75
	Ascorbic acid (100ml/L	3.63	0.70	1.66	1.77	0.35	6.35	4.29	4.03	4.69
	Ascorbic acid (200ml/L	3.42	073	1.66	1.73	0.35	6.38	4.22	4.16	4.65
	L.S.D at 0.05	040	0.1	0.1	0.14	0.03	0.08	0.13	0.19	0.25

4- Seed Quality:

Concerning with the behavior of seed germination tests i.e. seed germination ratio (%), germination rate (days) and sprout length (cm) as affected by the common bean three levels regimes of water, Data Table (6a) illustrated that seed germination ratio (%) and germination rate (days) and sprout length (cm) were increased by the complete level of water (100%) as compared with the other treatments. this increment were significant in both experimental seasons.

Table 6a. Germination ratio (%) , germination rate(days) and sprout length(cm) of common bean dry seeds as affected by water stress levels and applied antioxidants during the two seasons of 2017 and 2018.

Seasons	1st Season			2nd Season		
Treatments	Germination ratio%	Germination rate(days)	Sprout length(cm)	Germination ratio%	Germination rate(days)	Sprout length(cm)
Water levels 100% ETo (cont.)	95.9	3.2	27.4	96.1	3.1	29.1
75% ETo	92.5	2.9	28.0	92.9	2.8	27.6
50% ETo	84.1	4.0	19.2	85.2	3.9	20.5
L.S.D at 0.05	2.05	0.4	3.3	1.82	0.34	2.4
foliar application Control (Tap water)	85.8	3.9	21.0	88.2	3.7	23.4
Putrscine (25 mg/L)	92.0	3.2	25.8	91.8	3.3	25.7
Putrscine (50 mg/L)	94.7	3.1	26.7	94.6	3.0	28.4
Ascorbic acid (100 mg/L)	89.1	3.3	25.2	89.6	3.2	24.8
Ascorbic acid (200 mg/L)	92.7	3.4	25.7	92.8	3.3	26.2
L.S.D at 0.05	2.31	0.4	2.63	1.87	0.21	2.4

As for the influence of some foliar application with antioxidants; putrescine and ascorbic acid on seed germination ratio (%), germination rate (days) and sprout length (cm), It is clear from the data in the same Table (6a) that, the application of putrescine at the rate of 50 mg/L followed by ascorbic acid at the highest rate of 200 mg/ L gave the highest seed quality as compared with the other treatments or the control. This positive effect of putrescine and ascorbic may be attributed to its role as a cofactor for enzymes involved in photosynthesis, hormone biosynthesis and the regeneration of antioxidants which led to increment of seed germination ratio and rateAccording to the interaction effect of the interactions effect between water regimes and foliar spraying with antioxidants treatments on seed germination ratio (%), germination rate (days) and sprout length(cm), data in Table (6b) indicated that there were significant interactions among of all the treatments, the results indicated that the superiority combined treatment was by irrigated plants with 75 % from plants irrigation requirements /fed. and received putrescine at the rate of 50 mg/L which increased seed germination ratio (%) and germination rate (days) as compared with the studied treatments.

Table 6b. Germination ratio (%) , germination rate(days) and sprout length(cm) of common bean dry seeds as affected by the interaction between water stress levels and applied antioxidants during the two seasons of 2017 and 2018.

Seasons		1st Season			2nd Season		
Treatments		Germination ratio%	Germination rate(days)	Sprout length(cm)	Germination ratio%	Germination rate(days)	Sprout length(cm)
100% ETo	Control (Tap water)	94	3.6	26.0	94.7	3.5	29.7
	Putrscine (25 mg/L)	96	3.2	27.7	96.0	3.2	28.7
	Putrscine (50ml/L)	98	2.9	28.0	98.3	2.8	30.7
	Ascorbic acid(100ml/L	98.3	3.2	27.3	93.7	3.1	28.3
	Ascorbic acid(200ml/L	98	3.1	28.0	97.7	3.0	28.0
75% ETo	Control (Tap water)	83.3	3.5	19.3	88.0	3.5	22.7
	Putrscine (25 mg/L)	94	2.8	29.3	92.7	2.7	27
	Putrscine (50ml/L)	100	2.5	31.7	98.7	2.4	32.7
	Ascorbic acid(100ml/L	91.3	2.9	29.0	90.3	2.6	25.7
	Ascorbic acid(200ml/L	94	3.2	30.7	94.7	2.9	30.0
50% ETo	Control (Tap water)	80.0	4.5	17.7	82	4.1	18
	Putrscine (25 mg/L)	86.0	3.7	20.3	86.7	3.9	21.3
	Putrscine (50ml/L)	86.0	3.9	20.3	86.7	3.8	22.0
	Ascorbic acid(100ml/L	82.7	3.9	19.3	84.7	3.9	20.3
	Ascorbic acid(200ml/L	86.0	4.0	18.3	86.0	3.9	20.7
	L.S.D at 0.05	3.9	0.63	4.7	3.2	0.39	4.04

CONCLUSIONS

it could be concluded that, under the conditions of this study, it can be recommended that cultivate common bean plants cv. Nebraska for local or export marketing irrigated with the appropriate schedule water regime at 75 % from plants irrigation requirements/ fed. with foliar application of putrescine at the rate of 50 mg/L to obtain the highest values in the vegetative growth character, total dry seed yield (kg/ fed.) and its components, water use efficiency and best dry seed quality as well as it is very important for saving a part of the irrigation water (about 25 %) especially under the condition of water stress or drought.

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تأثيرالرش ببعض مضادات الاكسده علي النمو والمحصول البذري الجاف والمكونات الكيميائيه لنباتات الفاصوليا الناميه تحت مستويات اجهاد مائي

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اجريت هذه الدراسه الحقليه بمزرعه بحوث الخضر بقها – محافظه القليوبيه التابعه لمعهد بحوث البساتين- مركز البحوث الزراعيه- جمهوريه مصر العربيه خلال الموسمين الصيفين 2017 و 2018علي الفاصوليا صنف نبراسكا.وقد كان الهدف من الدراسه هو دراسه تأثير اضافه مضادات الاكسده وهي عباره عن حامض الاسكوربيك بمعدل 100,200ميللي جرام /لتر و البتروسين بتركيز 25 و 50 ميللي جرام /لتر وذلك تحت ظروف ثلاث مستويات من الاجهاد المائي 100% (الكنترول), 75% (مستوي معتدل للري), 50%(مستوي الاجهاد المائي) علي التوالي من الاحتياجات المائيه للفاصوليا والتداخل بين المعاملات وتأثير ذلك علي صفات النمو الخضري والمحتوي الكيميائي لبذور الفاصوليا وايضا المحصول البذري الجاف ومكوناته. وقد صممت التجربه بتصميم القطع المنشقه مره واحده حيث وزعت مستويات الري في القطع الرئيسيه بينما وزعت معاملات الرش بمضادات الاكسده في القطع المنشقه. وقد اظهرت النتائج المتحصل عليها ان ري نباتات الفاصوليا بمعدل 100 % منفردا بدون رش مضادات اكسده اعطي اعلا النتائج من الري بمعدل 75 او 50 % وقد كانت افضل النتائج عند ري الفاصوليا بمعدل 75% مع الرش بالبتروسين بتركيز 50 ميللي جرام /لتر وذلك مقارنه بباقي المعاملات او الكنترول(بدون رش) حيث ادت هذه المعامله الي زياده جميع صفات النمو الخضري وقياسات المحصول البذري الجاف ومكوناته للفاصوليا كما ادت ايضا الي زياده المحتوي الكيميائي للبذور. كما ادت ابضا الي توفير مياه الري بمعدل 25% خاصه تحت ظروف الاجهاد المائي او الجفاف.