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THE MAIN EFFECTS OF DRIP IRRIGATION RATES, BIOFERTILIZERS RATES AND ANTIOXIDANTS SOURCES ON THE GROWTH, FLOWERING AND CHEMICAL CONSTITUENTS OF *Echinacea purpurea* L. PLANTED IN THE NEWLY RECLAIMED SOILS

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ABSTRACT

Two field experiments were carried out during two successive seasons of 2010 and 2011 at the Experimental Farm of El-Kassasin Horticultural Research Station, Ismailia Governorate, Egypt, to investigate the effect of drip irrigation rates (784, 1568 and 2352 m^3 water/fad.), biofertilizers rates (control, 500 g nitrobein + 500 g phosphorein, 1000 g nitrobein + 1000 g phosphorein and 1500 g nitrobein + 1500 g phosphorein) and antioxidants (control, citric acid, salicylic acid and glutathione) at rate 100 ppm each, on growth, flowering and chemical constituents of *Echinacea purpurea* L. plants. The results declared that vegetative growth, flowering and chemical constituents of *Echinacea purpurea* L. plants were significantly increased gradually with increasing water quantity from 784 up to 1568 m^3 water/fad., in both seasons. Moreover, data manifested that raising the application rates of nitrobein and phosphorein to plants, generally, caused a gradual and steady increase in growth, flowering and chemical constituents in both seasons as compared to without inoculation (control). In this respect, inoculation plants at rate of 1500 g nitrobein + 1500 g phosphorein/fad., recorded high values of growth, flowering and chemical constituents than other biofertilizers rates or control treatments. Furthermore, vegetative growth, flowering and chemical constituents were promoted with all spraying antioxidants as compared to control. Spraying plants with glutathione recorded uppermost values of growth, flowering and chemical constituents more than the other antioxidants.

Key words: *Echinacea purpurea* L., drip irrigation rates, biofertilizers rates, antioxidants, vegetative growth, flowering, chemical constituents.

INTRODUCTION

Echinacea is relatively easy to cultivate and commercial growers and tolerant to drought, though grows better in cultivation with adequate watering, and can tolerate fairly diverse soil types (Hobbs, 1989). Exceptionally drought tolerant is beginning its production. We have a lot to learn about the optimum growing, harvesting, quality control, and storage techniques for Echinacea.

Results showed that increasing drought decreased significantly plant growth, dry weight, leaf area, diameter and weight of inflorescences as well as flowering yield. On the same trend, Saleem (2007) on tuberose plants, Yousef *et al.* (2008) on *Majorana hortensis* L. plants and Younis *et al.* (2009) on *Hibiscus sabdariffa* L., results showed that carbohydrates, total soluble solids, non reducing sugars and total sugars were increased significantly with increasing water quantity, whereas, reducing sugars were increased with decreasing water amounts.

Some investigators dealt with the effect of biofertilizers on plant growth, Abo El-Fetooh (2010) on marigold and Dube (2011) on *Stevia rebaudiana*, illustrated that raising the application rates of nitrobein and phosphorein to

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plants caused a generally gradual and steady increase in vegetative growth (plant height, number of leaves and branches/plant and dry weight) as well as flowering characters.

Plants can protect themselves against oxidative damage by antioxidant system including antioxidative enzymes and nonenzymatic compounds, (Mittler, 2002). Citric acid, salicylic acid and glutathione are crucial nonenzymatic compounds involved in defense against oxidative stress. Hussain *et al.* (2008) on *Helianthus annus,*L., and Zeng *et al.* (2011) on *Dianthus caryophyllus* L., showed that applied antioxidants as exogenously at vegetative and flowering stage improved significantly vegetative growth and flowering characters.

Therefore, this work aimed to study the effect of drip irrigation rates, biofertilizaters rates and antioxidants on plant growth, flowering, plant chemical composition and postharvest characters of *Echinacea purpurea* L. grown under sandy soil conditions.

MATERIALS AND METHODS

Two field experiments were carried out during the successive seasons of 2010 and 2011 at the Experimental Farm of El-Kassasin Horticultural Research Station, Ismailia Governorate, Egypt to investigate the effect of drip irrigation rates, biofertilizers rates and antioxidants on growth, flowering and chemical constituents of *Echinacea purpurea* L.

The soil of the Experimental field was sand in texture and the physical and chemical analyses of soil are shown in Table 1.

This experiment included 48 treatments, which were the combinations between 3 drip irrigation rates, 4 biofertilizers rates and 4 antioxidants sources as follows:

Drip Irrigation Rates

1. 784 m^3 water/fad.,
2. 1568 m^3 water/fad.,
3. 2352 m^3 water/fad.

Prior the irrigation treatments, all experimental units received equal amounts of water (50 m^3/fad.).

The irrigation treatments began at emergency (31 May) and were added in the morning (two times/week) up to the end of July, thus number of irrigation times/season were 35 ones. The amounts of water were added using water counter and pressure counter at 1 bar. The amounts of calculated water were added to different treatments, express through drippers (4 l/hr) to give such amounts of water which are presented in Schedule 1.

The experimental unit area was 9 m^2 (3x3 m) and each experimental unit contains 4 dripper lines with 3 m length for each with 75 cm width, moreover the distance between emitters was 25 cm, thus each experimental unit contained 48 emitters.

Biofertilizers Rates

1.Zero biofertilizer (control),

2.500 g/fad. nitrobein + 500 g/fad. phosphorein,

3.1000 g/fad. nitrobein+1000 g/fad. phosphorein,

4.1500 g/fad. nitrobein+1500 g/fad. phosphorein.

Nitrobein is the commercial name of nitrogen fixing bacteria, which contains *Azospirillum sp.*and *Azotobacter sp.* Whereas, Phosphorein is the commercial name of phosphate dissolving bacteria, which contains *Bacillus megatherium* var. *phosphoticum.*

Biofertilizers were obtained from General Organization for Agriculture Equalization Fund (GOAEF), Ministry of Agriculture, Egypt, and biofertilizers rates were mixed with sand (1:10 w/w) and supplied as soil inoculation into root absorption zone of plants, and applied in two doses, after 15 days of transplanting and the second dose was after one month of first dose.

Antioxidants Sources

1. Spraying with water,
2. Spraying with 100 ppm citric acid,
3. Spraying with 100 ppm salicylic acid,
4. Spraying with 100 ppm glutathione.

Echinacea plants were sprayed with antioxidants twice/season at age of 45 and 60 days after sowing in the morning.

Table 1. Physical and chemical analyses of the experimental soil

Physical analyses

Particle size distribution (%)				Textural class	Ca CO_3%	O.M%
Coarse	Fine	Silt	Clay			
5.38	78.53	10.08	6.01	Sandy	1.20	0.80

Chemical analyses

pH*		EC* dS/m		SP	Available (mg/kg)		
					N	P	K
8.1		0.83		27	58.60	9.50	190.51
Ion concentration in paste extract ($mmol_c$/l)							
Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO^{-3}	HCO^{-3}	Cl^{-}	SO^{--4}
3.90	2.70	1.85	0.55	0.00	1.30	4.55	3.15

Samples of the soil were obtained from 25 cm soil surface.

* pH in paste, and EC in paste extract.

Schedule 1. Total amount of water, amount of water supply at every irrigation and time needed to give such amounts

Treatments (m^3/fad.)	Water supply every irrigation (m^3/fad.)	Time needs (min)
784	22.40	15
1568	44.80	30
2352	67.20	45

Echinacea purpurea, L., seeds were sown in nursery on 15th Nov., and nursery was covered by plastic on Dec., Jan. and Feb. and seedlings were transplanted on 21st March with 7-10 cm height in both seasons.

Seedlings were hand-sown on 21st March every season on dripper line at spacing of 75 cm between dripper lines and 25 cm between plants in each dripper line.

These treatments were arranged in split-split plot design with three replicates in both seasons. Irrigation rates treatments were assigned at random in the main plots, while sub plots were devoted to biofertilizers rates treatments and antioxidants sources were allotted in the sub-sub plots.

Organic fertilization (20 m^3 FYM/fad.) was mixed with 200 Kg/fad. super phosphate (15.5% P_2O_5), 100 Kg/fad. amoinum sulphate (20.5% N) and 50 Kg/fad. potassium sulphate (48% K_2O) were applied at soil preparation in mid-row and covered with 10 cm sand.

Data Recorded

The obtained data in this study were as follows:

Plant growth parameters

Six guarded plants from each plot were labeled at random to evaluate the following characters at age of 100 days after transplanting.

1. Plant height (cm),
2. Number of leaves/plant,
3. Number of branches/plant,
4. Fresh and dry weights (g) of whole plant at flowering stage.

Flowering characters

1. Length (cm), diameter (cm) and fresh weight (g) of main inflorescence,
2. Total number of inflorescences/plant,
3. The longevity of main inflorescence was measured by the period from the first vase day to the end of vase life when the flowers lost their ornamental value, as defined by pedicel bending, flower wilting, flower bluing and general discoloration.

Chemical constituents

1. Carbohydrates contents

Total carbohydrates contents in dried spikes were determined according to the method described by (AOAC, 1990).

2. Sugar contents

Total, reducing and non reducing sugars were determined, in dried samples of spikes after harvesting, calorimetrically according to the methods described by (AOAC,1990).

Statistical Analysis

The collected data were subjected to statistical analysis of variance according to Steel and Torrie (1980) and the means were compared by using Least Significantly Difference (LSD).

RESULTS AND DISCUSSION

Vegetative Growth

Effect of drip irrigation rates

Data in Table 2 show the effect of drip irrigation rates (784, 1568 and 2352 m^3 water/ fad.) on vegetative growth (plant height, number of leaves and branches/plant and fresh and dry weights of whole plant) of *Echinacea purpurea* L. at age of 100 days after sowing. It could be concluded that vegetative growth characters were significantly increased gradually with increasing water quantity applied from 784 up to 2352 m^3 water/fad. in both seasons.

These results are in harmony with those reported by Halepyati *et al.* (2002) on tuberose and Dore (2004) on rose. They reported that application of high rate of water irrigation gave the highest values of vegetative characteristic.

Effect of biofertilizers rates

The effect of biofertilizers rates on vegetative growth of *Echinacea purpurea* L. are shown in Table 2. It is evident from such data that biofertilizers rates had a positive significant effect on plant height at different sampling dates. It is obvious that vegetative growth parameters were promoted with all biofertilizers rates as compared to control, which recorded the lowest values. It could noticed that vegetative growth was significantly increased with increasing biofertilizers rates. In this regard, application of 1500 g nitrobein + 1500 g phospherein gave the highest values of plant height, number of leaves and branches/plant and fresh and dry weights of whole plant as compared to other rates.

These results agreed with those reported by Mamta *et al.* (2010) on *Stevia rebaudiana*, Veerendra *et al.* (2011) on *Stevia rebaudiana* plants and Dube (2011) on *Stevia rebaudiana*, who concluded that growth parameter of plants were positively affected by bacterial inoculation.

Effect of antioxidants

Results given in Table 2 testify the effect of antioxidants (citric acid, salicylic acid and glutathione) at rate of 100 ppm each as well as spraying with water (control) on vegetative growth of *Echinacea purpurea* L.

It is obvious from such data that vegetative growth traits were promoted with all spraying antioxidants in both seasons upon control. In this respect, spraying plants with glutathione recorded high values of plant height than other antioxidants or control treatments. Meanwhile, salicylic acid had a positive increase more than citric acid.

These results are in agreement with those obtained by Hussain *et al.* (2008) on *Helianthus annuus* L., Zeng *et al.* (2011) on *Dianthus caryophyllus* L., who reported that all spraying materials with antioxidants improved vegetative growth as compared to control.

Table 2. Effect of drip irrigation rates, biofertilizers rates and antioxidants on vegetative growth of *Echinacea purpurea* L., during two seasons of 2010 and 2011

Characters / Treatments	Plant height (cm)		No of leaves/plant		No of branches/plant		F.W of whole plant (g)		D.W of whole plant (g)	
	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
Effect of drip irrigation rates										
784 m^3/fad.	33.20	37.90	31.51	33.56	11.69	12.88	60.11	96.74	28.33	25.22
1568 m^3/fad.	44.68	47.89	38.53	41.85	12.80	14.90	71.75	109.70	33.93	26.03
2352 m^3/fad.	49.76	54.77	38.74	45.06	13.70	15.93	72.68	117.33	34.41	26.15
$LSD_{0.05}$	1.21	1.93	1.65	0.80	0.38	0.29	2.52	1.39	1.12	0.36
Effect of biofertilizers rates										
Control	38.47	40.81	35.17	36.90	12.06	13.60	61.37	101.05	29.00	25.27
Bio.1	42.01	44.51	36.07	38.94	12.67	14.07	64.64	105.50	30.46	25.66
Bio.2	43.29	49.04	36.57	41.15	13.18	14.93	71.90	110.42	33.97	25.99
Bio.3	46.40	53.06	37.24	43.64	13.01	15.67	74.82	114.72	35.47	26.28
$LSD_{0.05}$	0.89	0.57	1.10	0.64	0.57	0.32	3.01	1.82	1.53	0.25
Effect of antioxidants										
Control	39.15	41.82	32.83	36.68	10.56	13.81	62.97	100.75	29.74	25.33
Citric acid	41.79	45.07	35.46	39.03	11.75	14.25	66.33	105.58	31.42	25.62
Salicylic acid	43.51	48.44	37.40	41.31	12.49	14.82	68.45	110.08	32.39	25.91
Glutathione	45.72	52.08	39.35	43.63	16.13	15.39	74.97	115.28	35.35	26.34
$LSD_{0.05}$	0.95	0.56	0.89	0.40	0.53	0.24	3.54	2.73	1.69	0.45

Control = zero untreated Bio 1 = 500 g nitrobein + 500 g phosphorein
Bio 2 = 1000 g nitrobein + 1000 g phosphorein Bio 3 = 1500 g nitrobein + 1500 g phosphorein

Flowering Characters

Effect of drip irrigation rates

Table 3 shows the effect of drip irrigation rates on main inflorescence characters (length, diameter and fresh weight), number of total inflorescences/plant and longevity of main inflorescence in two seasons.

It is obvious from the data in Table 3 that length, diameter and fresh weight of main inflorescence, number of total inflorescences/ plant and longevity were increased with increasing water quantity applied to plants in sandy soil from 784 up to 2352 m^3/faddan. The highest water quantity for increasing length, diameter and fresh weight of main inflorescence, number of total inflorescences/plant and longevity was 2352 m^3/fad. in two seasons under study. These results are in good line with those obtained from the data of vegetative growth in Table 2 in this study.

The obtained results are in harmony with those reported by Dore (2004) on rose, Anupama *et al.* (2005) on chrysanthemum, Nickolee *et al.* (2006) on *Echinacea purpurea* L. and Álvarez *et al.* (2009) on *Dianthus caryophyllus* L., they showed that increasing irrigation water amounts to plants increased significantly fresh and dry weights of inflorescence, number of total inflorescences/plant and longevity.

Effect of biofertilizers rates

Data recorded on main inflorescence characters, number of total inflorescences/plant and longevity as influenced by biofertilizers rates are shown in Table 3. It is obvious from such data that raising the application rates of nitrobein and phosphorein to plants caused,

Table 3. Effect of drip irrigation rates, biofertilizers rates and antioxidants on flowering characters of *Echinacea purpurea* L., during two seasons of 2010 and 2011

Characters / Treatments	Length of main inflore. (cm)		Diameter of main inflore. (cm)		F.W of main inflore. (g)		No. of total inflore./plant		Longevity of main inflore.	
	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
Effect of drip irrigation rates										
784 m^3/fad.	25.94	25.78	8.01	7.77	14.89	12.39	31.80	32.78	8.30	8.23
1568 m^3/fad.	31.65	31.51	8.86	8.71	20.92	15.93	40.06	45.18	9.86	9.90
2352 m^3/fad.	31.95	30.79	9.01	8.98	21.93	16.22	43.89	47.53	10.37	10.97
LSD$_{0.05}$	0.66	0.91	0.13	0.18	0.90	1.03	1.23	1.07	0.11	0.17
Effect of biofertilizers rates										
Control	26.93	26.71	8.15	8.04	15.94	12.36	33.87	35.16	8.40	8.83
Bio.1	29.16	28.42	8.47	8.28	18.24	14.07	38.08	39.18	9.21	9.35
Bio.2	31.31	30.40	8.76	8.67	20.80	15.51	40.05	44.60	10.01	10.04
Bio.3	32.00	31.92	9.14	8.96	22.00	17.46	41.85	48.38	10.42	10.57
LSD$_{0.05}$	0.50	1.01	0.11	0.06	0.57	0.50	2.01	1.68	0.18	0.12
Effect of antioxidants										
Control	27.33	26.32	8.01	8.06	15.60	11.43	30.15	36.28	8.70	9.00
Citric acid	29.45	28.08	8.51	8.31	18.22	13.68	35.60	39.75	9.35	9.46
Salicylic acid	30.10	30.28	8.81	8.60	20.12	15.58	39.26	43.70	9.69	9.92
Glutathione	32.51000	32.76	9.18	8.97	23.05	18.70	49.32	47.58	10.29	10.42
LSD$_{0.05}$	0.57	0.72	0.11	0.12	0.62	0.49	2.11	2.05	0.15	0.23

Control = zero untreated
Bio 1 = 500 g nitrobein + 500 g phosphorein
Bio 2 = 1000 g nitrobein + 1000 g phosphorein
Bio 3 = 1500 g nitrobein + 1500 g phosphorein

generally, gradual and steady increase in length, diameter and fresh weight of main inflorescence, number of total inflorescences/plant and longevity in both seasons as compared to untreated plants. In this respect, inoculation plants with biofertilizers at rate of 1500 g nitrobein + 1500 g phosphorein/fad. recorded the highest values of main inflorescence characters, number of total inflorescences/plant and longevity than other biofertilizers rates or control treatments.

The presented results coincided with those reported by Singh *et al.* (2008) on *Calendula officinalis* and Abo El-Fetooh (2010) on marigold, who illustrated that raising the application rates of nitrobein and phosphorein to plants caused a generally gradual and steady increase in flower diameter, flower fresh and dry weights and flower number.

Effect of antioxidants

Data given in Table 3 show that main inflorescence characters (length, diameter and fresh weight of main inflorescence, number of total inflorescences/plant and longevity) were promoted with all spraying antioxidants in both seasons upon control. In this respect, spraying plants with glutathione recorded high values than other antioxidants or control treatments. Meanwhile, salicylic acid had a positive increase than citric acid.

These results are in agreement with those obtained by Meir *et al.* (1994) on cut flowers of *Godetia grandiflora* as well as rose and Zeng *et al.* (2011) on *Dianthus caryophyllus* L., results showed that all spraying materials improved flowering characters as compared to control.

Sugars and Total Carbohydrates

Effect of drip irrigation rates

Data in Table 4 clear that drip irrigation rates had a significant effect on sugar and total carbohydrates. Reducing sugars content decreased with increasing water quantity applied from 784 to 2352 m^3/fad. On the other hand, non reducing as well as total sugars and total carbohydrates contents increased with increasing water quantity. Under water stress, the absorption of water by plants decreased and then water content in the tissues decreased also as a result and that could be led to increase the concentration of sugars and pyruvic acid in tissues.

These results are in line with those reported by Wook *et al.* (1998) on chrysanthemum and Saleem (2007) on tuberose. They reported that reducing sugar contents decreased with increasing water quantity. On the other hand, non reducing and total sugars and total carbohydrates contents increased with increasing water quantity.

Effect of biofertilizers rates

Data in Table 4 illustrate the effect of biofertilizers rates on sugar and total carbohydrates contents. It is clear from the data in Table 4 that biofertilizers rates had significant effect on sugar and total carbohydrates contents. Moreover, addition of biofertilizers to plants, promoted non reducing and total sugars and total carbohydrates upon without inoculation treatment (control).

Results in Table 4 reveal that reducing sugars were decreased with increasing biofertilizers rates. On the other hand, non reducing and total sugars and total carbohydrates contents were increased with increasing biofertilizers rates.

These above mentioned results coincided with those reported by Ali (2009) on fennel and Abo El-Fetooh (2010) on marigold, who found that reducing sugar decreased with increasing biofertilizers rates. On the other hand, non reducing and total sugars and total carbohydrates contents were increased with increasing biofertilizers rates.

Effect of antioxidants

It is quite clear from data in Table 4 that spraying plants with antioxidants (citric acid, salicylic acid and glutathione) at rate of 100 ppm caused a significant increase in non reducing and total sugars and total carbohydrates contents upon control. On the other hand, reducing sugars was at the highest values without spraying plants by antioxidants. Spraying plants with glutathione caused a higher increase of non reducing and total sugars and total carbohydrates contents compared with other antioxidants.

Under low soil moisture level water stress under this conditions, that may be caused losses in tissue water which reduced turgor pressure in the cell, thereby inhibited enlargement and division of cells, reduced photosynthetic activity, (Mahajan and Tuteja, 2005), increased in ABA/cytokine ratio, which in turn decreases plant growth (Marschner, 1995) and decreased carbohydrate metabolism, protein synthesis and the activities of many enzymes that may reflect a change in the balance between rates of synthesis and degradation leading to decrease in plant growth and dry matter accumulation (Hamlyn, 1986). On the other hand, under sufficient water conditions there was decrease in ABA and an increase in cytokinin, GA and IAA reflecting good growth and dry matter content (Marschner, 1995).

Biofertilizer may induce growth promotion directly or indirectly. Directly influence includes production of phytohormons, improving availability of nutrient, non symbiotic nitrogen fixation and stimulation of disease resistance mechanisms (Zdor and Anderson, 1992), which all together may promote the vegetative growth. Indirect effect arises altering the root environment and ecology. Biofertilizers releasing of certain other nutrients; viz., Fe, Zn and Mn (Bhonde *et al.,* 1997), through the break down of organic nutrients in the soil and make these elements in available forms, producing some organic acids and phytohormones which could stimulate absorption of nutrients and consequently high dry weight could be achieved (Jagnow *et al.,* 1991).

The enhancement effect of applied antioxidants on plant height may be explained as these substances encourage nutrients absorption and stimulate some growth activators synthesis, enhance plant cell growth and development and stimulate cell vacuolization and elongation as well as root growth factors that's could positively reflected on plant growth (Abd El-Naem, 2005). Antioxidants used to overcome the harmful effect of some environmental stresses on plant growth (El-Khayat, 2001). which reflected on main inflorescence characters.

Table 4. Effect of drip irrigation rates, biofertilizers rates and antioxidants on sugar and total carbohydrates contents in leaves of *Echinacea purpurea* L., during two seasons of 2010 and 2011

Characters / Treatments	Reducing Sugars (%)		Non reducing sugars (%)		Total sugars (%)		Total carbohydrates (%)	
	2010	2011	2010	2011	2010	2011	2010	2011
1. Effect of drip irrigation rates								
784 m^3/fad.	3.02	3.08	7.58	7.75	10.60	10.82	27.33	27.15
1568 m^3/fad.	2.66	2.85	8.58	9.08	11.24	11.93	29.77	29.83
2352 m^3/fad.	2.41	2.50	9.94	10.15	12.35	12.64	31.80	32.27
$LSD_{0.05}$	0.04	0.03	0.01	0.02	0.02	0.03	0.02	0.02
2. Effect of biofertilizers rates								
Control	2.79	2.91	8.30	8.56	11.09	11.46	28.82	28.86
Bio.1	2.72	2.84	8.57	8.88	11.30	11.71	29.42	29.47
Bio.2	2.67	2.77	8.83	9.17	11.50	11.94	29.90	30.06
Bio.3	2.60	2.71	9.09	9.36	11.69	12.07	30.39	30.63
$LSD_{0.05}$	0.02	0.01	0.01	0.02	0.03	0.04	0.03	0.04
3. Effect of antioxidants								
Control	2.72	2.83	8.60	8.89	11.32	11.72	29.45	29.53
Citric acid	2.70	2.82	8.67	8.96	11.38	11.78	29.57	29.67
Salicylic acid	2.69	2.80	8.73	9.02	11.42	11.82	29.69	29.83
Glutathione	2.67	2.78	8.79	9.09	11.46	11.87	29.83	29.98
$LSD_{0.05}$	0.01	0.01	0.02	0.02	0.03	0.02	0.03	0.04

Control = zero untreated; Bio 1 = 500 g nitrobein + 500 g phosphorein
Bio 2 = 1000 g nitrobein + 1000 g phosphorein; Bio 3 = 1500 g nitrobein + 1500 g phosphorein

REFERENCES

AOAC. (1990). Official Methods of Analysis of the Association Official Agricultural Chemists, published by Association of Official Agric. Chemist. 13th (ed.) Washington.

Abd El-Naem, G.F. (2005). Effects of three antioxidants on some chemical constituents enzymatic browning of tomato and browning prevention by polyphenol oxidase inhibitors. Minia J. Agric. Res. Dev., 25 (5) 815-842.

Abo El-Fetooh, H.A. (2010). Effect of biofertilizer on the growth and chemical composition of *Calendula officinalis* L. Ph.D. Thesis, Fac. Agric., Mansoura Univ., Egypt.

Ali, H.M.H. (2009). Effect of biofertilization on growth, yield and constituents of fennel plant. Ph.D. Thesis, Fac. Agric., Cairo Univ., Egypt.

Álvarez, S., A. Navarro, S. Bañón and M.J. Sánchez-Blanco (2009). Regulated deficit irrigation in potted *Dianthus* plants: Effects of severe and moderate water stress on growth and physiological responses. Scientia Hort., 122 (4): 579-585.

Anupama S., M.C. Singh, R. Kumar, B.S. Parmar and A. Kumar (2005). Performance of a new superabsorbent polymer on seedling and post planting growth and water use pattern of chrysanthemum grown under controlled environment. Acta Hort., 742 : 43-49.

Bhonde, S.R., S.B. Sharma and A.B. Chougule (1997). Effect of biofertlizer in combination with nitrogen through organic and inorganic sources on yield and quality of onion. National Hort. Res. Dev.. Found, 17 (2): 1-3.

Dore, C.P. (2004). Malformation of roses due to drought stress. Scientia Hort., 99 (1): 79-87.

Dube, K.G. (2011). Effect of organic manures, biofertilizers and growth regulators in alone and combination treatments on the growth of leaves in *Stevia rebaudiana* Bertoni. Asiatic J. Biotech. Resources, 2 (4): 403-413.

El-Khayat, A.S.M. (2001). Physiological effects of tryptophane, thiamine and ascorbic acid on *Hibisscus sabdariffa,*L. plants. The 5th Arabian Hort. Conf. Ismailia, Egypt, 11: 251-263.

Halepyati, A.S., K. Sujatha and M. Prabhakar (2002). Growth, yield and water use of summer tuberose as influenced by irrigation regime and plant density. J.Ornamental Hort. New Series, 5 (1): 47-50.

Hamlyn, G.J. (1986). Drought and drought tolerance in plants and microclimate. Cambridge Univ. Press, Cambridge, London, New York, New Rochelle, Melbourne, Sydney, 212-237.

Hobbs, C. (1989). The Echinacea Handbook. 118 pp, Eclectic Institute Inc., 2545 N.W. Division.

Hussain, M., M.A. Malik, M. Farooq, M.Y. Ashraf and M.A. Cheema (2008). Improving drought tolerance by exogenous application of glycinebetaine and salicylic acid in sunflower. J. Agr. and Crop Sci., 194 (3): 193-199.

Jagnow, G.G., H. Hoflich and K.H. Hoffman (1991). Inoculation of non symbiotic rhizosphere bacteria possibilities of increasing and stabilizing yield. Angew Botanik, 65: 97- 126.

Mahajan, S. and N. Tuteja (2005). Cold, salinity and drought stresses: an overview. Arch. Biochem. Biophys., 444 : 139–158.

Mamta, B.P.R., V. Pathaniad, A. Gulatic, B. Singh, R.K. Bhanwra and R. Tewari (2010). Stimulatory effect of phosphate-solubilizing bacteria on plant growth, stevioside and rebaudioside-A contents of *Stevia rebaudiana* Bertoni. Applied Soil Ecology, 46 : 222–229.

Marschner, H. (1995). Mineral Nutrition of Higher Plants. 2nd (ed.), Academic Press Limeted, Text Book.

Meir, S., Y. Reuveni, I. Rosenberger, H. Davidson, S. Philosoph-Hadas and P. Sass (1994). Improvement of the postharvest keeping quality of cut flowers and cuttings by application of water-soluble antioxidants. Acta-Hort., 368: 355-364.

Mittler, R. (2002). Oxidative stress, antioxidants and stress tolerance, Trends Plant Sci., 7: 405-410.

Nickolee, Z., R. Kjelgren, R. Cerny-Koenig, K. Kopp and R. Koenig (2006). Drought responses of six ornamental herbaceous perennials. Scientia Hort., 109 (3): 267-274.

Saleem, F.E.M. (2007). Pre and postharvest treatments as affecting the growth and keeping quality of tuberose in the new lands. M.Sc. Thesis, Fac. Agric., Zagazig Univ., Egypt.

Singh, Y.P., R. Dwivedi and S.V. Dwivedi (2008). Effect of biofertilizer and graded dose of nitrogen on growth and flower yield of calendula (*Calendula officinalis*, L.). Plant Archives, 8 (2): 957-958.

Steel, R.G.D. and S.H. Torrie (1980). Principles and Procedures of Statices. Mc Gra Hill Book Comp., JWC, New York.

Veerendra, P.S., R.K. Singh, J. Prakashl, A.K. Singh and S.I. Biradar (2011). Effect of spacing and biofertilizers on yield and quality parameters of stevia (*Stevia rebaudiana* Bertoni). Int. J. Agric. Sci., 7 (2): 325-329.

Wook, O.H., O.H. Kim-KiSun and K.S. Kim (1998). Effects of irrigation method and frequency, and nutrient solution on rooting, growth, and nutrient uptake of chrysanthemum cuttings. J. Korean Society Hort. Sci., 39 (4): 464-468.

Younis, S.I., I.A. Moursi, F.R. Moussa and I.A. Shalaby (2009). Effect of irrigation intervals on the yield and quality of Roselle plants (*Hibiscus sabdariffa* L.) under drip irrigation in heavy clay soils. J. Biol. Chem. Environ. Sci., 4 (1): 589-605.

Yousef, R.M.M., A.M.A. Hamouda and N.G. Ghaly (2008). Effect of irrigation and organic fertilization on growth and productivity of *Majorana hortensis* L., in sandy soils. J. Agric. Sci., Mansoura Univ., 33 (11): 8039-8056.

Zdor, R.E. and A.J. Anderson (1992). Influence of root colonizing bacteria on the defense response of bean. Plant and Soil, 140: 99-107.

Zeng, C.L., L. Liu and G.Q. Xu (2011). The physiological responses of carnation cut flowers to exogenous nitric oxide. Scientia Hort., 127 (3): 424-430.

التأثيرات الرئيسية لمعدلات الرى بالتنقيط ومعدلات الأسمدة الحيوية ومصـــادر مضادات الأكســـدة على النمو والتزهير والمحتوى الكيماوى للإشينسيا المزروعة فى الأراضى المستصلحة حديثا

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أجريت تجربتان حقليتان خلال موسمى ٢٠١٠ ، ٢٠١١ فى مزرعة التجارب البحثية بمحطة بحوث البساتين بالقصاصين ، محافظة الاسماعيلية ، مصر، لدراسة تأثير معدلات الرى بالتنقيط (٧٨٤ ، ١٥٦٨ ، ٢٣٥٢ م^3/فدان) ومعدلات الأسمدة الحيوية (كنترول ، ٥٠٠ جم نتروبين/فدان + ٥٠٠ جم فوسفورين/فدان ، ١٠٠٠ جم نتروبين/فدان + ١٠٠٠ جم فوسفورين/فدان ،١٥٠٠ جم نتروبين/فدان + ١٥٠٠ جم فوسفورين/فدان)، وأربعة مصادر لمضادات الأكسدة (كنترول وحمض الستريك وحمض السلسليك والجلاتاثيون) بتركيز ١٠٠ جزء من المليون من كل منها على النمو الخضرى والإزهار والمحتوى الكيماوى لنباتات الإشينسيا، وقد أوضحت النتائج زيادة النمو الخضرى والإزهار والمحتوى الكيماوى لنباتات الإشينسيا زيادة معنوية مع زيادة كمية المياة من ٧٨٤ إلى ٢٣٥٢ م^3/فدان فى كلا من الموسمين، كما أظهرت البيانات أن زيادة معدلات الأسمدة الحيوية من النتروبين والفوسفورين المضاف إلى النباتات أدى إلى تدرج فى زيادة النمو الخضرى والإزهار والمحتوى الكيماوى فى الموسمين مقارنة بمعاملة عدم التلقيح (الكنترول)، وفى نفس الإتجاة ، سجلت معاملة تلقيح النباتات بمعدل ١٥٠٠ جم نتروبين + ١٥٠٠ جم فوسفورين أفضل القيم من النمو الخضرى، والإزهار، والمحتوى الكيماوى مقارنة بباقى معاملات التسميد الحيوى ومعاملة الكنترول، كما أظهرت النتائج تحسناً في النمو الخضرى والإزهار والمحتوى الكيماوى مع كل معاملات الرش بمضادات الأكسدة مقارنة بمعاملة الكنترول، وأعطى رش النباتات بالجلوتاثيون أعلى القيم من النمو الخضرى والإزهار والمحتوى الكيماوى مقارنة بباقى معاملات مضادات الأكسدة.

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