Studying The Interaction between Drought Stress and Ascorbic Acid on Growth Analysis and Biochemical Responses of *Tagetes erecta* Plants Grown under Various Growing Media

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ABSTRACT: The goal of this study was to assess the effect of the interaction between ascorbic acid application as a foliar spray, growing media, and irrigation rates on the development, flowering, and chemical constituents (chlorophyll, carotenoids, and proline) of *Tagetes erecta*, L. plants. Three replicates in a split-split plot experimental design were employed during both seasons. The main plot was the various growth media [75% calcareous soil + 25% peatmoss (v/v) or 75% sand + 25% peatmoss (v/v), or 25% sand soil + 25% calcareous soil + 50% peatmoss (v/v)]. Three irrigation intervals were utilized in the subplot (daily as normal stress, three days as mild stress, and six days as severe stress). The sub sub-plot displayed Ascorbic Acid (As.A) solution as foliar spray three times per season at T_0 (tap water), T_1 (100 mg l^{-1}), and T_2 (200 mg l^{-1}).Results revealed a substantial interaction between varied potting media, irrigation intervals, and ascorbic acid applications. The most beneficial growth (plant height, leaves and branches numbers, and leaves dry weight/plant) and flower quality (flower number, diameter, as well as dry weight) resulted from using growing media of (75% sandy soil + 25% peatmoss (v/v) or 25% sandy soil + 25% calcareous + 50% peatmoss (v/v) in addition to irrigating every three days as moderate stress. The chemical components of leaves also increased significantly, such as proline, total chlorophyll and carotenoids content. The findings of this investigation also showed that ascorbic acid increased plant resistance to water stress and decreased the harmful effects of stress.

Keywords: *Tagetes erecta, L., summer annuals, ornamental plants, soil conditions, irrigation rates, ascorbic acid, drought tolerance, drought stress.*

Abbreviations: (GM) = Growing media, (I.I.R) = Irrigation Interval Rate, (As.A) = Ascorbic Acid.

INTRODUCTION

Mexico and Central America are the natural habitats of *Tagetes erecta*, sometimes known as the as big marigold, African marigold, Aztec marigold, or American marigold. 40–50 species belong to the genus Tagetes, L. (Asteraceae), according to Lawrence (1985). Its flowers are often double-globular, varying in white, yellow, and orange tints. Angular stems with glabrous, pinnate leaves. Flowers and leaves provide a sweet smell when touched or crushed. Plants are reproduced by seeds, and they favor sunny environments despite tolerating dryness and poor soils (Nooh and El-Naggar, 2021).

Marigold has recently attracted a lot of interest from domestic producers due to its ornamental and therapeutic properties. Additionally, varieties with wonderful yellow and orange colors are often planted as bedding plants for mass exhibits, pots, borders, window and porch boxes and cut flowers crop (Nau, 1997).

It is widely accepted that ascorbic acid treatment and irrigation rate are two of the most important factors affecting flowering plants. Redy *et al.*, 2003 reported that Two-thirds of the earth's surface is covered with water, one of the most important substances on the planet. Water shortage, however, is a significant problem that affects the production of agricultural products in most regions of the world. Due to rivalry for water resources with other industries and water shortages, (FAO 2002) claimed that over the past few decades, there has been a lot of interest in using water efficient technologies in the agricultural sector. Additionally, according to Mancosu *et al.*, (2015) and Bañon *et al.*, (2006), water scarcity has an effect on plant growth and is one of the main problems restricting agricultural and food safety globally. Water stress, according to studies by Khalifa *et al.*, (2002) and El-Sobky *et al.*, (2014), decreased the uptake of essential nutrients, impacted photosynthetic capacity, and brought to an abnormal accumulation of intermediary substances, such as reactive oxygen compounds, which in turn led to oxidative damage to proteins, lipids, and DNA., and proteins and reduced plant growth. The influence of water regime on growth and flower yield of potted marigold (*Tagetes patula*) plants watered with 0.5, 1.0, or 1.5 liters of water/pot was examined by Razin and Omar in 1999. According to their findings, plant growth parameters and flower yield were significantly lowered by the lowest water volume, whereas these parameters were increased by the maximum water volume. With 0.5 liters of water / pot, the best results were attained.

One way to solve the issue and improve plant stress tolerance is to use ascorbic acid (As. A) as a foliar spray.The white powder has the chemical formula $C_6H_8O_6$ and dissolves in water. As.A interacts in several kinds of operations, such as photosynthesis, cell wall development , expansion and resistance to environmental stresses as reported by Smirnoff and Wheeler (2000), Galal *et al*., (2000), Pignocchi and Foyer (2003) and Darvishan *et al.*, (2013). According to Mazher *et al*., (2011), growing Codiaeum variegatum L. (Croton) plants with 200 p.p.m of ascorbic acid resulted in the greatest significant means of plant height, leaves number, branches number, as well as fresh and dry weights. According to Eid *et al*., (2011), *Tagetes erecta* plants grew higher and have more fresh and dry branches weights when Ascorbic acid levels ranged from 100 and 200 p.p.m were sprayed. Gul *et al*., (2015), demonstrated that Ascorbic acid plays a role in increasing stress tolerance and significantly improves plant growth and yield. According to research by Hemmati *et al*., (2018) on the effect of ascorbic acid on *calendula officinalis* L. (pot marigold), conditions of water stress increased the activity of antioxidant enzymes, proline and proteins content, and total amount of essential oils. Khazaei *et al*., (2020) examined how ascorbic acid affected pepper(*Capsicum annuum* L.) plant tolerance to water stress and discovered that ascorbic acid treatment increased proline content.

Many ornamental plants' growth and flowering are significantly influenced by the characteristics and textures of the soil. In newly reclaimed areas, landscape gardeners have been mixing the sandy soil to enhance and/or improve its chemical and physical characteristics. As a growing medium, soil texture has a significant impact on the growth of ornamental plants, particularly annuals. The selection of suitable growth medium or substrates is crucial for the creation of high-quality horticultural crops. It has an immediate impact on the growth and subsequent preservation of the broad functioning root system. Awing *et al*., (2009) reported that good growing medium would give the plant enough anchoring or support, behave as a container for nutrients and water, enable oxygen passage to the roots, and allow gaseous exchange between the roots and the environment outside the root substrate. Abd EL-Hady (2006) indicated that application of compost from green waste to sand medium by 15% and 85% (v/v), respectively, at the recommended rates (2.0 gm of N + 1.5 gm of P_2O_5) increased plant growth of geranium and periwinkle plants. Green waste compost application to sand medium at 15-25% (v/v) rate significantly increased leaf chlorophyll content of both ornamental plants. EL-Sayed and EL-Shal (2008) showed that peat moss was superior than other media (peat +sand by 1:1 (v/v) ratio and peat + sand + clay by 1:1:1 (v/v) ratio) in plant height, number of leaves/ plant, stem diameter and fresh and dry weights of foliage and roots of *Brassaia actinophylla* plants. Lolo (2022) Using growing media of 50% calcareous soil + 50% peatmoss with humic acid (HA) level at 1.50 g/plant gave the maximum beneficial effect on growth and flower quality of *Calendula officinalis* plants.

The purpose of this study was to ascertain the impact of drought stress presented by irrigation intervals and ascorbic acid application under different growing media on the growth and chemical constituents of *Tagetes erecta*, L. which is one of the most important outdoor plants.

MATERIALS AND METHODS

The present work was carried out during two successive seasons (2019 and 2020) at the nursery of the Department of Floriculture, Ornamental Horticulture and Landscape Gardening of Faculty of Agriculture, Alexandria University, Egypt to investigate the effect of irrigation intervals and ascorbic acid application under different growing media on plant growth, flowers production and the chemical constitutes of *Tagetes erecta, L.* plants.

Planting seeds, Treatments and experimental layout

1- Preparation of Growing Media (GM)

On February 23, *Tagetes erecta* seeds were sown in seed beds for both seasons. Individual transfers of uniform seedlings, 45 days old and 15 cm height, were planted into clay pots with a 30 cm diameter contained three different types of growth media: the first one, GM_I, was composed of 75% calcareous soil and 25% peatmoss (v/v); the second, GM_{II}, of 75% sand and 25% peatmoss (v/v); and the third, GM_{III}, of 25% sand soil plus 25% calcareous and 50% peatmoss (v/v). Sand made up 61.50% of the calcareous soil, silt made up 16.25%, and clay made up 22.25%, according to the mechanical study. The sandy soil used to prepare the medium was mechanically analyzed, and it was found to contain 92% sand, 5% silt, and 3% clay. The three selected growth media's primary chemical characteristics are shown in (Table 1).

Table (1): The initial chemical properties of the experimental growing media

GM	pH	Ec dSm^{-1}	Soluble Cations (meq/l)			Soluble Anions (meq/l)				Available Macro Nutrients (mgl^{-1})		
			Ca^{2+}	Mg^{2+}	Na^{+}	CO_3^{--}	HCO_3^{-}	Cl^{-}	SO_4^{--}	N	P	K
GM_I	8.10	3.31	9.8	2.6	8.1	0.51	2	10	10.4	10	8	18
GM_{II}	7.92	2.53	10.2	1.1	9.7	0.42	3	11	10.3	12	10	13
GM_{III}	7.40	3.00	8	5	9.7	0.13	7	9	7.1	15	13	16

2- Irrigation Interval Rate (I.I.R)

During the two growth seasons, three irrigation interval rates were used: once daily as a normal stress ($I.I.R_I$), once every three days as a moderate stress ($I.I.R_{II}$), and once every six days as a severe stress ($I.I.R_{III}$). After two weeks within the transplanting procedure, plants were irrigated with (500 ml/pot). .

3- Foliar spray of Ascorbic acid (As.A)

Three times throughout each season, the plants received three different dosages of Ascorbic acid (As. A) solutions: T_0 (tap water), T_1 (100 mg/l), and T_2 (200 mg/l). The treatments were applied to the marigold's aerial parts as foliar spray. Prior to irrigation for each treatment interval, ascorbic acid was sprayed three times per month throughout the growth season, and spraying continued until leaves run off early in the morning before the reproductive stage.

A full mineral fertilizer, 19:19:19: (N: P_2O_5: K_2O), was applied as a dressing to the plants under study at intervals of one month at a dosage of 3.0 g/pot. One month following the last transfer, the fertilization process began.

4- Experimental design and statistical analysis

The experiment's layout was created to provide a split-split plot experimental design with three replicates, each with three treatments (three GM, three IR, and three As.A levels). Five plants were present in each experimental unit (Snedecor and Cochran, 1990). Three different soil textures (GM_I, GM_{II}, and GM_{III}) were distributed to the main plots as growth media, while the irrigation rates ((IRI, (IRII), and (IRIII) were allocated to sub-plots and the three levels of ascorbic acid (As.A) solutions T_0 (only tap water), T_1=100, and T_2=200 (mgl^{-1}) occupy the sub-sub plots. The least significant differences ($L.S.D_{0.05}$) test at the 95% probability level method (p=0.05) was used to compare the means of data on vegetative growth and chemical analysis measurements.

In order to maintain the foliage clean and healthy, fungicides and insecticides were sprayed on plants to protect them from pests and diseases.

Following morphological measurements and biochemical reactions were performed on the marigold plants at the end of the growth season.

I- Morphological Measurements

Plant height (cm), branches number, leaves number, and leaf dry weight per plant (g) were among the vegetative growth data that were considered. The flowering data comprised the number of flowers per plant, the flower's diameter in cm, and the fresh weight of each flower per plant in g.

Plant Analysis and biochemical Estimates

1- Pigments content: chemical analysis of the total chlorophyll content was determined by direct spectrophotometer method according to Horowitz, 1975.

2- Carotenoids content (mg.100g^{-1} L.F.W.) according to Wellburn (1994).

3- Proline (mg/g L.D.W.): The determination of this amino acid is very useful to assess the physiological status and understand stress tolerance in plants. It was determined in dry leaves during the two seasons using the method of Bates *et al*. 1973. Samples of leaves (0.1g dried matter) were homogenized in 10 ml of Sulfosalicylic acid. The homogenate was filtered and 2ml of the filtrate was left to react with 2 ml acid ninhydrine and 2.0 ml of glacial acetic acid in a test tube for one hour at 10ºC.The reaction mixture was extracted with 4.0 ml of toluene mixed strongly for 15-20 second. The toluene phase was carefully pipetted out into a glass test tube, and its absorbance was measured at 520 nm in a spectrophotometer.

RESULTS AND DISCUSSION

1. Impact of growing media, irrigation rate, ascorbic acid level and their combination treatments on vegetative growth characteristics of *Tagetes erecta* ,L.

Tables 2, 3, 4, and 5's data revealed that the interaction between medium irrigation rate and ascorbic acid level had a substantial impact on the vegetative growth traits during each of the two seasons.

The interactions between growth media, irrigation interval rate and ascorbic acid levels in seasons of 2019 and 2020 were highly significant, according to data presented in tables (2, 3, 4, and 5). The maximum plant height recorded was (79.25 and 82.75 cm), the highest significant mean for branches number/ plant was (14.28 and 15.39), leaves number recorded (107.00 and 112.32), and leaves dry weight were (7.15 and 7.19 g). The previous mentioned data were obtained using 25% sand soil + 25% calcareous + 50% peatmoss (GM_{III}) under moderate stress (every three days) .Whereas, branches number /plant (8.10 and 9.69) , leaf number (60.79 and 62.13) and dry weight of leaves (2.12 and 2.11 g) was recorded on 75% calcareous + 25% peatmoss (GM_I) plus severe stress (every 6 days) without any addition of ascorbic acid ($As.A_0$) in the first and second seasons, respectively.

Similar findings were made on *Tagetes patuala* by Razin and Omar in 1995, *Salvia splendens* by Khattab *et al*., in 2002, and sunflower (*Helianthus annuus* L.) by Kiani *et al*., in 2008. Additionally, Abo-Marzoka *et al*., (2016) found that foliar spraying ascorbic acid at 200 p.p.m increased water uptake and essential nutrients by adjusting cell osmotic potential, which in turn affected the vegetative growth of plants. Khalil *et al*., (2010) sprayed Ascorbic acid at 100,150 and 200 mgl^{-1} on basil plants to promote effect on plants growth under water deficit conditions.

Table (2): Means of plant height (cm) as influenced by growth media, irrigation interval rate, ascorbic acid level, and their interaction in *Tagetes erecta*, L.

Growing media	Irrigation Interval Rate	Ascorbic acid (As.A) mgl^{-1} (1st) season			(2nd) season		
		0.00	**100**	**200**	**0.00**	**100**	**200**
GM_I	$I.I.R_I$	37.79	33.79	42.87	31.36	35.73	26.58
	$I.I.R_{II}$	40.99	43.31	46.54	43.79	46.36	50.31
	$I.I.R_{III}$	30.29	36.71	37.25	29.91	34.90	36.36
GM_{II}	$I.I.R_I$	32.62	42.25	35.67	39.78	38.96	39.93
	$I.I.R_{II}$	37.52	44.09	46.35	38.18	42.25	44.57
	$I.I.R_{III}$	35.53	38.71	44.90	43.02	42.93	42.95
GM_{III}	$I.I.R_I$	47.57	36.07	70.36	48.65	36.87	76.78
	$I.I.R_{II}$	50.80	55.61	79.25	52.50	58.48	82.75
	$I.I.R_{III}$	38.34	40.23	45.15	39.92	38.64	39.16
L.S.D 0.05			**3.96**			**4.16**	

$L.S.D_{(0.05)}$ = Least significant differences at 0.05 probability level.

Table (3): Means of branches number /plant as influenced by growth media, irrigation interval rate, ascorbic acid levels and their interaction of *Tagetes erecta* ,L.

Growing media	Irrigation Interval Rate	Ascorbic acid (As.A) mgl^{-1} (1st) season			(2nd) season		
		0.00	**100**	**200**	**0.00**	**100**	**200**
GM_I	$I.I.R_I$	10.01	11.12	11.71	10.59	11.44	11.52
	$I.I.R_{II}$	10.51	10.22	11.96	11.19	12.05	12.78
	$I.I.R_{III}$	8.10	9.44	9.84	9.69	11.93	11.77
GM_{II}	$I.I.R_I$	10.46	11.48	11.15	10.04	11.28	11.62
	$I.I.R_{II}$	10.19	10.48	10.10	11.34	12.24	12.45
	$I.I.R_{III}$	9.80	10.69	14.23	16.32	14.69	17.59
GM_{III}	$I.I.R_I$	12.76	13.64	11.22	12.70	13.27	12.08
	$I.I.R_{II}$	13.71	13.33	14.28	14.50	15.20	18.39
	$I.I.R_{III}$	11.08	10.52	12.10	15.11	15.00	18.31
L.S.D 0.05			**0.92**			**1.11**	

L.S.D (0.05) = Least significant differences at 0.05 probability level.

Table (4): Means of leaves number as influenced by growth media, irrigation interval rate, ascorbic acid level and their interaction of *Tagetes erecta* ,L.

Growing media	Irrigation Interval Rate	Ascorbic acid (As.A) mgl^{-1}					
		(1st) season			(2nd) season		
		0.00	100	200	0.00	100	200
GM_I	$I.I.R_I$	71.00	65.00	71.50	61.46	68.93	77.33
	$I.I.R_{II}$	78.33	89.66	89.00	81.32	89.66	86.66
	$I.I.R_{III}$	60.79	65.00	65.30	62.13	62.66	64.00
GM_{II}	$I.I.R_I$	71.33	73.00	73.00	73.66	76.33	79.33
	$I.I.R_{II}$	93.33	94.33	96.33	95.66	96.66	99.00
	$I.I.R_{III}$	93.33	97.33	94.33	101.00	97.66	95.33
GM_{III}	$I.I.R_I$	79.66	86.33	87.66	81.66	90.33	94.66
	$I.I.R_{II}$	97.00	103.66	107.00	99.66	109.00	112.32
	$I.I.R_{III}$	72.00	83.66	92.00	78.66	89.33	91.33
L.S.D 0.05			**1.26**			**1.32**	

L.S.D (0.05) = Least significant differences at 0.05 probability level.

Table (5): Means of leaves dry weight (g) as influenced by growth media, irrigation interval rate, ascorbic acid level and their interaction of *Tagetes erecta* ,L.

Growing media	Irrigation Interval Rate	Ascorbic acid (As.A) mgl^{-1}					
		(1st) season			(2nd) season		
		0.00	100	200	0.00	100	200
GM_I	$I.I.R_I$	3.59	3.15	3.83	3.83	4.51	5.06
	$I.I.R_{II}$	4.42	4.70	5.20	5.70	5.85	5.99
	$I.I.R_{III}$	2.12	2.45	3.12	2.11	2.55	3.17
GM_{II}	$I.I.R_I$	3.36	3.73	4.02	5.23	5.63	5.98
	$I.I.R_{II}$	4.51	4.74	5.32	4.39	4.74	5.74
	$I.I.R_{III}$	5.48	4.02	4.30	4.22	4.61	4.69
GM_{III}	$I.I.R_I$	6.03	5.97	5.59	6.07	6.50	6.74
	$I.I.R_{II}$	5.23	7.08	7.15	6.85	7.02	7.19
	$I.I.R_{III}$	5.13	6.04	6.11	5.50	6.64	6.21
L.S.D 0.05			**0.34**			**0.38**	

L.S.D (0.05) = Least significant differences at 0.05 probability level.

2.Impact of growth media, irrigation interval rate, ascorbic acid level and their combination treatments on flowering characteristics of *Tagetes erecta* ,L .

Results revealed that the means for number of flowers / plant as well as their diameters and dry weights were improved as a result of spraying *Tagetes erecta*, L. plants with ascorbic acid with irrigation rates under different used media (tables 6,7 and 8).

Data presented in tables (6, 7 and 8) showed that the interaction between growing media, irrigation interval rates and ascorbic acid level revealed to an increase in the flower number (17.03and 16.24), flower diameter (9.83 and 9.06 cm) and flower dry weight /plant (3.77 and 3.76 cm) on sandy soil 75% + peatmoss 25% (GM_{II}) plus moderate stress (every 3 days) with ascorbic acid at 200 mgl^{-1} in the two seasons, respectively. Followed by the treatment by using 25% sand soil + 25% calcareous + 50% peatmoss (GM_{III}) under moderate stress (every 3 days) condition with ascorbic acid at 200 mgl^{-1} , flower number (14.61and 14.20), flower diameter (7.48 and 7.19 cm) and flower dry weight /plant (3.65 and3.62 cm) in the two seasons. GM_I (75% calcareous soil + 25 % peatmoss) irrigation rate at severe stress without ascorbic acid ($As.A_0$) gave the lowest value of flower number (7.16and 7.83 cm), flower diameter (3.09 and 3.21cm) and flower dry weight /plant (2.04 and2.05) in the two seasons, respectively. Furthermore, increasing stress to moderate at irrigation interval (3 days), applied As.A at 200 mgl^{-1} when the plants grown in sandy soil 75% + peatmoss 25% (GM_{II}) was very effective to obtain high means values of flowering characteristics . The presence of peatmoss in a proper ratio may have contributed to these results by enhancing the soil's characteristics and providing minerals to the plants. Consequently, the used plants' vegetative growth parameters would be increased, and would enhanced the quality of their flowers. These findings concur with those of Gul *et al*., (2015), who claimed that As.A. has a role in enhancing stress tolerance and results to a considerable improvement in plant growth, yield, and quality production. El Hwary *et al*., (2011) found that when water stress levels rise, stomata close, which results in a reduction in CO_2 fixation. Also, Ascorbic acid spraying significantly boosted the number of flowers / plant and the duration of the flowering period on *Gazania rigens*, according to Sardoei *et al*.'s (2014) research.

Many researches obtained similar results such as EL-Sayed (1991) on *Chrysanthemum* and *Dianthus*, Khattab *et al.* (2002) on *Salvia splendens* , Mazher *et al.* (2012) on *Amaranthus tricolor*, Abdul-Hafeez *et al*. (2015) on *Gardenia jasminoides*, and Idrovo *et al. (2019) on Rosa hybrid.*

Table (6): Means of flowers number /plant as influenced by growth media, irrigation interval rate , ascorbic acid level and their interaction of *Tagetes erecta* , L.

Growing media	Irrigation Interval Rate	Ascorbic acid (As.A) mgl^{-1}					
		(1st) season			(2nd) season		
		0.00	**100**	**200**	**0.00**	**100**	**200**
GM_I	$I.I.R_I$	10.15	10.40	11.56	10.83	11.00	11.56
	$I.I.R_{II}$	11.96	12.89	12.58	11.88	12.49	12.73
	$I.I.R_{III}$	7.16	8.66	9.53	7.83	9.27	9.42
GM_{II}	$I.I.R_I$	13.43	13.96	14.57	13.48	11.16	23.52
	$I.I.R_{II}$	14.50	15.52	17.03	14.68	14.89	16.24
	$I.I.R_{III}$	15.76	16.25	16.04	14.91	15.55	15.70
GM_{III}	$I.I.R_I$	11.83	11.93	10.32	11.02	11.73	11.89
	$I.I.R_{II}$	13.14	13.39	14.61	12.87	13.68	14.20
	$I.I.R_{III}$	12.44	11.36	12.83	11.13	11.55	12.78
L.S.D $_{0.05}$			**0.57**			**0.62**	

L.S.D $_{(0.05)}$ = Least significant differences at 0.05 probability level.

Table (7): Means of flower diameter (cm) as influenced by growth media, irrigation interval rate , ascorbic acid level and their interaction of *Tagetes erecta* , L.

Growing media	Irrigation Interval Rate	Ascorbic acid (As.A) mgl^{-1}					
		(1st) season			(2nd) season		
		0.00	**100**	**200**	**0.00**	**100**	**200**
GM_I	$I.I.R_I$	3.79	4.12	5.92	3.47	3.50	5.28
	$I.I.R_{II}$	4.34	4.43	6.08	4.97	5.12	6.26
	$I.I.R_{III}$	3.09	4.16	4.61	3.21	8.00	12.24
GM_{II}	$I.I.R_I$	5.27	6.54	7.21	4.53	5.18	6.18
	$I.I.R_{II}$	5.01	6.87	9.83	5.04	6.78	9.06
	$I.I.R_{III}$	6.35	7.14	7.35	7.15	7.12	7.10
GM_{III}	$I.I.R_I$	5.68	6.23	6.83	5.66	6.37	6.92
	$I.I.R_{II}$	5.62	6.53	7.48	6.22	6.45	7.19
	$I.I.R_{III}$	6.10	6.64	6.57	6.17	6.41	7.11
L.S.D $_{0.05}$			**0.32**			**0.38**	

L.S.D (0.05) = Least significant differences at 0.05 probability level.

Table (8): Means of flower dry weight /plant (g) as influenced by growth media, irrigation interval rate, ascorbic acid level and their interaction of *Tagetes erecta* , L.

Growing media	Irrigation Interval Rate	Ascorbic acid (As.A) mgl^{-1}					
		(1st) season			(2nd) season		
		0.00	100	200	0.00	100	200
GM_I	$I.I.R_I$	2.11	2.32	2.36	2.13	2.19	2.38
	$I.I.R_{II}$	2.40	2.52	2.74	2.26	2.69	2.80
	$I.I.R_{III}$	2.04	2.12	2.33	2.05	2.15	2.33
GM_{II}	$I.I.R_I$	2.17	2.72	2.89	2.14	2.64	2.92
	$I.I.R_{II}$	2.45	3.59	3.77	2.42	3.54	3.76
	$I.I.R_{III}$	2.29	2.48	3.17	2.33	3.14	3.21
GM_{III}	$I.I.R_I$	2.16	2.32	2.51	2.31	2.34	2.83
	$I.I.R_{II}$	2.23	2.39	3.65	3.10	3.26	3.62
	$I.I.R_{III}$	2.26	2.35	2.48	2.22	2.33	2.46
L.S.D $_{0.05}$			0.18			0.21	

L.S.D (0.05) = Least significant differences at 0.05 probability level.

3-Impact of growing media, irrigation interval rate, ascorbic acid level and their combinations on chemical analysis of *Tagetes erecta* ,L.

Data in tables (9,10 and 11) clarified that the effect of the interaction between growing media, irrigation intervals and ascorbic acid level were significantly increased the total chlorophyll, carotenoids and proline contents in leaves. The maximum amount resulted in treatment of GM_{1I} plus 3 days irrigation intervals and with the concentration of As.A at 200 mgl^{-1} in both seasons, respectively. While a decrease in total chlorophyll , carotenoids and proline contents were resulted from applying the treatment of GM_1 (75% calcareous + 25% peatmoss) combined with 6 days irrigation intervals without any addition of Ascorbic acid ($AS.A_0$) (113.0,113.19),(10.44, 10.87) and (1.20 ,1.12), respectively. In addition, water stress affects leaf stoma which is a pivotal gate controlling the exchange of CO_2 and water vapor, consequently affect photosynthesis process Buckley (2005). The previous findings agreed with Abo-Marzoka *et al.*, (2016) and Penella *et al.* (2017) illustrated that (As.A) increased water uptake and essential nutrients through adjusting cell osmotic potential, and reduced cell membrane damage in water-stressed plants. Moreover, Yazdanpanah *et al.* (2011) on *Satureja hortensis* demonstrated that water stress was associated with the sugar amount, this reduction affects amount of chlorophyll and photosynthesis, so applying ascorbic acid to stressed plants increase the amount of sugar and this effect could lead to the improvement of plant resistance. Also one reason for the decrease in chlorophyll concentration under water stress conditions increase in chlorophyllase activity that under stress conditions gene expression of this enzyme is induced Zonouri *et al*., (2014). Cvikrova´ *et al.*, (2012) reported that proline which protects the plants against a number of abiotic stresses e.g. water stress. Proline act a very fine role in inner side of plant i.e. metal chelator, antioxidant defense and signaling molecule Hayat *et al.*, (2012), Kaur and Asthir (2015).Beside, The role of ascorbate in proline synthesis is evidenced from some reports. Ascorbic acid may be required, for instance, for the production of the non-essential amino acid derivative hydroxyl proline, according to Rana *et al*., (2017). Ascorbate is also necessary for the production of collagen, particularly for the hydroxylation of prolyl residues. Exogenous As.A has been shown to have positive impacts on plant survival rate, biomass, shoot and root growth under water stress (Shalata and Neumann, 2001; Athar *et al*., 2008). While ascorbic acid used externally (100 mg/l and 150 mg/l) significantly increased the fresh and dry weights of shoots and roots, plant height, and chlorophyll. It also increased the accumulation of leaf proline. Similar results were noticed by other residues, , Gad (2003) on *Schefflera actinophylla*, Youssef (2008) on *Pentas laneceolata* , El-Naggar and El-Nasharty (2009) on *Hippeastrum vittatum*, Hassanein and EL-Sayed (2009) on *Gladiolus antakiensis* , Yang *et al.*, (2010) on lawn grass, Mazher *et al.*, (2012) on *Amaranthus tricolor*, Hendawy *et al.*, (2015) on *Lallemantia iberica* , Malik *et al.*, (2013) on wheat and Abdul-Hafeez *et al*., (2015) on *Gardenia jasminoides* Ellis.

Table (9): Means of total chlorophyll content (mg/100 g L.F.W.) as affected by growing media, irrigation interval rate, ascorbic acid level and their interaction of *Tagetes erecta* ,L.

Growing media	Irrigation Interval Rate	Ascorbic acid (As.A) mgl^{-1}					
		(1st) season			(2nd) season		
		0.00	100	200	0.00	100	200
GMI	I.I.RI	118.33	129.66	134.00	120.54	133.95	134.84
	I.I.RII	142.38	161.00	169.33	144.30	165.16	170.00
	I.I.RIII	113.00	117.43	120.53	113.19	119.49	127.86
GMII	I.I.RI	129.66	156.33	187.66	127.98	157.93	190.54
	I.I.RII	172.00	183.60	210.00	174.75	183.86	210.73
	I.I.RIII	168.35	187.79	205.00	166.84	185.70	205.29
GMIII	I.I.RI	120.13	127.95	157.90	121.43	129.42	161.97
	I.I.RII	161.23	180.19	191.00	160.80	182.25	193.09
	I.I.RIII	156.65	163.74	183.56	155.95	167.82	188.15
L.S.D 0.05			**5.98**			**5.17**	

L.S.D (0.05) = Least significant differences at 0.05 probability level.

Table (10): Means of carotenoids content (mg/100 g L.F.W.) as affected by growing media, irrigation interval rate, ascorbic acid level and their interaction of *Tagetes erecta* , L.

Growing media	Irrigation Interval Rate	Ascorbic acid (As.A) mgl^{-1}					
		(1st) season			(2nd) season		
		0.00	100	200	0.00	100	200
GMI	I.I.RI	12.43	17.73	19.39	11.02	17.73	10.27
	I.I.RII	15.14	17.39	20.61	14.87	16.68	21.65
	I.I.RIII	10.44	11.36	12.83	10.87	11.55	13.78
GMII	I.I.RI	17.43	15.26	16.57	13.48	11.16	23.52
	I.I.RII	19.50	30.52	34.03	20.68	33.89	38.24
	I.I.RIII	17.77	24.25	28.04	17.91	26.42	29.06
GMIII	I.I.RI	14.42	18.79	21.15	12.11	14.88	15.11
	I.I.RII	18.53	26.93	33.07	18.47	24.68	32.72
	I.I.RIII	13.49	16.75	19.80	14.62	20.55	23.62
L.S.D 0.05			**1.87**			**1.98**	

L.S.D (0.05) = Least significant differences at 0.05 probability level.

Table (11): Means of proline content as affected by growing media, irrigation interval rate , ascorbic acid level and their interaction of *Tagetes erecta* ,L.

Growing media	Irrigation Interval Rate	Ascorbic acid (As.A) mgl^{-1}					
		(1st) season			(2nd) season		
		0.00	100	200	0.00	100	200
GMI	I.I.RI	1.51	1.85	1.97	1.26	1.44	1.83
	I.I.RII	2.33	2.40	2.59	2.27	2.55	2.62
	I.I.RIII	1.20	1.24	1.94	1.12	1.29	1.54
GMII	I.I.RI	1.66	1.83	1.98	11.11	12.35	12.58
	I.I.RII	3.16	3.67	3.68	3.10	3.59	3.63
	I.I.RIII	2.46	2.63	3.16	2.20	2.64	3.18
GMIII	I.I.RI	1.83	1.97	2.16	1.86	2.00	2.18
	I.I.RII	2.30	2.76	2.98	2.32	2.77	2.95
	I.I.RIII	2.23	2.65	2.50	2.13	2.71	3.32
L.S.D 0.05			**0.15**			**0.12**	

L.S.D (0.05) = Least significant differences at 0.05 probability level.

CONCLUSION

Therefore, it can be advised that growing *Tagetes erecta*, L. plants of high quality for various decorative purposes in landscaping can be accomplished by using a mixture of sandy soil 75% + peatmoss 25% or 25% sandy soil + 25% calcareous + 50% peatmoss plus irrigation interval rate every three days as moderate stress with foliar spray of ascorbic acid (As.A) at 100 or 200 mgl^{-1}.

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الملخص العربي

دراسة التفاعل بين إجهاد الجفاف وحامض الأسكوربيك على تحليل النمو والإستجابات الكيموحيوية لنباتات القطيفة النامية في بيئات نمو مختلفة

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كان الهدف الرئيسي من البحث هو دراسة تأثير التفاعل بين بيئات النمو و معدلات الرى والرش بحمض الأسكوربيك على النمو الخضري والإزهارو المحتوى الكيماوى للأوراق من الكلوروفيل و الكاروتينيدات والبرولين فى نبات القطيفة *Tagetes erecta,* L. ، وكان تصميم التجربة القطع المنشقة مرتين (ثلاث مكررات) وخصصت القطع الرئيسية المتمثلة في بيئات النمو [الجيرية 75% + بيتموس 25 % (حجم/حجم)، الأراضي الرملية 75% + بيتموس 25 %(حجم / حجم) ، الجيرية 25% + الأراضي الرملية 25% + بيتموس 50 % (حجم/ حجم)] وكانت القطع الصغيرة فترات الرى وتمثل فترات الرى الثلاثه (يوميا ، 3 ، 6 أيام) ، أما القطع الصغيرة الفرعية فقد تمثلت فى الرش بحمض الأسكوربيك (0.0 ، 100، 200 مليجرام / لتر) ، قد أوضحت النتائج المتحصل عليها أن البيئة المكونة من 75% تربة رملية + 25% بيتموس وكذلك بيئة الأراضى الجيرية 25% + الأراضي الرملية 25% + بيتموس 50 % فى ظروف الإجهاد المعتدل (فترة الري كل 3 أيام) مع الرش الورقى بحمض الأسكوبيك بتركيز 200 مليجرام / لتر قد أعطت أفضل النتائج من حيث صفات النمو الخضرى (إرتفاع النبات ، عدد الأفرع ، عدد الأوراق ، و الوزن الجاف) والزهرى مثل زيادة عدد النورات وقطرها ووزنها الجاف كما وجدت زيادة معنوية لمعاملات التفاعل بين أنواع بيئات النمو و ظروف الإجهاد المعتدل ومعاملات حمض الأسكوربيك حيث زاد محتوى الأوراق الكلى من الكلوروفيل والكاروتينيدات وكذلك زيادة معنوية فى محتوى الأوراق من البرولين. بينما تحققت أقل القيم معنوية باستخدام تربة الأراضى الجيرية 75% + بيتموس 25 % تحت ظروف الإجهاد الشديد (فترة الري كل 6 أيام) دون إضافة أى من تركيزات حمض الأسكوربيك . وأشارت نتائج الدراسة أيضًا إلى أن حامض الأسكوربيك يقلل من الآثار الضارة للإجهاد ويحسن مقاومة النبات للإجهاد المائي.