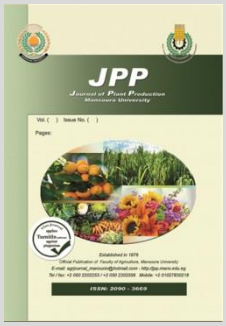
Journal of Plant Production

Journal homepage: www.jpp.mans.edu.eg
Available online at: www.jpp.journals.ekb.eg

Effect of Potassium and Salicylic Acid Foliar Application on *Dieffenbachia picta* Plants with Different Irrigation Water Rates

Abd El-Hady, W. M.[1] and A. A. Hegazy[2*]

[1] Ornamental Plants and Landscape Gardening Research Department, Horticulture Research Institute, Agriculture Research Center, Giza, Egypt.
[2] Vegetable and Floriculture Dept., Fac. Agric., Mansoura Univ., Egypt.



ABSTRACT

The effects of the treatment of irrigation at different intervals (every 3, 6 and 9 days) in interacted with foliar application treatments (tap water as control, potassium silicate at 1 and 2 % as well as salicylic acid at 25 and 50 ppm) on growth, root parameters and some chemical constituents of *Dieffenbachia picta* were investigated. The current search was carried out at Horticulture Research Station at Mansoura, Dakahlia Governorate, Egypt, for two summer consecutive seasons of 2019 and 2020. Attained results referred to that irrigated dieffenbachia plants every six days significantly increased plant height, leaf length, leaf width and leaf number per plant at both seasons after three and six months from repotting date compared to the other irrigated intervals under study. Furthermore, the highest values of average of leaf area, root length, dry roots weight per plant as well as total chlorophyll, carotenoids and proline contents were obtained by the treatment of irrigation every 6 days. In addition, the highest values of above-mentioned parameters were recorded by foliar spray of potassium silicate at 2 % concentration compared with the other concentration of both potassium silicate and salicylic acid under study. In any case, the better growth and root parameters, higher chemical constituents (total chlorophyll, carotenoids and proline) could be obtained by spraying potassium silicate at 2% concentration on irrigated dieffenbachia plants every six days.

Keywords: *Dieffenbachia picta*, irrigation, potassium silicate, salicylic, growth, root, chlorophyll, proline.

INTRODUCTION

Dumb cane (*Dieffenbachia picta*, Schott) is an ornamental implant, common household and perennial plant belonging to family Araceae. The dieffenbachia plants are regional to tropical West Indies, especially Costa-Rica, Colombia and America and however currently can be set in many subtropical and tropical climates. (Oloyede *et al*., 2011). A dieffenbachia plant is annoying to skin and dermatitis can evolve in people who handle these foliage plants frequently (Blessing *et al*., 2009). Moreover, foliage plant production acts for a substantial industry of agriculture worldwide with a net value of wholesale of € 50 billion (Lütken *et al*., 2012). Healthy houseplants can supplement value to our lives by enhancing indoor air fineness aesthetics to the interior of our homes. Else purpose why people want to cultivate plants indoors is that they have an influence on carbon dioxide (CO_2) levels (Sevik *et al*., 2018).

Moisture content and fertility levels as well as growing media can be regulated to meet indoor plants requirements. The building up of environmental stresses has led to the demolition of ornamental plants (Noman *et al*., 2017). Drought stress is one of the ultimate serious stressors influencing plant development, growth and yields (Ghodke *et al*., 2018). Plants have promoted different drought resistant plantings at the physio-biochemical and morphological levels to reply and adapt to water deficient stress (Larkunthod *et al*., 2018 and Almeida *et al*., 2019).

Potassium is a greater nutrient of plant and plays a fundamental role in a assortment of physiological processes, i.e. keeping of water status in tissues of plant, photosynthesis and protein synthesis (Marschner, 2012). Also, it impacts synthesis and transformation as well as storage carbohydrates as well as wheat growth and yield (Niu *et al*., 2013). Potassium silicate (K_2SiO_3) improved maize dry weights of shoot and root, leaf area index and mineral nutrients (N, P and K) percentages under water stress conditions (Ibrahim *et al*., 2020).

Salicylic acid (SA) is a plant growth stimulating recognized as an endogenous coding molecule, which is included in different physiological processes in plants, such as photosynthesis, nutrient uptake, growth regulation, plant water relations and stomatal conductance as well as mechanisms of plant resistance (Popova *et al*., 1997; Hayat *et al*., 2010; Rady and Mohamed, 2015). In addition, foliar spray with SA enhanced all vegetative and flowering parameters of *Gazania rigens* (Saeed, 2020).

The work aims to provide large quantities of fresh irrigation water that is consumed by dieffenbachia plants and most of this water is tap water suitable for drinking due to the use of this plant in hotels and tourist chalets. However, this study objective to evaluate the advantageous effects of foliar spraying of potassium silicate and salicylic acid in terms of improved growth of *Dieffenbachia picta* under Dakahlia Governorate, Egypt conditions.

MATERIALS AND METHODS

Two pot experiments were carried out during two consecutive summer seasons of 2019 and 2020 at the

* **Corresponding author.**
E-mail address: ahhegazy1510@gmail.com
DOI: 10.21608/jpp.2021.152024

experimental farm of Horticulture Research Station at Mansoura, Dakahlia Governorate, Egypt. This study was conducted to investigate the effect of different irrigation intervals (every 3, 6 and 9 days), foliar application treatments (tap water as control, potassium silicate at 1 and 2 % as well as salicylic acid at 25 and 50 ppm) as well as their interaction treatments on plant growth, root parameters and some chemical constituents of Dumb cane (*Dieffenbachia picta*, Schott) plant. Dieffenbachia plants were obtained from Egypt Green Company Nurseries (Safwat Habib), Canal Mansouriya Street in Giza, Giza Governorate, Egypt, during the second week of March, in 20 cm pots. All plants were similar in growth and 20 cm in length and contained 5 leaves per plant. On first week of April during the 1st and 2nd seasons, respectively, plants were repotting in 30 cm pots it contains peat moss media. One plant was planted per pot. Every pot has 1100 g peat moss. The analysis of used peat moss media was shown in Table (a) as well as the analysis of used tap water was presented in Table (b).

Table a. The analysis of used peat moss media

pH	E.C. m. mohs/ cm	Soluble cations (meq./L)			Soluble anions (meq./L)		Total nutrients (%)		
		Mg^{++}	Ca^{++}	Na^{+}	Cl^{-}	SO_4^{--}	N	P	K
5.28	1.96	1.1	1.8	21.7	22.62	1.98	0.72	1.2	2.8

Table b. The analysis of tap water

pH	E.C. m.mohs/cm	Turbidity	Temperature (° C)	Total dissolved solids (ppm)
7.26	0.486	0.74	24.5	261

The experiment contained about 135 pots (3 irrigation × 5 foliar spray × 3 replicates × 3 plants); five plants from each replication were randomly distributing for observing growth and root parameters as well as some chemical constituents of dieffenbachia. The mean value of each parameter was computed from 3 plants (one plant from each replication). As of May, repotting plants were sprayed with potassium silicate at concentrations of 1%, 2%, as well as salicylic acid at concentrations of 25 and 50 ppm, with different irrigation intervals, until September of the same year (for 5 months).

All plants received traditional agricultural practices whenever they demanded. All plants were fertilized with NPK (30:5:15) fertilization at the rate of 10 g/plant with irrigation water (5 times per month) from May to September every season.

Experimental design:

The statistical layout of this experiment was a split-plot design experiment between irrigation intervals (three intervals) as main plot and foliar spray treatments (five concentrations) as sub-plot in randomized complete blocks design (RCBD) with three replicates. The combination treatments between irrigation water intervals and foliar spray concentrations were consisted of 15 treatments.

Data recorded:

Growth and root parameters: Plant height (cm), leaf length and width (cm) and leaves number per plant were recorded after 3 and 6 months from repotting date. In addition, average of upper 4th leaf area (cm^2 as described by Barbieri *et al*., 1994), root length (cm) and dry weight of roots/ plant (g) were recorded 6 months only from repotting date. Three plants were randomly chosen from each experimental unit in both seasons.

The drought resistance index: The drought resistance index (DRI %), as a real indicator for drought stress tolerance was studied from the equation aforesaid before on pearl millet by Bidinger *et al*. (1982): DRI (%) = Mean dry weight of root of the water stress treated plants/mean dry root of control one × 100.

Some chemical analysis: In upper 3rd fresh leaf samples taken after six months from repotting, photosynthetic pigments (total chlorophyll a +b and carotenoids, mg/100g as fresh weight) were measured according to the methods of Saric *et al*. (1967). Also, the free amino acid proline (mg/g as dry weight) by the method explained by Bates *et al*., (1973) were determined.

Statistical analysis:

The obtained data were statistically analyzed and the means were compared using least significant difference (L.S.D) at 5% level as reported by Gomez and Gomez (1984). The means were compared using computer program of Statistix version 9 (Analytical software, 2008).

RESULTS AND DISCUSSION

Growth and root parameters:

From data recorded in Tables 1, 2, 3 and 4 that, dieffenbachia plants that irrigated every six days significantly increased plant height (cm), leaf length (cm), leaf width (cm) and number of leaves per plant after 3 and 6 months from repotting date compared to control (irrigation every 3 days) and the other one (irrigation every 9 days) in both seasons. In addition, the same trend was noticed regard average of leaf area (cm^2), root length and root dry weight per plant (Tables 5 and 6) compared to the other intervals under study. Moreover, using foliar application treatments (potassium silicate and salicylic acid) significantly increased dieffenbachia height, leaf length and width as well as leaf number per plant compared to untreated plants in 2019 and 2020 seasons. In the same time, using treatment of 2% potassium silicate significantly increased growth and root parameters compared to control and the other concentrations of potassium silicate and SA in both seasons. Moreover, the increases in leaf area average was about 50.01 and 43.75 % for potassium silicate at 2 % treatment, with significant difference between this treatment and control (sprayed with tap water) in the 1st and 2nd seasons, respectively. Furthermore, the combination between drought stress and potassium silicate or salicylic acid increased abovementioned parameters comparing to control (except that of irrigation every 9 days without foliar spray) in both seasons.

The ability of dieffenbachia plants on noticed lower height, leaf length and width, leaf number per plant at the treatment of irrigation every 9 days than those of irrigation every 6 days may be elucidated according to Webster *et al.* (2000), they suggested that water stress blocked the cytokinin transport from root to shoots and promoted the amount of abscisic acid in leaf which be inverted in decreasing growth parameters. These results may be due to the avoidance mechanism out of modification of plant growth rate or minimized rate of photosynthesis. However, drought in summer in southern China negatively influences the growth of oil tea seedlings (Dong *et al*., 2017).

Table 1. Effect of potassium silicate and salicylic acid as foliar spray (F), irrigation intervals (I) and their interaction treatments (F×I) on plant height (cm) of *Dieffenbachia picta* plant during 2019 and 2020 seasons

Irrigation intervals (days)	Foliar spray treatments (F)					Mean (I)
	Control	Potassium silicate (%)		Salicylic acid (ppm)		
		1	2	25	50	
First season (2019)						
After 3 months from repotting date						
3 days	44.90	48.20	51.43	48.63	49.63	48.56
6 days	45.33	49.53	53.57	49.37	51.23	49.81
9 days	43.40	47.83	49.60	47.50	48.70	47.41
Mean (F)	44.54	48.52	51.53	48.50	49.86	
LSD at 5 %	For (I)= 0.77		For (F)=0.66		For (F×I) = 1.26	
After 6 months from repotting date						
3 days	45.40	49.40	52.23	48.77	50.47	49.25
6 days	46.37	50.37	53.70	50.67	51.37	50.49
9 days	43.80	48.97	51.10	48.53	50.20	48.52
Mean (F)	445.19	49.58	52.34	49.32	50.68	
LSD at 5 %	For (I)= 0.26		For (F)= 0.57		For (F×I) = 0.91	
Second season (2020)						
After 3 months from repotting date						
3 days	60.83	65.73	71.37	65.17	68.77	66.37
6 days	63.13	68.47	75.80	66.43	72.17	69.20
9 days	59.90	64.83	69.20	64.80	68.37	65.42
Mean (F)	61.29	66.34	72.12	65.47	69.77	
LSD at 5 %	For (I)= 0.51		For (F)= 0.51		For (F×I) = 0.93	
After 6 months from repotting date						
3 days	61.83	67.53	72.83	66.23	71.07	67.90
6 days	64.10	69.57	76.27	68.63	72.00	70.11
9 days	61.20	66.60	70.90	65.30	69.57	66.71
Mean (F)	62.38	67.90	73.33	66.72	70.88	
LSD at 5 %	For (I)= 0.38		For (F)= 0.64		For (F×I) = 1.06	

Table 2. Effect of potassium silicate and salicylic acid as foliar spray (F), irrigation intervals (I) and their interaction treatments (F×I) on leaf length (cm) of *Dieffenbachia picta* during 2019 and 2020 seasons

Irrigation intervals (days)	Foliar spray treatments (F)					Mean (I)
	Control	Potassium silicate (%)		Salicylic acid (ppm)		
		1	2	25	50	
First season (2019)						
After 3 months from repotting date						
3 days	6.70	7.77	8.27	7.40	7.77	7.58
6 days	7.13	8.30	9.30	7.93	8.17	8.17
9 days	6.40	7.10	7.53	7.17	7.33	7.11
Mean (F)	6.74	7.72	8.37	7.50	7.76	
LSD at 5 %	For (I)= 0.61		For (F)= 0.41		For (F×I) = 0.87	
After 6 months from repotting date						
3 days	7.03	8.27	8.97	8.03	8.17	8.09
6 days	7.13	8.73	9.50	8.27	8.50	8.43
9 days	6.70	7.60	8.00	7.53	8.33	7.63
Mean (F)	6.96	8.20	8.82	7.94	8.33	
LSD at 5 %	For (I)= 0.22		For (F)= 0.36		For (F×I) = 0.60	
Second season (2020)						
After 3 months from repotting date						
3 days	15.33	17.23	18.00	16.50	17.20	16.85
6 days	16.37	18.43	19.27	17.27	18.07	17.88
9 days	15.33	18.67	16.87	16.23	16.53	16.73
Mean (F)	15.68	18.11	18.04	16.67	17.27	
LSD at 5 %	For (I)= 0.47		For (F)= 0.39		For (F×I) = 0.76	
After 6 months from repotting date						
3 days	16.20	17.57	18.37	16.87	17.63	17.33
6 days	17.00	18.20	19.57	18.13	18.37	18.25
9 days	16.17	16.83	17.57	16.70	17.03	16.86
Mean (F)	16.46	17.53	18.50	17.23	17.68	
LSD at 5 %	For (I)= 0.38		For (F)= 0.40		For (F×I) = 0.72	

The foliar sprays of potassium significantly increased the wheat morphological characters when grown in the absence as well as presence of drought stress conditions (Ahmad *et al*., 2019). In addition, potassium silicate at 8cm^3/l, pointed out a uniform influence in alleviating inhibition of *Calendula officinallis* L. plant growth parameters under moderate salinity stress condition (Attia and Elbohy, 2019). Application of potassium (K) made efficient the capability of plant to tolerate osmotic stress, including water deficit by minimizing its negative influences on plant and improving the translocation and uptake of water to make a poise (Adhikari *et al*., 2020). Using potassium silicate at 3 ml/l or 5 ml/l significantly impacted plant height, number of branches, leaf area and plant fresh and dry weights of *Tagetes patula* plants under drought stress conditions (Ayyat and Abdel-Mola, 2020).

Table 3. Effect of potassium silicate and salicylic acid as foliar spray (F), irrigation intervals (I) and their interaction treatments (F×I) on leaf width (cm) of *Dieffenbachia picta* during 2019 and 2020 seasons

Irrigation intervals (days)	Foliar spray treatments (F)					Mean (I)
	Control	Potassium silicate (%)		Salicylic acid (ppm)		
		1	2	25	50	
First season (2019)						
After 3 months from repotting date						
3 days	2.73	5.70	7.43	5.13	6.90	5.58
6 days	3.30	6.37	9.13	6.00	8.37	6.63
9 days	2.30	4.97	6.13	4.60	5.27	4.65
Mean (F)	2.78	5.68	7.57	5.24	6.84	
LSD at 5 %	For (I)= 0.61		For (F)= 0.48		For (F×I) = 0.95	
After 6 months from repotting date						
3 days	3.63	6.07	8.30	5.97	8.00	6.39
6 days	4.37	7.47	9.73	6.70	8.33	7.32
9 days	3.13	6.23	7.37	5.93	6.47	5.83
Mean (F)	3.71	6.59	8.47	6.20	7.60	
LSD at 5 %	For (I)= 0.31		For (F)= 0.42		For (F×I) = 0.72	
Second season (2020)						
After 3 months from repotting date						
3 days	8.57	9.77	10.90	8.73	9.87	9.57
6 days	8.70	9.87	12.13	9.17	10.43	10.06
9 days	7.50	8.33	9.53	7.87	9.17	8.48
Mean (F)	8.26	9.32	10.86	8.59	9.82	
LSD at 5 %	For (I)= 0.26		For (F)= 0.36		For (F×I) = 0.61	
After 6 months from repotting date						
3 days	9.03	10.33	11.33	9.57	10.33	10.12
6 days	9.80	10.33	12.63	9.67	11.03	10.80
9 days	8.53	8.77	10.03	8.80	10.13	9.25
Mean (F)	9.12	9.99	11.33	9.34	10.50	
LSD at 5 %	For (I)= 0.31		For (F)= 0.30		For (F×I) = 0.55	

Furthermore, the importance of salicylic acid has been growing seen in enhancing plant abiotic stress-tolerance via salicylic-mediated control of great plant-metabolic processes (Khan *et al*., 2015). Salicylic acid at 100 mg/l increased the plant height, leaf number/plant and leaf area of zinnia cultivars in comparison with control (Zeb *et al*., 2017). Enhancing in terms of growth and root parameters were obtained for *Petunia hybrid* (Sardoei *et al*., 2014), *Ixora coccinea* (Gad *et al*., 2016), *Zinnia elegans* (Elbohy *et al*., 2018) and *Gerbera jamesonii* (Mohammed and Abood 2020).

Table 4. Effect of potassium silicate and salicylic acid as foliar spray (F), irrigation intervals (I) and their interaction treatments (F×I) on leaf number per plant of *Dieffenbachia picta* during 2019 and 2020 seasons

Irrigation intervals (days)	Foliar spray treatments (F)					Mean (I)
	Control	Potassium silicate (%)		Salicylic acid (ppm)		
		1	2	25	50	
First season (2019)						
After 3 months from repotting date						
3 days	2.33	2.67	3.00	3.00	3.00	2.80
6 days	2.67	3.00	3.33	3.00	3.00	3.00
9 days	2.00	2.33	3.00	2.67	2.67	2.53
Mean (F)	2.33	2.67	3.11	2.89	2.89	
LSD at 5 %	For (I)= N.S.		For (F)= N.S.		For (F×I) = N.S.	
After 6 months from repotting date						
3 days	2.33	3.00	3.33	3.00	3.33	3.00
6 days	2.67	3.33	3.67	3.00	3.33	3.20
9 days	2.33	3.00	3.33	3.00	3.00	2.93
Mean (F)	2.44	3.11	3.44	3.00	3.22	
LSD at 5 %	For (I)= N.S.		For (F)= 0.65		For (F×I) = 1.32	
Second season (2020)						
After 3 months from repotting date						
3 days	5.00	6.33	7.67	6.00	7.00	6.40
6 days	5.67	6.67	8.00	6.33	7.33	6.80
9 days	4.33	6.00	6.33	5.33	5.67	5.53
Mean (F)	5.00	6.33	7.33	5.89	6.67	
LSD at 5 %	For (I)= 0.82		For (F)= 0.74		For (F×I) = 1.39	
After 6 months from repotting date						
3 days	6.00	7.33	8.67	7.00	7.67	7.33
6 days	6.67	7.67	8.67	7.33	8.00	7.67
9 days	5.33	7.00	7.67	6.33	6.33	6.53
Mean (F)	6.00	7.33	8.33	6.89	7.33	
LSD at 5 %	For (I)= 0.97		For (F)= 0.67		For (F×I) = 1.41	

The drought resistance index:

Data presented in Table 6 demonstrate that, drought resistance index (%) was significantly increased with irrigation every six days treatment as well as it was decreased with irrigation every nine days compared with control (irrigation every three days) in both seasons. In other words, the increases in this connection were about 8.25 and 6.76 % for irrigation interval at 6 days, with significant difference between this treatment and control in the 1st and 2nd seasons, respectively. *Dieffenbachia picta* drought resistance index percentage was significantly increased by using potassium silicate and salicylic acid compared to control (unsprayed plants) in both seasons. Moreover, drought resistance index (%) of dieffenbachia was increased as a result of the treatments of 2% potassium silicate or 50 ppm salicylic acid combined with irrigation every 6 days treatment compared to the interaction between potassium silicate or salicylic acid and the longest intervals of irrigation water in the two seasons. The increases in this connection were about 98.20 and 104.14 % for potassium silicate at 2 % as well as about 91.02 and 92.37 % for salicylic acid at 50 pmm with significant difference between control (irrigation every 3 days without foliar spray) in the 1st and 2nd seasons, respectively.

An increase in drought resistance index percentage perhaps attributed to the silicon physiological function is relied on relations between potassium and silicon precipitation at sure points and improved resistance to different stresses (Shaaban and Abou El- Nour, 2014). Using potassium silicate as foliar spray has the possibility to mitigate the negative influences of drought stress on sugar beet plants grown in calcareous soils (Ali *et al*., 2019).

Table 5. Effect of potassium silicate and salicylic acid as foliar spray (F), irrigation intervals (I) and their interaction treatments (F×I) on leaf area average (cm^2) and root length (cm) of *Dieffenbachia picta* after 6 months from repotting date during 2019 and 2020 seasons

Irrigation intervals (days)	Foliar spray treatments (F)					Mean (I)
	Control	Potassium silicate (%)		Salicylic acid (ppm)		
		1	2	25	50	
Leaf area average (cm^2)						
First season (2019)						
3 days	131.34	168.31	196.38	143.99	169.67	161.94
6 days	142.36	181.95	233.81	158.37	188.40	180.98
9 days	114.92	155.53	160.86	127.67	151.43	142.08
Mean (F)	129.54	168.60	197.02	143.34	169.83	
LSD at 5 %	For (I)= 7.83		For (F)= 7.59		For (F×I) = 14.01	
Second season (2020)						
3 days	146.44	181.50	208.13	161.45	182.21	175.95
6 days	166.61	197.80	247.17	175.20	202.67	197.89
9 days	137.98	147.63	176.23	146.89	172.65	156.28
Mean (F)	150.34	175.64	210.51	161.18	185.84	
LSD at 5 %	For (I)= 5.83		For (F)= 7.39		For (F×I) = 12.77	
Root length (cm)						
First season (2019)						
3 days	28.53	40.00	43.53	38.83	41.27	38.43
6 days	30.97	41.23	45.37	39.47	42.03	39.81
9 days	27.77	38.77	41.63	37.67	40.80	37.33
Mean (F)	29.09	40.00	43.51	38.66	41.37	
LSD at 5 %	For (I)= 0.80		For (F)= 0.61		For (F×I) = 1.22	
Second season (2020)						
3 days	29.07	41.70	44.47	40.90	43.33	39.89
6 days	32.07	42.73	46.60	42.53	44.33	41.65
9 days	29.77	40.13	41.67	39.67	40.50	38.35
Mean (F)	30.30	41.52	44.24	41.03	42.72	
LSD at 5 %	For (I)= 0.45		For (F)= 0.45		For (F×I) = 0.83	

Table 6. Effect of potassium silicate and salicylic acid as foliar spray (F), irrigation intervals (I) and their interaction treatments (F×I) on root dry weight per plant (g) and drought resistance index (%) of *Dieffenbachia picta* after 6 months from repotting date during 2019 and 2020 seasons

Irrigation intervals (days)	Foliar spray treatments (F)					Mean (I)
	Control	Potassium silicate (%)		Salicylic acid (ppm)		
		1	2	25	50	
Root dry weight per plant (g)						
First season (2019)						
3 days	1.11	1.84	2.16	1.66	2.05	1.77
6 days	1.23	2.07	2.21	1.92	2.13	1.91
9 days	1.06	1.55	2.05	1.37	1.83	1.57
Mean (F)	1.13	1.82	2.14	1.65	2.00	
LSD at 5 %	For (I)= 0.09		For (F)= 0.07		For (F×I) = 0.14	
Second season (2020)						
3 days	1.13	2.04	2.23	1.78	2.14	1.86
6 days	1.24	2.19	2.31	2.02	2.18	1.99
9 days	1.16	1.83	2.13	1.66	1.88	1.73
Mean (F)	1.18	2.02	2.22	1.82	2.07	
LSD at 5 %	For (I)= 0.05		For (F)= 0.05		For (F×I) = 0.09	
Drought resistance index (%)						
First season (2019)						
3 days	100.00	165.24	194.02	149.39	184.42	158.61
6 days	110.17	186.26	198.20	172.77	191.02	171.68
9 days	95.50	139.26	183.84	123.39	164.05	141.21
Mean (F)	101.89	163.59	192.02	148.51	179.83	
LSD at 5 %	For (I)= 8.50		For (F)= 5.90		For (F×I) = 12.36	
Second season (2020)						
3 days	100.00	179.66	196.53	156.82	189.15	164.43
6 days	109.10	193.62	204.14	178.50	192.37	175.55
9 days	102.36	161.48	187.72	146.26	165.85	152.73
Mean (F)	103.82	178.25	196.13	160.52	182.46	
LSD at 5 %	For (I)= 4.47		For (F)= 4.33		For (F×I) = 8.00	

Apart from its participation in the mobilization of defense- linked genes and stress resistance in biotic stressed plants (Kumar, 2014), SA has been presented to enhance plant tolerance to main abiotic stresses such as drought stress (Fayez and Bazaid, 2014). Salicylic acid appeared to alleviate salinity-mediated stress of *Plectranthus ciliatus* plant (Salachna *et al*., 2015).

Chemical constituents:

The recorded data in Table 7 point out that, there was a decrease in total chlorophyll and carotenoids contents (mg/100g as fresh weight) in the first season and second seasons by using irrigation intervals from 3 days to 9 days and an increase in this regard by using the interval of every 6 days with significant differences between them. In contrast increasing water deficient from 3, 6 to 9 days gradually increased proline content (mg/g as dry weight).

Table 7. Effect of potassium silicate and salicylic acid as foliar spray (F), irrigation intervals (I) and their interaction treatments (F×I) on total chlorophyll content and carotenoids content (mg/100g as fresh weight) as well as proline content (mg/g as dry weight) of *Dieffenbachia picta* after 6 months from repotting date during 2019 and 2020 seasons

Irrigation intervals (days)	Foliar spray treatments (F)					Mean (I)
	Control	Potassium silicate (%)		Salicylic acid (ppm)		
		1	2	25	50	
Total chlorophyll content (mg/100g as fresh weight)						
First season (2019)						
3 days	0.836	0.916	1.049	0.871	0.916	0.918
6 days	0.910	0.971	1.204	0.881	0.954	0.984
9 days	0.666	0.833	0.931	0.785	0.802	0.803
Mean (F)	0.804	0.907	1.062	0.846	0.891	
LSD at 5 %	For (I)= 0.040		For (F)= 0.070		For (F×I) = 0.115	
Second season (2020)						
3 days	0.758	0.950	1.098	0.880	0.951	0.928
6 days	0.938	0.984	1.323	0.932	0.978	1.031
9 days	0.690	0.868	0.955	0.856	0.859	0.846
Mean (F)	0.795	0.934	1.126	0.889	0.929	
LSD at 5 %	For (I)= 0.060		For (F)= 0.062		For (F×I) = 0.112	
Carotenoids content (mg/100g as fresh weight)						
First season (2019)						
3 days	0.365	0.420	0.457	0.403	0.393	0.408
6 days	0.404	0.440	0.469	0.416	0.388	0.423
9 days	0.294	0.385	0.402	0.354	0.357	0.358
Mean (F)	0.355	0.415	0.442	0.391	0.380	
LSD at 5 %	For (I)= 0.016		For (F)= 0.026		For (F×I) = 0.043	
Second season (2020)						
3 days	0.378	0.436	0.469	0.410	0.403	0.419
6 days	0.414	0.453	0.491	0.430	0.399	0.437
9 days	0.316	0.412	0.421	0.384	0.383	0.383
Mean (F)	0.369	0.434	0.460	0.408	0.395	
LSD at 5 %	For (I)= 0.014		For (F)= 0.016		For (F×I) = 0.028	
Proline content (mg/g as dry weight)						
First season (2019)						
3 days	0.969	1.237	1.377	1.129	1.170	1.176
6 days	1.048	1.420	1.623	1.157	1.303	1.310
9 days	1.210	1.563	1.707	1.430	1.457	1.473
Mean (F)	1.076	1.407	1.569	1.238	1.310	
LSD at 5 %	For (I)= 0.062		For (F)= 0.079		For (F×I) = 0.136	
Second season (2020)						
3 days	0.978	1.293	1.450	1.230	1.260	1.242
6 days	1.147	1.497	1.667	1.323	1.380	1.403
9 days	1.320	1.643	1.770	1.513	1.563	1.562
Mean (F)	1.148	1.478	1.629	1.356	1.401	
LSD at 5 %	For (I)= 0.103		For (F)= 0.082		For (F×I) = 0.162	

Total chlorophyll content, carotenoids content and proline content were increased by using potassium silicate or salicylic acid as foliar spray compared to control in the two tested seasons. However, the highest values in these constants were achieved with 2 % potassium silicate at compared with the other ones under study. Moreover, total chlorophyll and carotenoids contents in dieffenbachia leaves was increased as a result of the treatment of potassium silicate at 2 % interacted with those of water irrigation interval every 6 days in comparison to those of irrigation intervals every 3 or 9 days in both seasons.

Using saline water at 3000 ppm + potassium silicate at 8 cm^3/l increased proline, chlorophyll a and chlorophyll b contents in *Calendula officinalis* leaves compared to control (Attia and Elbohy, 2019).

Similarly, salicylic acid (SA) plays a key part in enhancing the plants resistance to drought stress and effects indices such as photosynthesis and proline contents (Fariduddin *et al*., 2003). Proline content in pea leaves rose with decreasing irrigation level up to the lowest one. Spraying plants with salicylic acid (SA) at 100 ppm had a positive significant influence in photothynthetic pigments (chlorophyll a+b and carotenoids) as well as proline content under drought stress (El-Saadony *et al*., 2017).

CONCLUSION

Utilizing a tolerated shortfall irrigation strategy (intermediate drought stress) will economize water. The results of this study revealed that irrigation application every 6 days followed by irrigation every 3 days compared to irrigation every 9 days plus 2% potassium silicate as foliar application will improve growth parameters, root parameter, drought resistance index of *Dieffenbachia picta* plants as well as total chlorophyll and proline content.

REFERENCES

Adhikari, B.; S. K. Dhungana; I. Kim and D. Shin (2020). Effect of foliar application of potassium fertilizers on soybean plants under salinity stress. Journal of the Saudi Society of Agricultural Sciences, 19: 261–269.

Ahmad, A.; Z. Aslam; M. Z. Ilyas; H. Ameer; A. Mahmood and M. Rehan (2019). Drought stress mitigation by foliar feeding of potassium and amino acids in wheat. Journal of Environmental & Agricultural Sciences, 18: 10-18.

Ali, A. M.; S. M. Ibrahim and I. Abou-Amer (2019). Water deficit stress mitigation by foliar application of potassium silicate for sugar beet grown in a saline calcareous soil. Egypt. J. Soil Sci., 59: 15–23.

Almeida, V. O.; K. A. Batista; M.C.B. Di-Medeiros; M.G. Moraes and K.F. Fernandes (2019). Effect of drought stress on the morphological and physicochemical properties of starches from *Trimezia juncifolia*. Carbohydrate Polymers, 212: 304-311.

Analytical Software (2008). Statistix Version 9, Analytical Software, Tallahassee, Florida, USA.

Attia, K. E. and N. F. S. Elbohy (2019). The influence of spraying with potassium silicate and irrigation with saline water in sandy soil on *Calendula officinalis* L. The Future Journal of Biology, 2: 39-56.

Ayyat, A. M. and M.A.M Abdel-Mola (2020). Response of *Tagetes patula* plants to foliar application of potassium silicate and seaweed extract under various irrigation intervals. Scientific J. Flowers & Ornamental Plants, (4):513-526

Barbieri, G.; S. Pascale; R. D'Andria and M. Mori (1994). Estimating gladiolus leaf area by linear measurements. Adv. Hort. Sci., 2: 85-89.

Bates, L. S., R. P. Waldern and T. D. Tear (1973). Rapid determination of free proline under water stress studies. Plant and Soil, 39: 205-207.

Bidinger, F. R.; Y. Mahalakshmi; B. S. Talukdar and G. Alagarswamy (1982). Improvement of drought resistance in pearl millet. In IRRI (Ed) Drought Resistance in Crops with Emphasis on Rice. IRRI, Los Banos, Laguna Philippines. pp. 357-375.

Blessing, O.; B. O. Green and C. Oguzor (2009). Application of biosystematic and nutritional parameters in the delimitation of family Areceae. African Journal of Basic & Applied Sciences, 1 (1-2): 44-48.

Dong, B.; B. Wu; W. Hong; X. Li; Z. Li; L. Xue and Y. Huang (2017). Transcriptome analysis of the tea oil camellia (*Camellia oleifera*) reveals candidate drought stress genes. PLoS One, 12 (8): 1-25.

Elbohy, N. F.S.; K.E. Attia and T.M. Noor El-Deen (2018). Increasing quality of *Zinnia elegans* plants by foliar spraying with ascorbic and salicylic acids. Middle East Journal of Agriculture Research, 7 (4): 1786-1797.

El-Saadony, F. M.; D. A. S. Nawar and H. G. Zyada (2017). Effect of foliar application with salicylic acid, garlic extract and proline on growth, yield and leaf anatomy of pea (*Pisum sativum* L.) grown under drought stress. Middle East Journal of Applied Sciences, 7 (3): 633-650.

Fariduddin, Q.; S. Hayat and A. Ahmad (2003). Salicylic acid influences net photosynthetic rate, carboxylation efficiency, nitrate reductase activity, and seed yield in *Brassica juncea*. Photosynthetica, 41: 281-284.

Fayez, K. A.; and S. A. Bazaid (2014). Improving drought and salinity tolerance in barley by application of salicylic acid and potassium nitrate. J. Saudi Soc. Agric. Sci., 13: 45–55.

Gad, M. M.; E. Y. Abdul-Hafeez and O. H. M. Ibrahim (2016). Foliar application of salicylic acid and gibberellic acid enhances growth and flowering of *Ixora coccinea* L. plants. J. Plant Production, Mansoura Univ., 7(1): 85-91

Ghodke, P. H.; P. S. Andhale; U. M. Gijare; A. Thangasamy; Y. P. Khade, V. Mahajan and M. Singh (2018). Physiological and biochemical responses in onion crop to drought stress. International Journal of Current Microbiology and Applied Sciences, 7: 2054-2062.

Gomez, K. A. and A. A. Gomez (1984). Statistical Procedures for Agricultural Research. John Wiley & Sons Inc., Singapore 680.

Hayat Q.; S. Hayat; M. Irfan and A. Ahmad (2010). Effect of exogenous salicylic acid under changing environment: A review. Environ. Exp. Bot., 68: 14–25.

Ibrahim, M. F. M.; G. Abd El-Samad; H. Ashour; A. M. El-Sawy; M. Hikal; A. Elkelish; H. Abd El-Gawad; A. Abou El-Yazied; W. N. Hozzein and R. Farag (2020). Regulation of agronomic traits, nutrient uptake, osmolytes and antioxidants of maize as influenced by exogenous potassium silicate under deficit irrigation and semiarid conditions. Agronomy, 1212 (10): 1-19.

Khan, M. I. R.; M. Fatma; T. S. Per; N. A. Anjum and N. A. Khan (2015) Salicylic acid-induced abiotic stress tolerance and underlying mechanisms in plants. Front. Plant Sci., 6:1-17.

Kumar, D. (2014). Salicylic acid signaling in disease resistance. Plant Sci., 228: 127–124.

Larkunthod, P.; N. Nounjan; J. L. Siangliw; T. Toojinda; J. Sanitchon; B. Jongdee and P. Theerakulpisut (2018). Physiological responses under drought stress of improved drought-tolerant rice lines and their parents. Notulae Botanicae Hort. Agrobotanici Cluj-Napoca, 46: 679-687.

Lütken, H.; J. L. Clarke and R. Müller (2012). Genetic engineering and sustainable production of ornamentals: Current status and future directions. Plant Cell Rep., 31: 1141–1157.

Marschner, P. (2012). Marschner's Mineral Nutrition of Higher Plants, 3rd ed.; Academic Press: London, UK. pp: 178-189.

Mohammed, R. A. J. and B. M. A. Abood (2020). Effect of bacterial inoculum, spraying with calcium nitrate and salicylic acid in vegetative and flowery growth traits of *Gerbera jamesonii*. Plant Archives, 20 (1): 633-638.

Niu, J.F.; W.F. Zhang; S.H. Ru; X.P. Chen; K. Xiao; X.Y. Zhang; M. Assaraf; P. Imas; H. Magen; and F.S. Zhang (2013). Effects of potassium fertilization on winter wheat under different production practices in the North China Plain. Field Crops Res. 140:69–76.

Noman, A.; M. Aqeel; J. Deng; N. Khalid; T. Sanaullah and H. Shuilin (2017). Biotechnological advancements for improving floral attributes in ornamental plants. Frontiers in Plant Science, 8: 1-15.

Oloyede, G. K.; P. A. Onocha and S. F. Abimbade (2011). Chemical composition, toxicity, antimicrobial and antioxidant activities of leaf and stem essential oils of *Dieffenbachia picta* (Araceae). European Journal of Scientific Research, 49 (4): 567-580.

Popova, L.; T. Pancheva and A. Uzunova (1997). Salicylic acid: properties, biosynthesis and physiological role. Bulg. J. Plant Physiol., 23: 85-93.

Rady, M. M. and G. F. Mohamed (2015). Modulation of salt stress effects on the growth, physio-chemical attributes and yields of *Phaseolus vulgaris* L. plants by the combined application of salicylic acid and *Moringa oleifera* leaf extract. Sci. Hort., 193: 105–113.

Saeed, A. A.J. M. (2020). Effect of ascorbic and salicylic acids on growth and flowering of *Gazania* cv. Frosty Kiss Mixed. Ornamental Horticulture, 26 (4): 537-544.

Salachna, P.; R. Piechocki; A. Zawadzińska and A. Wośkowiak (2015). Response of speckled spur-flower to salinity stress and salicylic acid treatment. J. Ecol. Eng. 2015; 16(5):68–75.

Sardoei, A. S.; M. Shahdadneghad; M. R. Yazdi and S. Gholamshahi (2014). Growth response of *Petunia hybrid* to zinc sulphate and salicylic acid. International journal of Advanced Biological and Biomedical Research, 2 (3): 622-627.

Saric, M., R. Kastrori, R. Curic, T. Cupina and I. Geric (1967). Chlorophyll Determination. Univ U Noven Sadu Parktikum is Fiziologize Biljaka, Beogard, Haucna, Anjige, p. 215.

Sevik, H.; M. Cetin; K. Guney and N. Belkayali (2018). The effect of some indoor ornamental plants on CO_2 levels during the day. Pol. J. Environ. Stud., 27 (2): 839-844.

Shaaban, M. M. and E. A. Abou El-Nour (2014). Macro and micro-nutrients concentrations and uptake by maize seedlings irrigated with fresh or saline water as affected by k-silicate foliar fertilization. American Journal of Plant Physiology, 9: 95-102.

Webster, A. D.; C. J. Altkinson; A. S. Lucas; S. P. Vaughan and L. Taylor (2000). Interactions between root restriction, irrigation and rootstock treatments on the growth and cropping of 'Queen Cox'apple trees: Effects on orchard growth and cropping. J. Hort. Sci. and Biotech., 75(2):181-189.

Zeb, A.; F. Ullah; S. L. Gul; M. Khan; B. Zainub; M. N. Khan and N. Amin (2017). Influence of salicylic acid on growth and flowering of zinnia cultivars. Sci. Int. (Lahre), 29 (6):1329-1335.

تأثير الرش الورقي بالبوتاسيوم وحمض السالسيليك على نباتات الدفينباخيا بيكتا تحت معدلات ري مختلفة

وليد محمد فهمي عبد الهادي[1] و أحمد عبد العال حجازي[2]

[1]قسم بحوث نباتات الزينة وتنسيق الحدائق ، معهد بحوث البساتين، مركز البحوث الزراعية، مصر.

[2]قسم الخضر والزينة ـ كلية الزراعة جامعة المنصورة.

تم دراسة تأثيرات فترات الري المختلفة (كل 3، 6 و9 أيام) بالتفاعل مع معاملات الرش الورقي [ماء الصنبور (كمعاملة مقارنة)، سليكات بوتاسيوم بتركيزات 1 و 2% وحامض الساليسيليك بتركيزات 25 و50 جزء في المليون] على صفات النمو والجذور وبعض المكونات الكيميائية لنبات الديفنباخيا بكتا. أجري هذا البحث في محطة بحوث البساتين بالمنصورة، محافظة الدقهلية، مصر خلال موسمي 2019 و2020. حيث أشارت النتائج المتحصل عليها أن ري نباتات الديفنباخيا كل ستة أيام أدى إلى زيادة كبيرة في ارتفاع النبات وطول وعرض الورقة وعدد الأوراق لكل نبات خلال كلا الموسمين بعد ثلاثة وستة أشهر من تاريخ إعادة التدوير مقارنة بفترات الري الأخري تحت الدراسة. وكذلك الحصول على أعلى القيم لمتوسط مساحة الورقة وطول الجذر ووزن الجذور الجافة لكل نبات وزيادة المحتوى الكلي من الكلوروفيل والكاروتينات والبرولين عن طريق معاملة الري كل ستة أيام. حيث سجلت أعلى القيم للصفات المذكورة أعلاه عن طريق الرش الورقي بسيليكات البوتاسيوم بتركيز 2%. ويمكن الحصول على أفضل صفات للنمو والجذور وأعلى محتوى كيميائي للأوراق (الكلوروفيل الكلي والكاروتينات والبرولين) عند رش النباتات بسيليكات البوتاسيوم بتركيز 2% للنباتات المروية كل ستة أيام.