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Effect of foliar application of some vitamins and irrigation intervals on vegetative growth, flowering, and some biochemical constituents of *Helianthus annuus L.* plants.

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ABSTRACT

A pot experiment was conducted during the seasons of 2017 and 2018 at Antoniades Research Branch, Horticulture Research Institute, A.R.C. Alexandria, Egypt to study the effects of foliar spray of some vitamins (control, ascorbic acid, α-tocopherol or nicotinamide) at 100 ppm and irrigation intervals (2 or 3 days) on the vegetative growth, flowering, and some biochemical constituents of *(Helianthus annuus* L.) plants. The results cleared that, most parameters were significantly affected by application of the three vitamins which were used in this study. The magnitude of increase is more pronounced by applying α-tocopherol, where, using α-tocopherol by 100 ppm gave the highest number of leaves and stem diameter, and the lowest proline concentration. Also, using of α-tocopherol by 100 ppm combined with 3 days irrigation interval gave the highest significant increases in the plant height, leaf area, leaves dry weight, stem dry weight, flower duration, flower dry weight, and leaves content of chlorophyll a, chlorophyll b and total carbohydrate.

KEYWORDS: *Helianthus annuus* L. - ascorbic acid - α-tocopherol - nicotinaide - irrigation intervals.

1. INTRODUCTION

Sunflower (*Helianthus annuus* L.) plant is a member of family Asteraceae. Its native origin is North America. It has been used in gardens as an ornamental plant for several years (Kirtimala *et al*, 2018). The beauty of its inflorescence, the possibility of using it as a cut flower increased its value in the flower and ornamental plant markets. (Cormenzana, 2001).

Water requirement is the most important factor that effect on the yield of sunflower. Kakar and Soomro (2001) found that increasing irrigation intervals caused a reduction in plant height, seed yield, head diameter, seed index, seed oil content and percentage of unfilled seeds. Also, Anwar *et. al.*, (1995) reported that all sunflower yield components were affected by the number of irrigations.

Vitamins have vital importance on plant growth, they help plants to grow by providing them with essential nutrients. They also improve their immunity against plant diseases. Application of vitamins is accompanied by enhancing alpha keto glutaric acid biosynthesis which is united with ammonia to form amino acids and proteins, controlling the incidence of disorders and stimulating the biosynthesis of natural hormones like IAA, cytokinins and gibberellins, cell division, plant pigments, enzymes, organic foods and plant metabolism (Oretili, 1987 and Samiullah et al., 1988). Vitamins have antioxidant properties which play a vital role in plant defense against oxidative stresses induced by unfavorable conditions.

Ascorbic acid (vitamin C) is an essential compound for plant tissues as it has antioxidant function, acts as an enzymatic cofactor and a plant growth regulator (Gomez and Lajolo, 2008). Ascorbic acid plays an important role in different processes. Like, photosynthesis, photoprotection and cell expansion resistance to environmental stress (Nicholas and Wheeler, 2000). Ahlam and Mustaf, 2019 reported that ascorbic acid plays an important role in controlling the timing of flowering and aging.

α-tocopherol (vitamin E) is a low molecular weight lipophilic antioxidant which protect membrane from oxidative damage (Hess 1993 and El Bassiouny *et al*. 2005).

Nicotinamide (vitamin B3) is a water-soluble vitamin, it is a part of vitamin B group. Nicotinamide is a well- characterized constituent of the pyridine dinucleotide coenzymes NADH and NADPH, nicotinamide induces and regulates secondary metabolic accumulation and the manifestation of defense metabolism in plant (Berglund, 1994, Sadak *et al*, 2010 and Bayan, 2019).

This study is a trial to investigate the effect of different vitamins and irrigation intervals on the vegetative growth, flowering and some biochemical constituents of *Helianthus annuus* L. in an effort to produce plants with high quality and providing the amount of used irrigation water.

2. MATERIALS AND METHODS

This study was done at Antoniades Research Branch, Horticulture Research Institute, A.R.C. Alexandria, Egypt, during the two successive seasons of 2017 and 2018.

Three weeks uniform sunflower seedlings were transplanted to plastic pots of 25 cm diameter using a mixture of sandy and clay soil at the ratio of 1:1 by volume on the 5th of April 2017 and the 11th of April 2018 in the first and second season respectively. The chemical analysis of the used medium is presented in Table (a).

Table a. Chemical analysis of the used mixture soil for the two growing seasons.

pH	EC ds/m	Cations (meq/l)				Anions (meq/l)		
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^-	Cl^-	SO_4^{--}
7.95	**1.60**	1.50	0.80	1.60	0.59	1.06	1.25	0.98

Two irrigation intervals treatments i.e. every 2 or 3 days were used combined with four vitamins treatments i.e. control, ascorbic acid (vitamin C), α-tocopherol (vitamin E) or nicotinamide (vitamin B3) producing (2x4= 8 treatments).

After one week from the transplanting date on the 12th of April 2017 and the 18th of April 2018 (in the first and second seasons, respectively) similar plants in shapes were arranged into the experiment and the irrigation treatments were started. Plants were irrigated till 100 % of the filed capacity of the used soil every 2 or 3 days. On the 13th of April 2017 and the 19th of April 2018 (in the first and second seasons, respectively) freshly prepared solutions of ascorbic acid (vitamin C), α-tocopherol (vitamin E) or nicotinamide (vitamin B3) at 100 ppm were prepared and sprayed with hand sprayer until the plants were wet to run off and control plants were sprayed with distilled water. The vitamins treatments repeated three times at two weeks intervals. All plants received normal fertilization of this plant. On the 2nd of July 2017 and 10th of July 2018 (in the first and second seasons, respectively) the experiment was terminated.

2.1. The following data were measured in both of the two growing seasons:

2.1.1. Vegetative growth:

Plant height (cm), leaves number, leaf area/plant according to Zidan, 1962. (cm^2), stem diameter (cm), leaves dry weight (g), and stem dry weight (g).

2.1.2. Flowering characteristics:

Flowering date (days), flower duration (days), flower diameter (cm) and flower dry weight (g).

2.1.3. Leaves chemical analysis:

Chlorophyll a and b content (mg/100 g fresh weight) was determined according to Moran (1982), total carbohydrate content (%) according to (Hedge and Hofreiter 1962) and proline content (µg/g) according to Bates *et al.* (1973).

The experiment layout was designed to provide complete randomized block design in factorial experiment, which contained three replicates, each replicate contained eight treatments. four pots were used as an experimental unit for each treatment in each replicate. The means of the individual factors and their interactions were compared by L.S.D test at 5% level of probability according to Snedecor and Cochran (1989).

3. RESULTS

3.1. Vegetative growth characteristics:

3.1.1. Effect of vitamins:

Application of vitamins treatments significantly affected all studied sunflower traits in 2017 and 2018 seasons (Tables 1 and 2). Data presented in Table (1) showed that all vitamins treatments have a significant increase in plant height, number of leaves per plant and leaf area per plant compared with the control in both seasons. Generally, data in the two experimental seasons indicated that, α-tocopherol caused the highest increase in plant height (94.65 and 109.11 cm), number of leaves per plant (25.11 and 30.03) and leaf area per plant (515.79 and 629.83) in the first and second seasons, respectively compared to the other treatments. Also, data in Table (2) cleared that application of any vitamin significantly increased the stem diameter, leaves and stem dry weight compared to the control. The highest increase in stem diameter (0.96 and 1.08 cm), leaves dry weight (7.06 and 8.84 g) and stem dry weight (10.11 and 12.66 g) in the both seasons, respectively were obtained with foliar spray of α-tocopherol at 100 ppm.

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Table 1. Means of the plant height (cm), number of leaves and leaf area/plant (cm^2) of *Helianthus annuus* L., as influenced by the interaction between foliar spray of different vitamins and different irrigation intervals during the two successive seasons of 2017 and 2018.

Treatments		**Plant height (cm)**		**Number of leaves**		**Leaf area/plant (cm^2)**	
Irrigation intervals (I)	**Vitamins Type (V)**	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
2 days	Control	78.67	95.83	18.83	24.11	375.20	473.28
	Ascorbic	86.17	103.22	20.00	25.94	390.00	550.66
	α-tocopherol	88.22	104.33	24.00	29.39	400.00	560.00
	Nicotinamide	84.17	98.33	22.83	27.67	393.90	564.67
Mean		**84.31**	**100.43**	**21.42**	**26.78**	**389.77**	**537.15**
3 days	Control	75.50	93.33	18.00	23.44	372.29	459.89
	Ascorbic	90.78	101.00	21.89	26.50	414.62	526.85
	α-tocopherol	101.07	113.89	26.22	30.67	631.58	699.67
	Nicotinamide	97.50	105.89	21.67	28.56	505.73	606.20
Mean		**91.21**	**103.53**	**21.94**	**27.29**	**481.05**	**573.15**
Mean of (V)	Control	77.08	94.58	18.42	23.78	373.74	466.59
	Ascorbic	88.47	102.11	20.94	26.22	402.31	538.76
	α-tocopherol	94.65	109.11	25.11	30.03	515.79	629.83
	Nicotinamide	90.83	102.11	22.25	28.11	449.81	585.43
L.S.D. at 0.05	I	N.S	N.S	N.S	N.S	34.05	30.30
	V	5.75	4.04	2.64	2.58	48.15	42.85
	V X I	8.13	5.72	N.S	N.S	68.09	60.61

L.S.D. at 0.05 = Least significant different at 0.05 level of probability. N.S. = not significant

Table 2. Means of the stem diameter (cm), leaves and stem dry weight (g) of *Helianthus annuus* L., as influenced by the interaction between foliar spray of different vitamins and different irrigation intervals during the two successive seasons of 2017 and 2018.

Treatments		**Stem diameter (cm)**		**leaves dry weight (g)**		**Stem dry weight (g)**	
Irrigation intervals (I)	**Vitamins Type (V)**	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
2 days	Control	0.76	0.78	5.15	5.27	7.03	8.07
	Ascorbic	0.83	0.86	6.33	7.44	8.33	9.33
	α-tocopherol	0.93	1.05	6.38	8.33	9.50	11.99
	Nicotinamide	0.84	0.93	6.10	7.06	9.05	11.18
Mean		**0.84**	**0.90**	**5.99**	**7.03**	**8.48**	**10.14**
3 days	Control	0.74	0.76	4.40	4.82	6.83	7.78
	Ascorbic	0.84	0.89	7.22	8.07	8.41	11.33
	α-tocopherol	1.00	1.10	7.75	9.35	10.73	12.99
	Nicotinamide	0.87	0.97	6.90	8.30	9.29	12.35
Mean		**0.86**	**0.93**	**6.57**	**7.63**	**8.81**	**11.11**
Mean of (V)	Control	0.75	0.77	4.77	5.04	6.93	7.93
	Ascorbic	0.84	0.87	6.78	7.76	8.37	10.33
	α-tocopherol	0.96	1.08	7.06	8.84	10.11	12.49
	Nicotinamide	0.86	0.95	6.50	7.68	9.17	11.76
L.S.D. at 0.05	I	N.S	N.S	0.44	0.36	0.28	0.74
	V	0.09	0.11	0.62	0.51	0.40	1.04
	V X I	N.S	N.S	0.88	0.72	0.56	1.48

L.S.D. at 0.05 = Least significant different at 0.05 level of probability. N.S. = not significant

3.1.2. Effect of irrigation intervals:

Data in Tables (1) indicated that, applying the 3 days irrigation intervals gave a significant increase in leaf area per plant (481.05 and 573.15 cm^2) during the two seasons, respectively compared with the 2 days intervals. However, there were insignificant difference between using either the two irrigation intervals on plant height and number of leaves during the two seasons. In addition, Tables (2) showed that, the 3 days irrigation intervals cause a significant increase in leaves Dry weight (6.57 and 7.63 g) and stem dry weight (8.81 and 11.11 g) in the first and second seasons, respectively compared to the 2 days intervals. On the contrary, using any of the two irrigation intervals did not cause a significant difference in stem diameter during the two experimental seasons.

3.1.3. The interaction between vitamins and irrigation intervals:

The interaction effect of irrigation intervals with the treatments of vitamin are presented in Table (1 and 2). The recording data showed that using the experimental vitamins could promote the vegetative growth of plants which are watered every 2 or 3 days compared with zero vitamin treatments. We observe that no usage of vitamins led to decrease in growth parameters with increasing the irrigation intervals. The highest significant increase of plant height (101.07 and 113.89 cm), leaf area (631.58 and 699.67 cm^2), leaves dry weight (7.75 and 9.39 g) and stem dry weight (10.73 and 12.99 g) in both seasons were obtained with using 3 days irrigation intervals combined with α-tocopherol at 100 ppm. The statistical analysis of the obtained data of number of leaves and stem diameter were not great enough to reach the level of significant at 5%.

3.2. Flowering characteristics:

3.2.1. Effect of vitamins:

Table (3) showed that different vitamins treatments caused a significant difference in flowering starting date (day), flower duration (day), flower diameter (cm) and flower dry weight (g) of sunflower plants comparing with the control treatment in both seasons. Moreover, using of the ascorbic acid gave the highest reduction in the time needed for flowering (80.28 and 85.67 day) and the maximum flower diameter (10.71 and 10.68 cm), where, using of α-tocopherol led to the highest flower duration (18.31and 17.97 day) and flower dry weight (6.79 and 7.40 g) compared with the other treatments during the two seasons.

3.2.2. Effect of irrigation intervals:

Data presented in Tables (3) showed that the application of higher irrigation intervals (3days) resulted in the better all the flowering characters on sunflower plants than using the lower intervals (2days). The previous data were true in both experimental seasons. The statistical analysis of the obtained data reveals that flower duration (16.25 and 15.81day) and flower dry weight (6.271 and 6.66 g) significantly increased by application of higher irrigation intervals (3days). On the other hand, these increase of flowering starting date (day) and flower diameter (cm) did not reach the significant level.

3.2.3. The interaction between vitamins and irrigation intervals:

Regarding with the interaction of both factor's data in Table (3) found that, flowering characters of sunflower plants was significant effect except the flowering starting date and flower diameter. Generally, the obtained data in both seasons indicated that the highest significant increase in flower duration (20.28 and 19.33 day) and flower dry weight (7.73 and 7.93 g) were recorded when plants sprayed by α-tocopherol (100ppm) and irrigated every 3days as compared with the other interaction treatments.

3.3. Chemical composition

3.3.1. Effect of vitamins:

Table (4) cleared that application of any of the mentioned vitamins significantly increased chlorophyll a, chlorophyll b and total carbohydrate contents, also, it led to a significant decrease in proline concentration in plant leaves as compared to the control treatment. Generally, application of α-tocopherol caused the highest increase in chlorophyll a (81.65 and 85.59 mg/100g), chlorophyll b (20.44 and 25.10 mg/100g) and total carbohydrate content (21.23 and 21.83 %) and lowest concentration of proline (64.45 and 71.15 µg/g) in the two growing seasons.

3.3.2. Effect of irrigation intervals:

The results of Table (4) show that 3days irrigation intervals superiority over 2 days in the chlorophyll a (77.64 and 80.72 mg/100g) and chlorophyll b (19.72 and 22.96 mg/100g) in the leaves of plant, furthermore, it decreased the concentration of proline (74.77 and 79.82 µg/g) in both experimental seasons. But, the increase of total carbohydrate did not reach the significant level.

Table 3. Means of the flowering starting date (days), flower duration (days), flower diameter (cm) and flower dry weight (g) of *Helianthus annuus* L., as influenced by the interaction between foliar spray of different vitamins and different irrigation intervals during the two successive seasons of 2017 and 2018.

Treatments		Flowering starting date (days)		Flower duration (days)		Flower diameter (cm)		Flower dry weight (g)	
Irrigation intervals (I)	**Vitamins Type (V)**	2017	2018	2017	2018	2017	2018	2017	2018
2 days	Control	95.06	95.22	13.06	12.83	8.68	9.14	4.56	5.40
	Ascorbic	77.89	86.44	16.12	16.28	10.62	10.68	5.90	6.65
	α-tocopherol	84.56	85.00	16.33	16.61	9.30	10.45	5.85	6.87
	Nicotinamide	82.22	84.33	16.00	15.56	9.68	9.95	5.67	6.21
Mean		**84.93**	**87.75**	**15.38**	**15.32**	**9.57**	**10.06**	**5.50**	**6.28**
3 days	Control	95.67	97.22	12.83	12.22	8.50	8.45	4.50	5.08
	Ascorbic	82.67	84.89	16.89	16.56	10.80	10.68	6.63	7.31
	α-tocopherol	84.67	89.67	20.28	19.33	10.00	9.67	7.73	7.93
	Nicotinamide	86.33	89.33	15.00	15.11	8.94	10.01	6.21	6.33
Mean		**87.33**	**90.28**	**16.25**	**15.81**	**9.56**	**9.70**	**6.27**	**6.66**
Mean of (V)	Control	95.36	96.22	12.94	12.53	8.59	8.80	4.53	5.24
	Ascorbic	80.28	85.67	16.51	16.42	10.71	10.68	6.26	6.98
	α-tocopherol	84.61	87.33	18.31	17.97	9.65	10.06	6.79	7.40
	Nicotinamide	84.28	86.83	15.50	15.33	9.31	9.98	5.94	6.27
L.S.D. at 0.05	I	N.S	N.S	0.65	0.38	N.S	N.S	0.38	0.27
	V	6.19	3.23	0.92	0.54	0.71	0.79	0.54	0.38
	V X I	N.S	N.S	1.30	0.76	N.S	N.S	0.76	0.54

L.S.D. at 0.05 = Least significant different at 0.05 level of probability. N.S. = not significant

Table 4. Means of the chlorophyll a, b (mg/100g leaves fresh weight), total carbohydrate (%) and proline concentration (µg/g) of *Helianthus annuus* L., as influenced by the interaction between foliar spray of different vitamins and different irrigation intervals during the two successive seasons of 2017 and 2018.

Treatments		chlorophyll a (mg/100g leaves fresh weight)		chlorophyll b (mg/100g leaves fresh weight)		Total carbohydrate (%)		Proline concentration (µg/g)	
Irrigation intervals (I)	**Vitamins Type (V)**	2017	2018	2017	2018	2017	2018	2017	2018
2 days	Control	51.14	60.91	12.41	17.47	14.33	14.49	107.97	109.96
	Ascorbic	68.52b	72.52	17.17	18.52	18.67	19.72	96.06	97.06
	α-tocopherol	73.18	80.15	18.03	22.80	20.17	21.00	67.82	77.33
	Nicotinamide	69.47	82.67	17.48	23.70	18.61	19.95	78.71	83.61
Mean		**65.58**	**74.06**	**16.27**	**20.62**	**17.95**	**18.79**	**87.64**	**91.99**
3 days	Control	47.07	57.73	11.98	14.49	14.00	14.05	102.17	111.67
	Ascorbic	88.58	88.21	22.72	24.97	21.38	22.51	70.51	72.54
	α-tocopherol	90.12	91.04	22.84	27.39	22.30	22.67	61.08	64.97
	Nicotinamide	84.77	85.90	21.36	24.97	18.33	18.68	65.31	70.09
Mean		**77.64**	**80.72**	**19.72**	**22.96**	**19.00**	**19.48**	**74.77**	**79.82**
Mean of (V)	Control	49.10	59.32	12.20	15.98	14.17	14.27	105.07	110.81
	Ascorbic	78.55	80.36	19.95	21.74	20.02	21.12	83.29	84.80
	α-tocopherol	81.65	85.59	20.44	25.10	21.23	21.83	64.45	71.15
	Nicotinamide	77.12	84.28	19.42	24.34	18.47	19.32	72.01	76.85
L.S.D. at 0.05	I	4.49	3.10	2.73	1.54	N.S	N.S	14.49	14.10
	V	6.35	4.38	3.87	2.17	2.13	1.19	10.25	9.97
	V X I	8.98	6.20	5.47	3.07	3.01	1.69	N.S	N.S

L.S.D. at 0.05 = Least significant different at 0.05 level of probability. N.S. = not significant

3.3.3. The interaction between vitamins and irrigation intervals:

Table (4) show that there were significant effects due to the interaction between application of different vitamins and irrigation intervals on the chlorophyll a, b and total carbohydrate content during the two seasons, compared to the control treatment. While, there was no significant effect on proline concentration in the first and second seasons. In addition, we observe that a negative effect on the all chemical composition in case of no usage of vitamins with increasing the irrigation intervals. Anyway, using of α-tocopherol combined with 3days irrigation intervals gave the highest leaves content of chlorophyll a (90.12 and 91.04 mg/100g), chlorophyll b (22.84 and 27.39 mg/100g) and total carbohydrate (22.30 and 22.67 %) during the two seasons respectively.

4. DISCUSION

4.1. Vegetative growth characteristics:

Our results highlighted that ornamental sunflower plants are able to grow well under irrigation intervals 2 or 3 days combine with vitamins compared with the zero vitamin treatments, especially, the plant height, leaf area, leaves and stem dry weight which are significant increased. These results may be due to vitamins accumulations occur in response to a variety of biotic stresses including high light, drought, salt and cold and may provide an additional line of protection from oxidative damage (Bosch, 1995). Also, this increment may be due to the enhancement of vitamins on cell division and /or cell enlargement (Mozafa and Oertli, 1992 and Arrigoni *et al.*, 1997) and / or the influence DNA replication (Noctor and Foyer, 1998 and Bartoli *et al.*, 1999).

The magnitude of increase is much more pronounced by applying α-tocopherol. It could be concluded that α-tocopherol is believed to protect chloroplast membranes from photo oxidation and help to provide an optimal environment for the photosynthetic machinery (Bosch, 1995). Similarly, α-tocopherol induced growth improvement was reported in *Vicia faba* (Orabi and Abdelhamid, 2014; Semida *et al.*, 2014), lettuce, Shafeek *et. al.*, (2013) *Calendula officinalis L* (Soltani *et al.*, 2012), geranium (Ayad *et al.*, 2009) and *Hibiscus rosasineses* (El-Aziz *et al.*, 2009) under stress conditions. They all attributed α-tocopherol induced improvement in growth attributes to better water potential, high accumulation of antioxidants, less oxidative damage and better cross-talk among different growth regulators.

Reduction of plant size and growth under water stress may be attributed to a decrease in the activity of meristemic tissues responsible for elongation. As well as the inhibition photosynthetic efficiency under insufficient water condition (Siddique et al., 1999). Amal *et.al.*, (2019) reported that water stress significantly decreased all characters of sesame yield and yield components.

4.2. Flowering characteristics:

Generally, results of the two seasons indicated that spraying of any vitamins at any irrigation intervals caused a significant increase in flower duration and dry weight compared with the zero vitamin treatments. Perhaps this may be due to the role of vitamins as co -enzyme in an enzymatic cofactor and plant growth regulator (Gomez and Lajolo, 2008). These findings are in agreement with those reported by El-Bassiouny et al. (2005), Al-Qubaie (2012) and Sadiq et al. (2017).

Also, the positive effect of ascorbic acid on flower characters may be due to Barth et al., (2004) who reported that the effects of ascorbic acid on flowering time could be related to alterations in phytohormone levels such as gibberellic acid, abscisic acid, salicylic acid and ethylene and that the redox status of ascorbic acid may play a role in signaling in this interconnected phytohormone network.

4.3. Chemical composition

The increase in photosynthetic pigments and carbohydrates content in sunflower leaves may be due to the role of antioxidants in protecting chloroplast membranes from photooxidation and help to provide an optimal environment for the photosynthetic machinery (Munné-Bosch and Alegre, 2002) and the vital roles of water supply at adequate amount for different physiological processes such as photosynthesis, respiration, transpiration, translocation, enzyme reaction and cells turgidity occurs simultaneously (El-Monayeri *et al.*, 1983) and (Mona *et al.*, 2000). These results are in agreement with those obtained by Hassanein et al. (2009) in maize when they used ascorbic acid and nicotinamide and Sadak et al. (2010) in sunflower when they used α-tocopherol and nicotinamide.

All the vitamins significantly decrease leaves proline content compared to control treatment which may due to the role of vitamins in decease of plant stress.

5. CONCLUSION

Based on the results of this study, we recommend that application of α- tocopherol at 100 ppm combined with 3 days irrigation intervals this treatment resulted the highest values of plant height, leaf area, leaves and stem dry weight, flower duration, flower dry weight, leaves chlorophyll content and total carbohydrate, besides, it saved the amount of irrigation water used in plant production by 33%.

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الملخص العربي

تأثير الرش الورقي ببعض الفيتامينات وفترات الري على النمو الخضري والإزهار وبعض المكونات البيوكيميائية لنباتات عباد الشمس

نجلاء محمد مصطفى

فرع بحوث نباتات الزينة بانطونيادس – الإسكندرية – قسم بحوث نباتات الزينة وتنسيق الحدائق – معهد بحوث البساتين – مركز البحوث الزراعية – جمهورية مصر العربية.

أجريت هذه الدراسة بفرع بحوث نباتات الزينة بأنطونيادس خلال الموسمين (٢٠١٧ – ٢٠١٨) لدراسة تاثير الرش الورقي ببعض الفيتامينات ((بدون – حمض الاسكوربيك (فيتامين ج) – الفاتوكوفيرول (فيتامين هـ) – نيكوتيناميد (فيتامين ب٣)) وفترات الري (٢ أو ٣ أيام) على النمو الخضري، الإزهار، وبعض المكونات البيوكيميائية لنباتات عباد الشمس. أوضحت النتائج أن معظم القياسات تأثرت بشكل كبير بتطبيق الفيتامينات الثلاثة التي تم استخدامها في هذه الدراسة، خاصة مع استخدام الالفا توكوفيرول. فقد ادي استخدام الالفا توكوفيرول بتركيز ١٠٠ جزء في المليون الي اعلي زيادة في عدد أوراق النبات وسمك الساق والي خفض تركيز حامض البرولين في انسجة الأوراق. كما ادي ري النباتات كل ثلاثة أيام مع رشها الالفا توكوفيرول بتركيز و١٠٠ جزء في المليون الي اعلي زيادة في ارتفاع النبات – المساحة الورقية – الوزن الجاف للأوراق – الوزن الجاف للساق – مدة بقاء الزهرة علي النبات – ووزن الزهرة الجاف – محتوى الأوراق من الكلوروفيل أ و ب والكربوهيدرات الكلية مما يؤدي الي توفير كمية الماء المستخدمة في انتاج النبات مع الحصول علي اعلي جودة له.