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SOME FOLIAR APPLICATIONS FOR IMPROVING SNAP BEAN (*Phaseolus vulgaris*, L.) QUALITY AND YIELD AT FALL SEASON.

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ABSTRACT

Understanding the impact of ambient environmental condition is a concern for agricultural production. This work was undertaken to study the responses of two snap bean cultivars ($Giza_3$ and Bronco) to some stimulant substances, i.e., Cu- EDTA 8% Cu 1 ml/l; Mg-EDTA/Cit 10% Mg, 5ml/l and Fe-EDTA/Cit 10% Fe, 2ml/l in chelated forms, Ca-citrate 25% Ca, 2.5ml/l and KP/AA, 45/33.2 K_2O, P_2O_5, 8.2% amino acids, 2.5ml/l; yeast extract, 25ml/l; seaweeds extracts, 5 ml/l and amino acids, 5ml/l as a foliar applications, throw two experiments conducted at El-Baramoon Res. Station, El-Dakahllia Governorate, Hort. Res. Inst. during the fall seasons of 2006 and 2007. Previous information showed that Bronco cv. display a physiological disorder at fall season (pale color of pods) which in turn negatively affects the economical value for the exportation of product, thereby, this work was suggested to improve yield and qualities, as well as growth and pigments of leaves and pods of snap bean plants, growing under abiotic stress conditions of fall season.

Results indicated that Bronco cv. surpassed Giza3 in most vegetative growth parameters. Also, chlorophyll a and b of leaves, as well as pod chlorophyll a, b and TSS showed the same trends as vegetative growth aspects, though; Giza3 had the greatest concentrations of leaf and pod carotenoids in the two seasons. In addition, the highest number of pods/plant and consequently fresh pod yield were collected by Bronco plants. in the two seasons. On the other hand, the tallest, thickness and heaviest pod were gathered from Giza3 plants. The enhanced yield was associated with pod performance and number of pods/plant, regarding genotype responses under such condition.

The applied treatments differed among them and were superior the control in all characteristics. The best applications with the two bean cvs. in most cases were Cu + Mg + Fe combination, KPaa, Mg, Fe, yeast, Ca, Cu. seaweeds extract and at least amino acids respectively, these increased the yield over control by, 24.8, 18.4, 17.3, 16.8, 13.7, 13, 12.1, 10.8 and 8.8% (mean of two seasons) respectively.

It can be concluded that sprayed snap bean plants with the combination between Cu 0.5ml/l (Cu- EDTA 8% Cu), Mg 2.5ml/l (Mg-EDTA/Cit 10% Mg) and Fe 1.0ml/l (Fe-EDTA/Cit 10% Fe) and K 2.5ml/l (KPaa, 45/33.2 K_2O, P_2O_5, 8.2% amino acids) for the best growth and maximum productivity under fall season conditions

INTRODUCTION

Snap bean *(Phaseolus vulgaris L)* is one of the most important leguminous crops grown in Egypt, which occupies a great figure in the local consumption and export. However, bean plants are relatively sensitive to environmental stresses that may occur in the field compared to most vegetable crops which negatively affect its growth, yield and even the quality of pods. Fall season, under locality, consider the main season for snap bean exportation, in which plants are periodically exposure to unfavorable wide different between day and night temperatures and afterward to low temperature in advanced fall season (Table 1). Under such stressful environmental conditions and the consequences of exposure to low temperature relatively, reduction in yield and different performances could be expected (Buis *et al.*, 1988; Fryer *et al.*, 1995; Greaves, 1996; Haldiman, 1998). Among the many physiological mechanisms responsible for these conditions is the potential for damage to the photosynthetic apparatus caused by the combination of low temperature and high light stress (Baker, 1994; Jones and Demmers-Derks, 1999). There was a reduction in chlorophyll content‹ a decrease in leaf size, and an increase in leaf thickness, all typical of photoacclimation to increased irradiance (Bjorkman, 1981). The degree of plant tolerance to environmental stress varies greatly not only between species but in different varieties of the same species (Wentworth *et al.*, 2006). However, under local conditions, some economical cultivars growing at fall season exhibited irregular symptoms on their fruits (e.g. pale color of Bronco cv. pods), which in turn negatively affects the economical value of the product quality. Therefore, some nutrients, i.e., copper, iron, magnesium in chelated form and their combination as well as calcium and potassium formulations, in addition, some biostimulants i.e., yeast extract, seaweeds extract and amino acids, should be suggested to protect bean plants against adverse effects of environmental stress and improve productivity and quality under such conditions. It was documented that beans are sensitive to deficiency of magnesium so application with Mg should be used (A. F. A., 2005). Magnesium ions (Mg^{2+}) have a specific role in the activation of enzymes involved in respiration, photosynthesis and the synthesis of DNA and RNA. Magnesium is also a part of the ring structure of the chlorophyll molecule. Studies indicate that 15 to 30% of the total magnesium in plants is associated with the chlorophyll molecule (Neales, 1956; Marschner, 1995).

Potassium, present within plants as the cation K^+, plays an important role in regulation of the osmotic potential of plant cells. It also activates many enzymes involved in respiration and photosynthesis (Marschner, 1995).

Calcium ions (Ca^{2+}) are used in the synthesis of new cell walls, particularly the middle lamellae that separate newly divided cells. Calcium is also used in the mitotic spindle during cell division (Marschner, 1995). It is required for the normal functioning of plant membranes and has been implicate as a second messenger for various plant responses to both environmental and hormonal signals (Sanders *et al.* 1999). Changa *et al.* (1996) showed that calcium or magnesium bridges between the free carboxyl groups of adjacent pectin molecules, resulted in increases in tissue firmness of snap bean pods.

Iron has an important role as a component of enzymes involved in the transfer of electrons (redox reactions), such as cytochromes. As in magnesium deficiency, a characteristic symptom of iron deficiency is intravenous chlorosis (Taiz and Zeiger 2002).

Copper is involved in many physiological processes in plants. It acts as a structural element in regulatory proteins and participates in photosynthetic electron transport, mitochondrial respiration, oxidative stress responses, cell wall metabolism and hormone signaling (Marschner, 1995; Raven *et al.*, 1999). Regarding, utilization of yeast extract for enhancing plant growth and performance, Barnett *et al.*, (1990) reported that yeast extract are the natural components (contains many compounds, i.e. cytokinins and proteins that enhance cell division and enlargement) which are safe and non-pollutant. Also it contains a considerable amount of amino acids (Abou Zaid, 1984), mineral elements, carbohydrates, reducing sugars, enzymes and vitamins B1,2,3,12 (Spencer *et al.*, 1983; Somer, 1987 and Fathy and Farid, 1996).

There is some evidence that seaweeds extract is known to exhibit different regulatory and defensive roles through elicitation and singling of different physiological and metabolically processes (Metting, 1990 Blunden (1991). Foliar application of seaweed extract increased harvestable bean (*Phaseolus vulgaris* L.) yields by an average of 24% (Templeand and Bomke, 1989), in the same line, Fathy and El-Hamady (2007) for foliar application of seaweeds extract and amino acids on environmentally stressed cowpea.

Not only the amino acids are vital for the synthesis of proteins but also amino acids serve as precursors for a large array of metabolites with multiple functions in plant growth and response to various stresses (Less and Galili, 2008).

MATERIALS AND METHODS

Two field experiments were carried out at El-Baramon Research farm, El-Dakahlia Horticulture Research Station, Horticulture Research Institute, during the two fall seasons of 2006 and 2007 to determine the influence of some foliar applications on snap bean plants cvs. Bronco and Giza3 towards improving quality and productivity at fall season.

Seeds of the two cvs. were sown, in the moderately moist soil at 15^{th} and 21^{st} September in the two fall seasons of 2006 and 2007 respectively, in hills on one side of ridges at 15 cm. apart and 65 cm. width. The experimental design was split plot with three replicates, where the cultivars were distributed at random in the main plot while the foliar applications were arranged at random in the sub plot. The experimental unit area was 13 m^2 (4 rows, 65cm width and 5m length).

Plants were sprayed three times, 20 days after sowing and repeated every 15 Days, with solutions of the following treatments:

1- Copper at concentration of 1 ml/l in the form of Cu- EDTA 8% Cu.
2- Calcium at concentration of 2.5 ml/l in the form of Ca-citrate 25% Ca.
3- Potassium at concentration of 2.5 ml/l in the form of KP/AA, 45/33.2 K_2O, P_2O_5, 8.2% amino acids.
4- Magnesium at concentration of 5 ml/l in the form of Mg-EDTA/Cit 10% Mg.
5- Iron at concentration of 2.0 ml/l in the form of Fe-EDTA/Cit 10% Fe.
6- Combination between Cu, Fe and Mg at concentration of 0.5, 1 and 2.5 ml/l respectively.
7- Yeast extract at concentration of 25 ml/l. Yeast extract was prepared according to procedure of Fathy *et al.* (2000), its chemical analysis according to methods of A. O. A. C. (1990).
8- Seaweed extract at concentration of 5 ml/l in the form of Goemar (86) from Goemar Lab. France., natural sea weed extract of *Ascophyllum nodosm*

a brown algae, contains more than 17 essential amino acids (5738µm/l), vitamins (40mg/kg), phytohormons (200 mg/l, Betaines (140mg/l), Polysaccharides 50% DM, also enriched with N, Mg, S, B and Mo.

9- Amino acids at concentration of 5 ml/l total 20% from biological origin comprises aspartic, therionine, serine, glutamic, prdine, glycine, alanine, histadine, lysine and arginine.

10- Control (Tap water).

At random representative samples of 5 plants from each plot were chosen at 60 days after sowing in both seasons to determine the vegetative growth characters, i.e., plant height, number of leaves and branches/plant and fresh and dry weight/plant as well as leaf area/plant.

Green pods of two rows of each plot were harvested at the proper maturity stage to determine the following parameters;

1-Average pod length = mean length of 20 pods (cm).

2- Average pod diameter = mean diameter of 20 pods (cm).

3- Average pod weight = mean weight of 20 pods (g).

4- Number of pods/plant (at random mean of 10 plants from each plot).

5- Fresh pod yield (ton /fed.), green pods harvested three times from each plot collected and weighted then converted to ton per feddan.

Chemical components:

1- Pigments determination for chlorophyll a, b and carotenoids of leaves and pods were determined according Yadava, (1986).

2-T.S.S., total soluble solids (TSS %) determined by using Zeiss Laboratory refractometer.

Data were subjected to the statistical analysis and means were compared using new L.S.D. according to (Gomez and Gomez 1984).

Table (1): Monthly means of day and night temperatures during 2006 and 2007 fall seasons at experimental region.

Month	2006		2007	
	Day (°C)	Night (°C)	Day (°C)	Night (°C)
Sep.	33.65	19.81	32.48	20.31
Oct.	29.68	17.27	31.28	18.60
Nov.	24.00	12.28	26.35	14.77
Dec.	20.13	9.10	22.02	9.96

RESULTS AND DISCUSSION

Vegetative growth

1- Effect of cultivars:

Data on vegetative growth as expressed on plant height, number of branches and leaves/plant and fresh and dry weight/plant as well as leaf area/plant of the two studied cultivars Giza3 and Bronco shown in Tables (2 and 3) indicated that the two Cvs. differed significantly in all mentioned characters in the two seasons. However, Bronco cultivar was superior to Giza3 in all parameters except plant height and number of branches in the second season only. The evidenced fact is that the plant growth is affected by genotype; therefore, such differences could be expected and utilized under abiotic stressful case like the present work in which the temperature stress/fall season that shown in Table (1). Similar variations under stress condition obtained by Wentworth *et al.*, (2006).. Moreover, the pronounced growth superiority of Bronco plants over Giza3 under present work condition could be due to its more expanded leaf area corresponded with more active biosynthesis and preservation of photosynthetic pigments (Tables, 4 and 5), in turn superior growth and consequently more biomass accumulation

2- Effect of foliar application:

It is obvious from Tables (2 and 3) that all foliar nutrients sprayed in organic form and biostimulants had significant enhancement on all growth aspects of snap bean, i.e. plant height, number of branches and leaves, fresh and dry weight and leaf area/plant over those of the control, they mostly differed considerably among them in the two seasons. Since, the growth increases in terms of dry weigh as a result of these treatments reaches about 7-16% (mean of two seasons). Also, the considerably most effective ones that had a to consequent their superiority in some or in all growth aspects with the highest values for accumulation of dry matter in their foliage parts, those were sprayed with Cu + Fe + Mg mixture followed by KP/aa, yeast extracts, Fe, seaweeds and Mg, their growth (D.W.) increments were 16, 11.9, 11, 10.6, 9.2 and 8.8% respectively. Interestingly, the promoting effects of Cu + Fe + Mg treatment on the whole growth performance of snap bean under fall season stressful conditions (Table 1) could be due to the efficient beneficial impacts of its individuals Mg, Fe and Cu on synthesis and content of photosynthetic pigments Tables (4 and 5). Moreover, it was observed that this mixture achieved the highest values of leaf surface area and chlorophyll a, b and carotenoids Tables (2, 3, 4 and 5) which reflected the metabolic capacity for CO_2 fixation and C bodies accumulation. Furthermore, such responses may be attributed to the stimulatory roles in physiological metabolism at the cell level via; activating many enzymes involved in physiological processes such as respiration, photosynthesis, DNA and RNA synthesis (Mg), structural component of enzymes involved in the transfer of electron through the redox reactions such as cytochromes (Fe), and as a component of chlorophyll structure (Mg), as well as oxidative stress responses (Cu), exhibition different regulatory and defensive roles through elicitation and signaling of different physiological and metabolically processes (seaweeds) and enhancing cell division and enlargement (yeast extract) (Metting, 1990, Barnett *et al.*, 1990, Blunden 1991, Marschner, 1995, Changa *et al.*, 1996, Sanders *et al.* 1999, Raven *et al.*, 1999). Likewise, KP/AA induce positive effect on the accumulation of dry matter even though it haven't the same efficiency on the other growth aspects, this may be explained based on the specificity of this nutritional formula of K, P and amino acids to act in synergistic way to alter photo assimilation process via leaf area unit and accumulation of C skeleton more efficient, also K activate RuB.bp carboxilase, not only the key enzyme for CO_2 fixation but also enhance their exportation from leaf sources into sinks, prevents the feedback inhibition of photosynthesis, moreover, via its role in stomatal conductance increase CO_2 influx, osmoregulation, cell turger and expansion (Mingel and Kirkby, 1987 and Marschner, 1995). On the other hand, the consistent reduction in all growth aspects of control plants exposures to adverse conditions, (Table 1), may be due to the potential for damage to the photosynthetic apparatus caused by the combination of low temperature and high light stress (Baker, 1994; Jones and Demmers-Derks, 1999).

Table (2): Plant height, number of branches and leaves per plant, fresh and dry weight per plant and leaf area per plant as affected by cultivars, some foliar applications (FA) and their interaction in fall season of 2006.

Char. / Treat.		Plant height (cm)	No. branches/plant	No. leaves/plant	FW/ plant (g)	DW/ plant (g)	Leaf area/ plant (cm²)
Cultivars							
Giza 3		29.1	3.52	13.48	62.124	10.376	148.294
Bronco		31.4	4.45	14.98	86.532	13.473	169.577
L.S.D. at 5 %		00.1	0.06	00.49	00.145	00.027	000.502
Foliar applications							
Cu		29.4	4.22	14.33	71.740	11.570	156.075
Ca		30.3	3.72	13.11	73.985	11.890	149.530
K		31.0	4.00	14.27	74.080	12.255	152.785
Mg		29.6	3.62	15.38	73.610	11.925	162.300
Fe		30.4	4.22	14.26	75.550	12.160	168.353
Cu+Mg+Fe		32.1	4.22	15.55	78.942	12.560	172.070
Yeast		30.9	4.27	14.77	76.117	12.215	163.800
Sea W.		29.0	3.83	14.11	73.590	11.835	160.245
Amino		31.7	4.22	14.49	76.825	11.855	161.960
Control		27.5	3.53	12.05	68.845	10.980	142.235
L.S.D. at 5 %		00.1	0.07	00.53	00.287	00.022	000.363
Interaction: Cultivars (Cvs) x Foliar applications (FA)							
Cvs	**FA**						
Giza 3	Cu	27.7	3.77	13.11	57.670	9.940	157.550
	Ca	27.7	3.44	12.22	60.220	10.070	143.240
	K	29.1	3.66	14.77	61.180	10.540	141.090
	Mg	29.2	3.22	14.88	62.470	10.260	156.230
	Fe	30.2	3.55	13.55	65.170	10.890	155.747
	Cu+Mg+Fe	30.2	3.33	13.55	68.503	11.260	158.680
	Yeast	30.7	3.66	13.66	66.100	11.020	145.200
	Sea W.	29.2	3.55	12.89	60.380	10.080	140.830
	Amino	30.3	3.77	14.22	64.270	10.450	148.270
	Control	26.8	3.22	12.00	55.280	9.250	136.100
Bronco	Cu	31.1	4.66	15.55	85.810	13.200	154.600
	Ca	33.0	3.99	14.00	87.750	13.710	155.820
	K	32.9	4.33	13.78	86.980	13.970	164.480
	Mg	29.9	4.02	15.89	84.750	13.590	168.370
	Fe	30.6	4.88	14.97	85.930	13.430	180.960
	Cu+Mg+Fe	33.9	5.12	17.55	89.380	13.860	185.460
	Yeast	31.2	4.88	15.88	86.133	13.410	182.400
	Sea W.	30.4	4.10	15.33	86.800	13.590	179.660
	Amino	33.1	4.66	14.76	89.380	13.260	175.650
	Control	28.2	3.83	12.11	82.410	12.710	148.370
L.S.D. at 5 %		00.1	0.08	00.75	00.405	00.028	000.514

These results are in harmony with those recorded by Jana and Kabir, 2006; Zaiter *et al.*, 1992; Changa *et al.*, 1996; Amer, 2004; Elballa *et al.*, 2004; El-Tohamy and El-Greadly, 2007 on snap bean plants, Ahmed, 2005 and El-Desuki and El-Greadly, 2006 on pea plants.

3-Effect of interaction:

The combination among cultivars and foliar applications revealed that the two studied cultivar showed a similar positive response to the applied treatments compared with the control in the two seasons (Tables, 2 and 3). However, plants of Bronco cv. Sprayed with Cu, Mg and Fe in mixture, KP/aa Mg, Fe, Ca and others had the greatest values of dry weight (dry matter accumulation) and not in all cases of the other growth parameters and the increments of dry weigh were 21.0, 18.8, 15.2, 15.1 and12.6% respectively (mean of the two seasons) over the control. With $Giza_3$ cv., the plants sprayed with Mg + Fe + Cu mixture, Mg, Fe, KPaa, yeast extract Cu and others, had the highest values of dry weigh and recorded increases above control by 29.2, 19.7, 18.8, 18.1, 16.7 and 16.6% (mean of the two seasons) respectively. This growth positive responses to different interaction treatments as the behaving of the two factors individually also due to their similar enhancable effects on photosynthetic pigments content (Tables 4 and 5), in turn the capacity of photoassimilation and growth benefits, added to the above mentioned roles and cited information about physiological involvements of each treatment and the sequence growth response.

Table (3): Plant height, number of branches and leaves/plant, Fresh and dry weight/plant and leaf area/plant as affected by cultivars, some foliar applications and their interaction in fall season of 2007.

Char. / Treat.		Plant height (cm)	No. branches/ plant	No. leaves/ plant	FW/ plant (g)	DW/ plant (g)	Leaf area/ plant (cm^2)
Cultivars (Cvs)							
G3		25.6	4.34	11.37	55.507	09.745	143.595
Bronco		24.2	3.99	12.24	77.623	12.151	157.724
L.S.D. at 5 %		00.1	0.07	00.08	00.154	00.016	000.124
Foliar applications (FA)							
Cu		24.7	4.25	11.60	65.635	10.849	148.190
Ca		23.9	3.90	11.50	66.179	10.895	142.555
K		24.9	4.27	11.43	67.162	11.242	145.030
Mg		25.4	4.25	12.50	67.249	10.910	153.413
Fe		25.7	4.10	12.23	67.631	11.062	154.347
Cu+Mg+Fe		26.4	4.83	13.13	67.306	11.764	160.645
Yeast		24.9	4.70	12.53	70.641	11.085	153.555
Sea W		24.4	4.07	10.90	66.297	11.066	154.610
Amino		26.9	4.00	12.33	64.554	10.596	156.965
Control		22.0	3.29	09.92	62.996	10.010	137.285
L.S.D. at 5 %		00.1	0.08	00.13	00.143	00.020	000.210
Interaction: Cultivars (Cvs) x Foliar applications (FA)							
Cvs	FA						
Giza 3	Cu	26.4	4.27	11.67	54.042	09.627	149.510
	Ca	24.9	4.40	11.80	54.212	10.110	137.510
	K	26.8	4.20	12.20	56.325	10.082	135.450
	Mg	25.5	4.00	11.60	54.147	09.205	148.387
	Fe	26.9	4.13	11.07	57.924	10.137	143.453
	Cu+Mg+Fe	25.0	5.33	10.93	57.812	11.161	156.630
	Yeast	24.4	5.07	10.73	62.003	10.064	139.710
	Sea W.	25.1	4.00	10.63	53.784	09.681	142.310
	Amino	28.1	4.47	13.53	52.918	09.003	152.330
	Control	23.2	3.57	09.60	51.908	08.624	130.660
Bronco	Cu	23.0	4.23	11.53	77.229	12.071	146.870
	Ca	22.8	3.40	11.20	78.147	11.680	147.600
	K	22.9	4.33	10.67	78.000	12.402	154.610
	Mg	25.3	4.50	13.40	80.350	12.615	158.440
	Fe	24.5	4.07	13.40	77.337	11.987	165.240
	Cu+Mg+Fe	27.8	4.33	15.33	76.800	12.368	164.660
	Yeast	25.5	4.33	14.33	79.280	12.107	167.400
	Sea W.	23.7	4.13	11.17	78.810	12.452	166.910
	Amino	25.7	3.53	11.13	76.190	12.190	161.600
	Control	20.8	3.02	10.23	74.084	11.396	143.910
L.S.D. at 5 %		00.1	0.09	00.19	00.160	00.024	000.297

Chemical constituents

1-Effect of cultivars:

Chlorophyll a, b and carotenoids in leaves and pods as well as pod TSS as affected by snap bean cvs. are presented in Tables (4 and 5), however, Bronco surpassed Giza3 in leaf and pod chlorophyll a, b and TSS contents in the two seasons, meanwhile, leaves and pods of Giza3 had the greatest concentration of carotenoids in 2006 and 2007 seasons.

2- Effect of foliar application:

It was clear, that all applied treatments showed significant increases of leaves and pods chl. a, b and carotenoids as well as TSS contents in the two seasons as compared with the control one (Tables 4 and 5).

Table (4): Leaf chlorophyll a, b and carotenoids, pod chlorophyll a, b and carotenoids and TSS as affected by cultivars, some foliar applications (FA) and their interaction in fall season of 2006.

Char. / Treat.		Leaf Chl. a (mg/g fw)	Leaf Chl. b (mg/g fw)	Leaf carotenoids (mg/g fw)	Pod Chl. a (mg/g fw)	Pod Chl. b (mg/g fw)	Pod carotonoids (mg/g fw)	TSS (%
Cultivars (Cvs)								
Giza 3		4.10	3.50	2.48	1.65	1.90	0.84	4.59
Bronco		7.83	5.04	2.45	2.07	2.02	0.79	5.73
L.S.D. at 5 %		0.17	0.23	0.06	0.06	0.02	0.02	0.04
Foliar applications (FA)								
Cu		6.04	4.64	2.59	2.10	2.16	0.92	5.22
Ca		6.00	4.25	2.18	1.25	1.64	0.93	5.03
K		6.00	4.47	2.50	1.39	2.11	0.88	5.40
Mg		6.22	4.64	2.51	1.42	2.02	0.78	4.97
Fe		6.40	4.55	2.51	1.42	2.13	.0.79	5.27
Cu+Mg+Fe		6.51	4.99	2.67	2.17	2.37	0.86	5.17
Yeast		5.69	4.24	2.74	1.81	1.78	0.75	5.19
Sea W.		5.91	4.37	2.31	1.76	1.99	0.75	5.52
Amino		5.79	4.36	2.57	1.25	2.18	0.82	5.03
Control		5.13	3.50	1.92	1.50	1.24	0.62	4.80
L.S.D. at 5 %		0.24	0.24	0.06	1.65	0.21	0.02	0.05
Interaction: Cultivars (Cvs) x Foliar applications (FA)								
Cvs	**FA**							
Giza 3	Cu	3.89	3.66	2.76	1.41	1.86	0.91	4.77
	Ca	4.42	3.52	2.17	1.42	1.70	0.90	4.67
	K	4.07	3.66	2.70	1.56	2.28	1.03	4.67
	Mg	4.20	3.62	2.74	2.02	2.25	0.74	4.37
	Fe	4.39	3.53	2.33	1.59	1.67	0.74	4.80
	Cu+Mg+Fe	4.75	4.18	2.19	1.96	2.30	0.92	4.57
	Yeast	4.42	3.35	2.50	1.91	1.68	0.83	4.48
	Sea W.	3.81	3.55	2.41	1.68	1.76	0.81	4.90
	Amino	3.96	5.11	3.01	1.57	2.16	0.88	4.40
	Control	3.60	2.8	1.97	1.33	1.17	0.60	4.27
Bronco	Cu	8.19	5.61	2.42	2.79	2.46	0.94	5.67
	Ca	7.56	5.65	2.19	2.07	1.59	0.96	5.40
	K	7.93	5.27	2.30	2.22	1.95	0.72	6.13
	Mg	8.46	5.20	2.61	1.82	1.79	0.82	5.57
	Fe	8.42	5.57	2.69	2.25	2.39	0.85	5.73
	Cu+Mg+Fe	8.27	5.80	3.15	2.39	2.44	0.80	5.77
	Yeast	7.22	5.08	2.98	1.70	1.89	0.67	5.90
	Sea W.	8.01	4.97	2.21	1.84	2.22	0.68	6.13
	Amino	7.83	5.65	2.13	1.93	2.20	0.77	5.67
	Control	6.56	4.80	1.87	1.67	1.30	0.64	5.33
L.S.D. at 5 %		0.34	0.41	0.34	0.06	0.02	0.02	0.07

Table (5): Leaf chlorophyll a, b and carotenoids, pod chlorophyll a, b and carotonoids and TSS as affected by cultivars, some foliar applications and their interaction in fall season of 2007.

Char. / Treat.		Leaf Chl. a (mg/g fw)	Leaf Chl. b (mg/g fw)	Leaf carotenoids (mg/g fw)	Pod Chl. a (mg/g fw)	Pod Chl. b (mg/g fw)	Pod carotonoids (mg/g fw)	TSS (%)
Cultivars (Cvs)								
Giza 3		3.83	3.31	2.13	1.60	1.80	0.82	4.78
Bronco		7.29	5.04	2.26	2.06	1.96	0.77	5.08
L.S.D. at 5 %		00.12	0.12	0.31	0.09	0.12	0.02	0.03
Foliar applications (FA)								
Cu		5.97	4.10	2.18	1.95	2.14	0.78	5.12
Ca		5.57	4.00	2.21	1.75	1.81	0.91	4.92
K		5.61	4.20	2.11	1.77	1.83	0.70	4.83
Mg		5.80	4.34	2.42	1.74	2.02	0.84	4.88
Fe		5.56	4.36	2.33	1.90	2.10	0.86	5.03
Cu+Mg+Fe		6.09	4.67	2.26	2.26	2.26	0.75	5.23
Yeast		5.26	4.09	2.11	2.03	2.15	0.69	4.80
Sea W.		5.51	4.33	2.10	1.56	1.68	0.83	4.87
Amino		5.43	3.97	2.35	1.76	1.61	0.96	5.10
Control		4.72	3.69	2.35	1.56	1.20	0.61	4.53
L.S.D. at 5 %		00.13	0.13	0.21	0.13	0.12	0.02	0.02
Interaction: Cultivars (Cvs) x Foliar applications (FA)								
Cvs	**FA**							
Giza 3	Cu	4.13	2.92	1.99	1.85	2.18	0.80	4.94
	Ca	4.12	3.22	2.28	1.35	1.72	0.89	4.63
	K	3.82	3.43	2.29	1.66	1.83	0.72	4.67
	Mg	3.75	3.44	2.23	1.62	1.67	0.88	4.70
	Fe	3.69	3.30	2.24	1.50	1.81	0.89	5.00
	Cu+Mg+Fe	4.48	3.95	2.19	1.91	2.20	0.79	5.00
	Yeast	3.81	3.29	1.91	1.90	2.16	0.72	4.53
	Sea W.	3.57	3.37	2.00	1.36	1.65	0.88	4.80
	Amino	3.70	3.27	2.56	1.52	1.66	1.00	5.13
	Control	3.19	2.87	1.83	1.29	1.15	0.59	4.40
Bronco	Cu	7.81	5.29	2.37	2.06	2.11	0.75	5.30
	Ca	7.01	4.77	2.13	2.14	1.89	0.94	5.20
	K	7.39	4.98	2.20	1.88	1.83	0.68	5.00
	Mg	7.85	5.25	2.61	1.86	2.36	0.81	5.07
	Fe	7.62	5.41	2.41	2.29	2.38	0.83	5.07
	Cu+Mg+Fe	7.69	5.39	2.33	2.61	2.32	0.71	5.47
	Yeast	6.71	4.88	2.31	2.16	2.14	0.66	5.07
	Sea W.	7.45	5.28	2.19	1.76	1.72	0.79	4.93
	Amino	7.15	4.68	2.15	2.01	1.56	0.92	5.07
	Control	6.26	4.50	1.68	1.83	1.26	0.63	4.67
L.S.D. at 5 %		00.14	00.14	00.14	0.19	0.12	0.02	0.02

Absolutely, the considerable highest values for chlorophylls and relatively high carotenoids and TSS were obtained by plants treated with the combination between Cu+ Fe+ Mg at both seasons, meanwhile, the highest contents for foliar and pod carotenoids were of Mg followed by amino acids and Cu + Fe + Mg mixture (in the first season), those for pod carotenoids were amino acids, Ca and Fe treatments respectively, (in the second season). On the other hand, seaweeds extract followed by KPaa (first season) and Cu+ Fe+ Mg combination followed by Cu treatments were of the significant highest values for pod TSS. The favorable effects induced by treatments under such conditions may be attributed to the roles of used stimulants in numerous physiological processes. The evident is that Cu is an essential cofactor for many metalloproteinase (Yruela, 2005). In addition, the specific role of Mg. as a part of the ring structure of chlorophyll molecule (Marschner, 1995). Obviously, photosynthetic ATP supply substituted for mitochondrial ATP in the leaves with the high K^+ concentration (Peoples and Koch, 1979). Furthermore, iron is required for the synthesis of some chlorophyll-protein complexes in the chloroplast, thereby, the leaves become chlorotic in the case of iron deficiency (Taiz and Zeiger 2002). Likewise, Yeast extract contains many components enhanced development and achieve stress tolerance, it also, with amino acids are vital for the synthesis of proteins (Yeo, *et al.*, 2000 and Less and Galili, 2008). Moreover, seaweed extracts improve growth and chlorophyll contents of treated plants (Whapham, 1993). Similarly, Garg and Hemantaranjan (1988) found that 5mg Fe-EDDHA or Fe-EDTA or 10mg FeSO4 gave maximum leaf chlorophyll a, b and IAA contents. In the same line, Favaro *et. al.*, (2007) mentioned that pod from snap bean plants grown in a solution without Ca presented necrosis in their apical region. In general, the synergistic action of Cu+ Fe+ Mg mixture in chloroplasts stability, photophosphorylation and energy metabolism, also their main role in protection and preservation of chlorophyll's against oxidative degradation during abiotic stress condition (Mingle and Kirkby, 1987, Marschner, 1995). Herein, of interest to observation that all treatments were greatly improved the photosynthetic pigments content of snap bean leaves which metabolically, in photoassimilation, increasing biomass accumulation in turn the growth and yield gain and benefits. Also, the content of pod chlorophylls are greatly over the control one, increased the concentration of pod green color and consequently reduced the incidence of pod pale color symptoms which observed during fall season as a result of temperature and light stress (Tables 1, 4 and 5), this stress condition suggested to be adversely suppressed the synthesis of chlorophyll's as well as inducing their degradation as a result of oxidative inhibition and toxic effects (Marschner, 1995). All greatly maintaining pod green color and increase its TSS content as an important economical traits for fall snap bean as main exportation season.

3- Effect of interaction

Data in Tables (4 and 5) showed that leaves and pod's chlorophyll a, b and carotenoids as well as pod's TSS of both cultivars were strongly affected by all treatments compared with control in the two seasons. Also, from the same data, Giza3 plants sprayed with Cu + Mg + Fe combination, followed by Ca, and yeast had the highest values of leaf chlorophyll a in the two seasons, Concerning, leaf chlorophyll b, the favorable treatments were of Cu + Mg + Fe followed by yeast extract and Ca, Fe then Mg (first season), Cu+ Mg+ Fe followed by Mg then Ca and Cu (second season), whereas the highest leaf chlorophyll a of Bronco cv. was of Cu+ Mg+ Fe, amino acid, Cu and Fe treatments respectively (first season), Cu+ Mg+ Fe, Mg then seaweeds extract and Cu respectively (second season). Regarding chlorophyll b the highest values were obtained from plants treated with Mg, Fe, Cu+ Mg+ Fe and Cu respectively (first season), Cu and Mg followed by Fe and Cu+ Mg+ Fe then KPaa and seaweeds respectively (second season). The best leaf carotenoids for $Giza_3$ cv. was of amino acids followed by Cu, Mg and KPaa respectively (first season), also, amino acids followed by Fe and Mg were the best applications in the second season. While, leaf carotenoids of Bronco cv. were obtained from Mg followed by Cu+ Fe+ mg and Cu treatments respectively (first season), Cu and Mg then Fe and Cu+ Mg+ Fe then KPaa and seaweeds (second season). The best treatments for pod chlorophyll a of $Giza_3$ cv. Were Mg followed by Cu+ Mg+ Fe and yeast extract respectively (firest season), Cu+ Mg+ Fe, KPaa, and Mg respectively (second season), meanwhile the favorable application for Bronco pod's chlorophyll a was Cu followed by Cu + Mg + Fe mixture, Fe and KPaa (first season), Cu + Mg + Fe, yeast extract then Ca (second season), as for chlorophyll b of Bronco's pods, Cu, Mg and Fe mixture or individual. In general, the plants of the two cultivars sprayed with Cu, Mg, and Fe individually or in combination, amino acids seaweeds and K had more contents of chlorophyll pigments in their leaves and pods and pod TSS contents. These results show the stimulatory effects of such substances on improving quality of bean plants under fall season conditions.

Yield and Yield components

1- Effect of cultivars:

It is clear from obtained data, as shown in Tables (6 and 7), that pod diameter, pod length, pod weight and number of pods/plant as well as fresh pod yield were significantly differed among Giza3 and Bronco cvs. in the two seasons. However, $Giza_3$ cv. surpassed Bronco cv. in pod length, diameter and weight, whereas, Bronco cv. had the superior pod number/plant and fresh pod yield, with over yielded (11.5%) (mean of two seasons) Giza3 one. This varaital yield increases could be attributed to the similar growth, dry matter accumulation and photosynthetic pigments increases Tables (2, 3, 4 and 5). In this respect, under Egyptian condition, El-Sayed (1990) found significant differences in pod length among six cultivars of snap bean at fall and summer seasons. Similar results were recorded by Mohamed, 2004. Likewise, Reddy *et al.*, (1990) mentioned that the number of pods/plant had the greatest effects on yield stability of eleven *Phaseolus vulgaris* genotype, also, Harer *et al.*, (2000) went to the same results on Rajman bean (*Phaseolus vulgaris*) cvs.

2- Effect of foliar application:

Data in Tables (6 and 7) illustrated that fresh pod yield and its attributes differed significantly among them and surpassed the control in the two seasons, except pod weight in the two seasons in which there were slightly differences among treatments. The most effective treatment was the mixture of Cu+ Mg+ Fe (for pod length, number of pods/plant and fresh pod yield), seaweeds and Mg as for pod diameter in the two seasons respectively, Fe as for pod weight in the two seasons. Generally, the applied treatments achieved yield increments by 24.8% (Cu+ Mg + Fe), 18.4% (KPaa), 17.3% (Mg), 16.8% (Fe), 13.7% (yeast extract), 13.0% (Ca), 12.1% (Cu), 10.8%

(seaweeds extract) and 8.8% (amino acids), mean of two seasons, respectively over the control. Interestingly, these increments may be explained on the bases that all used substances had favorable stimulatory effects on vegetative growth characters and enhanced photosynthetic apparatus, and consequently reproductive growth triggers a switch in partitioning from vegetative growth sinks to reproductive sinks Tables (2, 3, 4 and 5). Furthermore, the specific role of K in playing a central role in bioassimilate partitioning and translocation from the leaf source into reproductive sinks (pod weigh), also P involved in DNA and RNA metabolism and amino acids (argenine) as a precursor for poly amines thereby, the cell division, fertilization and pod setting processes enhancements (Marschner, 1995).

Table (6): Fresh pod yield and its constitutes, *i.e.*, pod diameter, pod length, pod weight and number of pods/plant as affected by cultivars, some foliar applications (FA) and their interaction in fall season of 2006.

Char. / Tret.		Pod diem (cm)	Pod L. (cm)	Pod weight (g)	No. pod/ Plant	Fresh yield (ton/fed.)
Cultivars (Cvs)						
Giza 3		0.81	17.39	5.354	20.41	5.449
Bronco		0.75	13.67	3.708	30.38	5.874
L.S.D. at 5 %		0.07	00.07	0.149	00.12	0.125
Foliar applications (FA)						
Cu		0.77	15.01	4.494	23.66	5.519
Ca		0.79	15.13	4.475	24.39	5.507
K		0.79	15.64	4.545	27.62	6.029
Mg		0.79	16.02	4.578	27.18	5.931
Fe		0.79	15.63	5.052	27.23	5.867
Cu+Mg+Fe		0.77	16.06	4.574	29.03	6.270
Yeast		0.77	15.87	4.470	25.79	5.689
Sea W.		0.84	15.53	4.417	23.85	5.454
Amino		0.80	15.58	4.397	23.54	5.367
Control		0.69	14.82	4.310	21.69	4.986
L.S.D. at 5 %		0.07	00.07	0.165	00.12	0.071
Interaction: Cultivars (Cvs) x Foliar applications (FA)						
Cvs	**FA**					
Giza 3	Cu	0.79	16.69	5.407	20.12	5.418
	Ca	0.87	16.99	5.346	19.63	5.253
	K	0.80	17.43	5.400	21.44	5.797
	Mg	0.80	17.83	5.498	22.11	5.915
	Fe	0.82	17.80	5.501	20.55	5.490
	Cu+Mg+Fe	0.79	18.39	5.350	22.80	6.206
	Yeast	0.77	17.9	5.375	21.25	5.509
	Sea W.	0.81	17.17	5.305	19.48	5.172
	Amino	0.83	17.27	5.250	18.48	5.044
	Control	0.77	16.40	5.110	18.22	4.690
Bronco	Cu	0.75	13.33	3.580	27.20	5.620
	Ca	0.71	13.27	3.603	29.14	5.761
	K	0.77	13.85	3.690	33.80	6.260
	Mg	0.79	14.20	3.657	32.24	5.947
	Fe	0.75	13.45	4.604	33.90	6.243
	Cu+Mg+Fe	0.75	13.73	3.798	35.25	6.335
	Yeast	0.77	13.82	3.565	30.33	5.869
	Sea W.	0.86	13.88	3.530	28.22	5.735
	Amino	0.78	13.89	3.545	28.60	5.690
	Control	0.62	13.23	3.510	25.15	5.283
L.S.D. at 5 %		0.07	00.07	0.132	00.52	0.172

Table (7): Fresh pod yield and its constitutes, *i.e.*, pod diameter, pod length, pod weight and number of pods/plant as affected by cultivars, some foliar applications (FA) and their interaction in fall season of 2007.

Tret. / Char.		Pod diem (cm)	Pod L. (cm)	Pod weight (g)	No. pod/ Plant	Fresh yield (ton/fed.)
Cultivars (Cvs)						
Giza 3		8.89	13.23	5.035	18.95	4.966
Bronco		8.20	11.88	3.543	28.87	5.724
L.S.D. at 5 %		0.06	00.04	0.142	00.12	0.079
Foliar applications (FA)						
Cu		8.54	12.62	4.294	24.26	5.347
Ca		8.73	12.25	4.303	24.57	5.439
K		8.84	13.16	4.300	25.26	5.464
Mg		9.26	12.07	4.277	24.12	5.446
Fe		8.28	11.87	4.405	22.93	5.458
Cu+Mg+Fe		8.43	14.24	4.382	26.42	5.828
Yeast		8.79	13.78	4.262	22.97	5.329
Sea W.		8.05	11.61	4.247	24.01	5.272
Amino		8.84	12.56	4.226	23.66	5.170
Control		7.72	11.43	4.195	20.92	4.700
L.S.D. at 5 %		0.06	00.05	0.141	00.10	0.035
Interaction: Cultivars (Cvs) x Foliar applications (FA)						
Cvs	**FA**					
Giza 3	Cu	9.30	13.08	5.067	19.55	5.125
	Ca	9.06	12.81	5.045	18.40	5.000
	K	9.30	13.84	5.000	18.77	4.901
	Mg	9.85	12.50	4.980	19.10	4.937
	Fe	8.41	12.13	5.210	17.72	5.250
	Cu+Mg+Fe	8.50	15.96	5.175	20.44	5.490
	Yeast	9.28	15.06	5.004	19.15	5.052
	Sea W.	8.30	12.10	4.995	20.11	4.725
	Amino	9.16	13.06	4.952	19.60	4.832
	Control	7.74	11.79	4.920	16.49	4.350
Bronco	Cu	7.77	12.15	3.521	28.98	5.569
	Ca	8.40	11.70	3.560	30.74	5.878
	K	8.37	12.48	3.600	31.75	6.027
	Mg	8.67	11.63	3.575	29.14	5.955
	Fe	8.15	11.60	3.600	28.15	5.667
	Cu+Mg+Fe	8.35	12.51	3.589	32.40	6.167
	Yeast	8.29	12.50	3.520	26.80	5.805
	Sea W.	7.79	11.11	3.500	27.92	5.819
	Amino	8.51	12.05	3.500	27.51	5.508
	Control	7.69	11.07	3.470	25.34	5.050
L.S.D. at 5 %		0.05	00.05	0.142	00.14	0.050

In addition, the direct effects of Cu + Mg + Fe treatment in maintenance of pollen grains and ovaries viability and consequently pod setting under stress temperature/oxidative conditions, added to the role of Mg in activation of membrane binding transporter enzymes, Cu and Fe in preservation of stress sensitive reproductive organs against oxygen radicals damages (Marschner, 1995).

These results are in harmony with those found by Jana and Kabir (1987), Garg and Hemantaranjan (1988), El-Tohamy *et al.*, (2001), Elballa *et al.*, (2004), El-Tohamy and El-Greadly (2007), Favaro *et al.*, (2007) and Oztekin and Tüzel (2007) on snap bean and Abd-El-Lateef *et al.*,(1998) on mung bean.

3-Effect of interaction:

The interaction between cultivars and foliar applications had significant effects on fresh pod yield and its components in both seasons (Tables 6 and 7). However Giza3 cv. attained the greatest responses above control when sprayed with Cu + Mg + Fe mixture, Mg, Fe, KPaa, yeast extract and others with yield increases by 29.2, 19.7, 18.8, 18.1 and 16.7% (mean of two seasons) respectively. Meanwhile, the highest values of Bronco yield were gathered from plants sprayed with Cu + Mg + Fe mixture followed by KPaa, Mg, Fe, Ca and others, with yield increments by 21.0, 18.8, 15.2, 15.1 and 12.6% respectively, mean of the two seasons. Such enhanced yield was associated with pod quality and number of pods/plant, regarding genotype responses under such condition. It's clear from the above results that these treatments to far extent gave similar enhancable effects on synthesis and contents of photosynthetic pigments, D.W., leaf area and the other growth aspects of their plants, (Tables 2, 3, 4 and 5) in turn more physiological and agronomical efficiency, as well as maintaining the most economical and exportational traits of pod deep green color and TSS content as previously shown.

On these important considerations the most concluded treatment for improving yield and qualities of snap bean plants as well as growth and pigments of leaves and pods under abiotic stress condition of fall season and to efficient reduction of the expected incidence of pod fading problem, foliar spraying of $Giza_3$ and Bronco cvs. with mixture of Mg + Cu + Fe in chelated forms at concentration of (2.5, 0.5 and 1ml/l), also other foliar feeding with KPaa formulation, Fe and/or Mg in chelated form too.

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بعض معاملات الرش لتحسين جودة ومحصول الفاصوليا فى الانتاج الخريفى.

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تعتبر الفاصوليا من محاصيل الخضر التى تمثل أهمية خاصة للاستهلاك المحلى والتصدير وبخاصة فى الانتاج الخريفى، فتعتبر هذه العروة هى العروة الاساسية لتصدير الفاصوليا خصوصاً الى الدول الاوربية. و تتعرض النباتات أثناء موسم النمو – خلال هذه العروة – إلى ظروف بيئية غير مناسبة تتمثل في زيادة الفرق بين درجتى حرارة النهار والليل؛ كذلك انخفاض درجات الحرارة بخلال مراحل النضج مما يؤدى الى ظهور بعض العيوب الفسيولوجية لبعض الاصناف الاقتصادية مثل ظهور اللون الشاحب فى قرون الصنف برونكو الذي يعتبر من الاصناف التصديرية الهامة. لذلك اجريت هذه الدراسة فى المزرعة البحثية بالبرامون محافظة الدقهلية والتابعة لمعهد بحوث البساتين خلال موسمي الزراعة الخريفى ٢٠٠٦و٢٠٠٧ لدراسة استجابة صنفين من الفاصوليا (جيزة ٣ وبرونكو) للرش ببعض المواد ذات التاثيرات المفيدة للنمو والجودة والانتاج.

تم استخدام بعض المغذيات فى صورة مخلبية (النحاس ١مل/لتر والماغنيسيوم ٥مل/لتر والحديد ٢مل/لتر– منفردا او في خليط من العناصر الثلاثة (نصف التركيز) – وسترات الكالسيوم ٢,٥مل/لتر ومركب البوتاسيوم والفوسفور المدعم بأحماض أمينية ٢,٥مل/لتر) كما استخدمت بعض المستخلصات الطبيعية (مستخلص الخميرة ٢٥مل/لتر ومستخلص الاعشاب البحرية ٥مل/لتر ومركب لبعض الاحماض الامينية٥مل/لتر)، استخدمت هذه المركبات رشا على النباتات ثلاث مرات خلال موسمى الزراعة، بداية من ٢٠ يوم بعد الزراعة وكررت كل ١٥يوم. أوضحت النتائج تفوق الصنف برونكو على جيزة٣ فى معظم صفات النمو الخضرى وكذلك فى محتوى الأوراق والقرون من صبغات الكلوروفيل ا، ب والمواد الصلبة الذائبة فى القرون وكذلك عدد القرون/النبات والمحصول الكلى فى موسمى التجربة. وكان هناك ارتباط واضح بين عدد القرون على النبات وكذلك محتواها من صبغات الكلوروفيل وكمية المحصول خلال موسمى التجربة. من ناحية أخرى، تفوق الصنف جيزة٣ فى طول القرن وقطره وكذلك فى وزنه على الصنف برونكو خلال الموسمين.

وقد اختلفت معاملات الرش فيما بينها وتفوقت جميعها على معاملة المقارنة (الكنترول) وكان ترتيبها تنازليا كالاتى: التفاعل بين النحاس والماغنيسيوم والحديد (في الصورة المخلبية)، البوتاسيوم، الماغنيسيوم المخلبى، الحديد المخلبى، مستخلص الخميرة، سترات الكالسيوم، النحاس المخلبى، مستخلص الاعشاب البحرية ثم الاحماض الامينية وأدت هذه المعاملات الى زيادة فى المحصول الطازج بمقدار ٢٤,٨– ١٨,٤–١٧,٣ –١٦,٨–١٣,٧–١٣,٠–١٢,١–١٠,٨ ثم ٨,٨٪ على الترتيب مقارنة بالكنترول، كذلك اثر التفاعل بين عاملي الدراسة معنويا على معظم الصفات المدروسة خلال موسمى التجربة.

وعموما يمكن التوصية برش نباتات الفاصوليا صنفى جيزة٣ وبرونكو بمخلوط من النحاس والماغنيسيوم والحديد بتركيز ٠,٥+٢,٥+١ مل/لتر على الترتيب في الصور المخلبية أو الرش بمركب البوتاسيوم والفوسفور المدعم باحماض أمينية بتركيز(٢,٥مل/لتر)، وذلك بمعدل ثلاث مرات اثناء موسم النمو بداية من ٢٠ يوم بعد الزراعة وتكرر كل ١٥يوم وذلك لتحسين الانتاج والجودة، علاوة على النمو وصبغات الكلوروفيل فى الاوراق والقرون الغضة تحت ظروف الاجهاد البيئى فى العروة الخريفى.