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THE PERFORMANCE OF DELPHINIUM (*Delphinium ajacis* (L.) Schur.) PLANTS UNDER DROUGHT STRESS, HYDROGEN PEROXIDE AND SALICYLIC ACID TREATMENTS

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ABSTRACT: Greenhouse experiments were conducted during the two successive winter seasons of (2016 – 2017) and (2017- 2018) in order to enhance the performance of Delphinium plants under drought stress conditions and the possibility of enhancing vegetative growth, flowering growth, and chemical composition. Experiments were designed as a split-plot based on randomized complete block with three replications in a private commercial nursery in Damanhour City, El-Beheira Governorate, Egypt. The experiments were conducted by applying foliar applications of hydrogen peroxide (H_2O_2) at 0, 1250 and 2500 ppm and salicylic acid (SA) at 0, 100 and 200 ppm. The vegetative, root and flowering growth and chemical composition of Delphinium plants grown under drought stress were examined. The obtained results of the two seasons revealed that either SA or H_2O_2 treatments caused significant increase in growth parameters and chemical composition of Delphinium plants compare to control plants. Salicylic acid at a concentration of 100 ppm was more effective in increasing vegetative, root and flowering growth, and photosynthesis parameters, followed by H_2O_2 at a concentration of 1250 ppm compared to the other treatments. On the other hand, H_2O_2 at a concentration of 2500 ppm was more effective in increasing total phenols and H_2O_2 content in leaves.

Keywords: *Delphinium ajacis*, *Consolida ajacis*, Larkspur, hydrogen peroxide, Salicylic acid, Drought stress.

INTRODUCTION

Delphinium ajacis L. [syn. *Consolida ajacis* (L.) Schur.] is one of the most important plants in family Ranunculaceae **(Wang *et al.*, 2010)**, with the common name of garden larkspur **(Liang *et al.*, 1991)**. It is an annual flowering plant topped with a raceme of many flowers, varying in color from purple and blue, to pink, red, yellow, or white **(Blanchè and Molero, 1993).** The name of the plant belongs to the flower itself because it is consists of five petal-like sepals that grow together to form a hollow pocket with a spur at the end, usually more or less dark blue. Within the sepals, there are four true petals, small, inconspicuous, and commonly colored similarly to the sepals **(Warnock, 1993).** Leaves of this plant are alternate, deeply lobed with three to seven toothed, pointed lobes in a palmate shape. Delphinium plants cultivated for its attractive color flowers and for varied uses like garden plants, for cut flowers and floristry, excellent for rising in the garden as borders and beds. Also, the blooming plant is used in displays and specialist competitions at flower and garden shows, such as the Chelsea Flower Show **(Bassett, 2006)**. Plants contain many active compounds such as alkaloids, phenols tannins, steroids, glycosides, resins, flavonoids, volatile oils, and fixed oils and they are present in leaves, flowers, bark, root, seeds, etc. **(Desai *et al.*, 1994)**. These phytochemicals have beneficial medicinal effects, especially its activity against human diseases **(Bonjar *et al*, 2004)**. As a traditional Chinese medicine, the roots of *D. ajacis* are applied to treat stomach ache, and the seeds are used to treat edema and asthma **(Ran *et al.*, 1993)**.

Also, seeds are being used for enhancement of hair and treatment of hair loss since ancient times in Mediterranean tradition medicine **(Wang *et al.*, 2010).**

In nature, plants often face the challenge of severe environmental conditions, which include various biotic and abiotic stresses that affect the plant growth and development causing considerable loss in crop productivity. Drought and water deficit is one of most important environmental factors causes of crop loss worldwide, reducing average yields for most major crop plants by inhibiting photosynthesis and decreasing growth and productivity of plants, also, drought affects more than 10 % of arable land, causing desertification especially in arid and semi-arid areas **(Bray *et al*. 2000)**. Because of population growth and development of economic sectors, the competition for water resources will also grow **(Laraus, 2004)**.

Oxidative damage is a common effect of drought stress, as with other environmental stresses. Oxidative stress occurs in plant cells when the production of reactive oxygen species (ROS) is excessive **(Sharma *et al.*, 2012)**. The ROS, including singlet oxygen (O_2^{-1}), superoxide anion ($O_2^{\bullet-}$), hydrogen peroxide (H_2O_2) and hydroxyl radical ($OH^{\bullet-}$), are constantly produced as by-products of metabolic reactions **(Sharma *et al.*, 2012)**. In the absence of effective mechanisms, which remove or scavenge free radicals, oxidative stress can seriously damage the plant by lipid peroxidation, protein degradation, breaking of DNA, and cell death **(Arora *et al.*, 2002)**. Among the ROS compounds, H_2O_2 is the one that received most of the attention of the scientific community in the last decade. Where, the increased data indicate the biological activity of H_2O_2 as a stress signal molecule in plants **(Hung *et al.*, 2005)**. Hydrogen peroxide (H_2O_2) is one of the major and the most stable ROS, which is induced to elevate in plants by biotic and abiotic stresses **(Ślesak *et al.*, 2007)**. Many studies stated that exogenous H_2O_2 application can increase abiotic stress tolerance either by modulating ROS detoxification or regulating multiple stress-responsive pathways and gene expression **(Hossain *et al.*, 2015)**. Furthermore, H_2O_2 directly regulates the expression of numerous genes involved in plant defense and the related pathways such as antioxidant enzymes, defense proteins and transcription factors **(Hung *et al.*, 2005)**. **Liu *et al.* (2010)** reported that H_2O_2 pre-treatment of two cucumber varieties improved osmotic stress resistance by activating the antioxidants system.

Additionally, salicylic acid (SA) is a phenolic compound with antioxidant properties and involved in the regulation of various physiological functions and biochemical activities in plants **(Mehrabian *et al*, 2011)**. Salicylic acid plays an important role as a molecular signal in creating a defensive response against various biotic and abiotic stresses by various mechanisms such as improved photosynthetic capacity **(Arfan *et al.*, 2007)**, maintaining the stability of membranes and thereby **(El-Tayeb, 2005)**. Salicylic acid changes the activity of antioxidant enzymes, which play a remarkable role in the protection of plants against oxidative damage by detoxification of strong oxidizing radicals **(Munns and Tester, 2008)**. Salicylic acid effects on peroxidase and catalase enzymes and osmotic regulators such as proline, glycine and betaine and ameliorates the effect of drought stress, heavy metals, heat, cold and salinity in corn **(Hussein *et al.*, 2007).** Therefore, the objective of the current study was to assess the role of exogenous H_2O_2 and SA application in inducing Delphinium plants drought tolerance, based on changes in some traits such as growth and its chemical components. In order to plant Delphinium plants in arid and semi-arid areas under rainwater.

MATERIALS AND METHODS

Experimental design

This experiment included 18 treatments which included all possible combinations between the three irrigation intervals levels (D3, D6, and D9), the three exogenous H_2O_2 treatments (H0, H1, and H2), and the three exogenous SA treatments (SA0, SA1, and SA2). Treatments were arranged in a split-plot design with three replicates each, and different irrigation treatments were assigned at random in the main plots, while sub-plots were devoted to the different exogenous H_2O_2 and SA treatments. However, the statistical analysis of the experiment was done as described in the randomized complete plot design.

Irrigation intervals, hydrogen peroxide (H_2O_2), and salicylic acid (SA) treatments

The following three irrigation intervals were applied throughout the period of plant life: 3, 6 and 9 days between irrigations. The H_2O_2 concentrations that were used during the experiment were H0 = untreated plants (control treatment). H1= sprayed with 1250 ppm hydrogen peroxide. H2= sprayed with 2500 ppm hydrogen peroxide. The following concentrations of SA were used during the experiment: SA 0 = untreated plants (control treatment). SA 1= sprayed with 100 ppm salicylic acid. SA 2= sprayed with 200 ppm salicylic acid.

Planting and growth conditions

Two pot experiments were carried out during the two successive winter seasons of (2016 – 2017) and (2017- 2018) in a split-plot design based on randomized complete block design with three replications in a greenhouse of a private commercial nursery in Damanhour City, El-Beheira Governorate, Egypt. A local variety of *Delphinium ajacis* plants was used throughout the study. Seeds were obtained

from the Experimental Station of Floriculture and Ornamental Horticulture, Faculty of Agriculture, University of Alexandria.

Seeds were sown on October 18th for both seasons in wooden trays filled with a mixture of equal parts of sand and peat moss. The trays were placed in a shady place in the commercial nursery and watered daily. After 5 weeks from sowing the seedlings were individually transplanted to 25 cm plastic pots containing sandy soil. The mechanical and chemical analyses of the soil were determined according to the standard method described by **Black *et al*. (1965)** and results are shown in Table (1).

Table 1. Some physical and chemical analyses of soil samples of the experiment

Physical analysis	**First season**	**Second season**
Clay (%)	1.77	1.72
Silt (%)	6.23	6.03
Sand (%)	92	92.25
Texture class	sand	sand
Chemical analysis		
EC (dS/m)	0.8	0.82
pH	7.7	7.9
Ca (meq/L)	20.21	20.32
Mg (meq/L)	6.20	6.78
SO_4 (meq/L)	8.21	7.94
K (meq/L)	5.31	5.33

The soil characteristic analyses were carried out at the Natural Resources and Agriculture Engineering Department, Faculty of Agriculture, Damanhour University.

After 75 days from seed sowing, plants were sprayed four times distributed once a week with hydrogen peroxide (H_2O_2) at (0, 1250 and 2500 ppm) and Salicylic acid (SA) at (0, 100 and 200 ppm) onto the leaves of each plant, and then irrigation was stopped. Treatments with H_2O_2 or SA were always followed by drought stress. Pot surface was covered with polyethylene before application to avoid falling of spray drips on the growing medium. All concentrations were applied using a hand sprayer and non-ionic surfactant tween 80 at 0.05% (v/v) was added to all treatments to reduce the surface tension and increase the contact angle of sprayed droplets. Each plant was sprayed individually, so that, all foliage was moistened until the point of run-off. The spraying volume was 18 ml per plant and the amount of water that was added to the pot to irrigate plants 450 ml per plant. All treatments received identical doses of N, P and K fertilization. Foliar sprays were utilized always early in the morning. All other cultural practices were adapted whenever they were necessary and as commonly recommended in the commercial production of Delphinium plants.

Data recorded

Plant growth characteristics, at the end of the experiment, plant height (cm), 100 seeds weight g/plant, number of branches per plant, shoot fresh and dry weight per plant (g) were determined without the inflorescences and also for roots for all plants. Also, root growth parameters were measured such as root length, root fresh and dry weight per plant (g). Flower characteristics, flower diameter (cm), flowering duration (day), flower fresh and dry weight (g) and the number of flowers per plant were determined.

Chemical analyses

Chlorophyll components and total chlorophyll contents (mg/g F.W.) were measured spectrophotometrically according to **Arnon (1949).** The concentrations of chlorophyll a, chlorophyll b and total chlorophyll were calculated using the following equation:

Chlorophyll a = 12.7 (A663) - 2.69 (A645)

Chlorophyll b = 22.9 (A645) - 4.68 (A663)

Total chlorophyll = 20.2 (A645) + 8.02 (A663)

Hydrogen peroxide (H_2O_2) and total phenolics content

The H_2O_2 content (µmol/g FW) was measured calorimetrically as described by **Jana and Chundhuri (1981).** Total phenolic contents (mg/g d.wt**)** were determined by the colorimetric method of folin-Denis as described by **Daniel and George (1972).** A calibration curve of pyrogallol was prepared, and the results were expressed as mg Pyr (Pyrogallol).

Statistical Analysis

All obtained data were statistically analyzed by Statistical Analysis Systems **(Costat, 2008)** and significant means were compared by the Tukey test at 0.05 probability.

RESULTS AND DISCUSSION

Vegetative growth characters

The data showing the main effects of the two studied factors (different irrigation intervals and different levels of "hydrogen peroxide and salicylic acid") and their interactions on plant growth of Delphinium plants during the two growing seasons of (2016 – 2017) and (2017- 2018) are presented in Table (2 and 3).

Regarding the main effect of drought stress on plant growth parameters, data in Table (2) proved that plant height, number of branches per plant, plant fresh weight, plant dry weight, root fresh weight and root

dry weight of Delphinium plants were significantly decreased with decreasing level of irrigation up to the lowest one in both seasons. However, root length was significantly increased. The greatest reduction of plant growth parameters mentioned before and the greatest increment of root length was obtained under severe drought stress, in both seasons. Under severe drought stress the estimated percentages decrease in plant height, number of branches per plant, plant fresh weight, plant dry weight, root fresh weight and root dry weight were (43.22% and 43.76%), (68.42 and 65.19%), (52.04 and 51.6%), (40.28 and 41.63%), (40.61 and 43.02%) and (41.33 and 48.34%) compared to the control treatment and for the first and second season, respectively. But, the estimated percentages increment of root length under severe drought stress was (153.65 and 8.715 %) compared to the control treatment and for the first and second season, respectively.

Plants suffer from drought stress either when the water supply to roots becomes difficult or when the transpiration rate becomes very high **(Ismail and Ozawa 2009).** The reduction in plant growth might be due to, the reduction in cell division and elongation and more leaf senescence resulting from reduced turgor pressure **(Shao *et al*. 2008)** or it may be due to a decrease in photosynthesis in tissues, because when leaf area is lower, the capacity to light trap decreases and this led to an imbalance between light capture and its utilization **(Khalid 2006 and Shao *et al*., 2008)** and by closing stomata, inhibited ribulose-1,5-bisphosphate carboxylase/oxygenase (Rubisco), and the impairment of ATP synthesis needed for plant growth **(Lawlor and Cornic, 2002)**. Also, the effect of drought stress on the growth of plant may be due to the lower availability of sufficient moisture in the rhizosphere which leads to the reduction of nutrients absorption **(Singh *et al*., 1997).** Moreover, water deficit causes plant growth inhibitors such as abscisic acid (ABA) to increase and growth regulator hormones to decrease **(Molz and Klepper, 1973)**. Moreover, water deficit leads to the excess accumulation of ROS that induced oxidative injuries to deoxyribonucleic acid, lipid, and protein and finally a growth reduction **(Yazdanpanah *et al*., 2011). Yin *et al*., (2005)** reported that fine root mass significantly decreases under water shortage. Increasing the irrigation interval causes a decrease in the root dry weight because the pattern of root distribution was similar to that of the moisture distribution **(Kramer, 1995). Scholander *et al*. (1965)** reported that when the soil is dry, the roots are more in-depth profiles of soil development which leads to increasing root length. **Leskovar (1998)** emphasized that irrigation method, rate, timing, and interval may influence the physical and chemical properties of the growing media and thereby, affecting root initiation, elongation and dry matter partitioning between roots and shoots. The obtained results were in harmony with those reported by **EL-Saadony *et al*. (2017)** on *Pisum sativum* L., **El-Sabagh *et al*. (2017)** and **Orabi, *et al*. (2018)** on canola plants and **Wang *et al*. (2019)** on rice.

Concerning the main effect of different rates of hydrogen peroxide and salicylic acid on the vegetative growth parameters, data in Table (2) indicated that spraying the Delphinium plants with the low concentrations of salicylic acid (100 ppm) and H_2O_2 (1250 ppm) significantly increased the plant growth parameters compared to control (spraying with tap water) in both seasons. The highest values of plant height, plant fresh weight, plant dry weight, root length, root fresh weight, and root dry weight were observed at 100 ppm salicylic acid compared to other treatments, in both seasons. However, the differences between salicylic acid at 100 ppm and H_2O_2 at 1250 ppm on the number of branches per plant and root dry weight in the second season only were at par.

Generally, the promotive effect of salicylic acid could be lead to its bioregulator effects on physiological and biochemical processes in plants such as ion uptake by the stressed plant, cell elongation, cell division, cell differentiation, enzymatic activities, protein synthesis, sink/source regulation and increase CO_2 assimilation and photosynthetic rate as well as increase the antioxidant capacity of plants **(El-Tayeb, 2005 and Raskin, 1992).** Also, salicylic acid plays a vital role in alleviation abiotic stresses through increasing the growth-regulating hormones such as auxins and cytokinins, GA, ABA **(Zarghami *et al*., 2014)**, which lead to enhance mitosis, cell division and cell elongation **(Sakhabutdinova *et al*., 2003).** Also, SA plays an important role in stimulating physiological processes, such as accelerated carbon assimilates, increased biosynthesis of metabolites and maintenance of tissue water status **(Habibi, 2012)**. Furthermore, SA plays an important role in enhancing chlorophyll content and photosynthetic rate **(Fariduddin *et al*., 2003)**. Additionally, the SA application enhanced total soluble sugar accumulation that served as a substrate for accelerating initiation of leaf primordial **(Munns *et al*., 1979).** The aforementioned results of Salicylic acid are in good accordance with those postulated by **Chattha *et al*. (2015)** on maize, **El-Saadony *et al*., (2017)** on pea and **Fardus *et al*. and Kareem *et al*. (2017)** on wheat.

Hydrogen peroxide considers as a key regulator in a broad range of physiological processes, like stomatal movement, photosynthesis **(Noctor and Foyer, 1998)**, senescence **(Peng *et al*., 2005)**, cell cycle and growth and development **(Deng *et al*., 2012)**. Hydrogen peroxide plays an important role in activating many other important signal molecules

(Ca^{+2}, SA, ABA, JA, and ethylene) of plants **(Dempsey and Klessig, 1995).** These signal molecules work together and play a complex role in signal transduction of resistance responses, and growth and development in the plant. Moreover, the change of H_2O_2 level may influence metabolic and antioxidant enzyme activity related to plant growth and development **(Barba-Espín *et al.*, 2011).** Furthermore, H_2O_2 affects leaf growth via the root accepting signals directly and then producing different growth-stimulating signals to mediate root physiological processes, like root activity or root growth, changing water absorption capacity and changing leaf water condition, finally affecting leaf metabolic processes **(Deng *et al.*, 2012).** Hydrogen peroxide plays an important role in enhancing root length by enhancing cell division either as primary or secondary effect to counterbalance the inhibition process of cell elongation and enhancing the process of new root emergence, which can be attributed to plant defense response to abolish the effect of stress (reduction in root length and weight) thereby, helping the plant to establish properly for attaining proper growth under stress condition **(Potikha *et al.*, 1999). Ren *et al.* (2000)** observed an increased level of H_2O_2 in wheat root cells, which enhanced the root growth under drought stress. The obtained results of H_2O_2 are in harmony with **Deng *et al.* (2012)** on sweet potato, **Goldani *et al.* (2012)** on *Origanum majorana* L., **Guler and Pehlivan (2016)** on soybean and **Orabi *et al.* (2018)** on canola plants.

The effect of interaction between the different irrigation intervals and different levels of "hydrogen peroxide and salicylic acid" on plant growth characters were significant during both seasons (Table 3). The statistical analysis, generally, revealed that the highest mean values of plant height, number of branches per plant, plant fresh weight, plant dry weight and root dry weight of Delphinium were achieved when spraying Delphinium plants with 100 ppm salicylic acid under 3 days irrigation interval in both seasons. On the other hand, the highest mean value of root length was achieved at the interaction between irrigation every nine days and the application with 100 ppm Salicylic acid in both seasons and 1250 ppm H_2O_2 in the second season only. The estimated percentages increase in plant height, number of branches per plant, plant fresh weight, plant dry weight, root length, root fresh weight, and root dry weight were 8.12 and 10.33%, 13.65 and 13.64%, 19.78 and 19.36%, 40.85 and 37.62%, 230.12 and 19.3%, 9.82 and 22.76% and 8.82% compared to the control treatment and for the first and second season, respectively.

Flower characteristics

Pertaining to the main effect of drought stress on flower parameters the gained results presented in Table (4) showed that there was a negative relationship between flower parameters and prolonging the period between irrigations. As irrigation period increased flower parameters i.e. the number of days to flowering, flowering duration, flower diameter, the number of flowers per plant, flower fresh weight and flower dry weight decreased. So, irrigation plants every nine days gave the lowest mean values of flower parameters but irrigation plants every three days gave the highest mean values of flower parameters, in both seasons. The estimated percentages decrease in number of days to flowering, flowering duration, flower diameter, number of flowers per plant, flower fresh weight and flower dry weight were 22.78% and 22.32%, 50.97 and 49.83%, 49.75 and 50.9%, 51.46 and 52.79%, 42.25 and 44.55% and 62 and 62.89% compared to the control treatment and for the first and second season, respectively.

Flowers are very sensitive to drought stress, the inhibition of flower growth characters under water deficit treatments would almost certainly be due to exposure to injurious levels of drought, causing a decrease of turgor which would result in a decrease of growth and decrease cell division and elongation **(Kareem *et al.*, 2017)** which lead to a reduction in flower diameter then reduction of flower fresh and dry weight. Plants under any type of stressed condition tend to shorten their life span and try to complete their life cycle in hasten which causes the minimum days to flowering **(Ponce *et al.*, 1996).** Also, water shortage decreases plant size, resulting in fewer locations for flower initiation and development **(Guilioni *et al.*, 2003)** which leads to a reduction in the number of flowers per plant then reduction of flowering duration. Moreover, the limitation of water at the flowering stage not only reduces flower formation but also increases flower abortion **(Mahendran and Bandara, 2000).** Our findings were in agreement with the results of **Al-Ubaydi *et al.* (2017)** on okra, **˘Cerekovi´c *et al.* (2013)** on *Ribes nigrum* L., **Shokrani *et al.* (2012)** on *Calendula officinalis* and **Turan *et al.* (2015)** on chrysanthemum.

Concerning the main effects of different rates of hydrogen peroxide and salicylic acid on flower parameters, data in Table (4) indicated that foliar spray of Delphinium plants with the low concentrations of salicylic acid (100 ppm) and H_2O_2 (1250 ppm) significantly increased the given flower parameters compared to control (spraying with tap water) in both seasons and the maximum mean values of these parameters were observed at 100 ppm salicylic acid.

Table 2. The main effect of different irrigation intervals and different levels of hydrogen peroxide and salicylic acid on plant growth parameters of Delphinium plants during the 2016/2017 and 2017/2018 seasons

Irrigation Interval Days	Plant height (cm)		N. of branches/ plant		Plant fresh weight (g)		Plant dry weight (g)		Root length (cm)		Root fresh weight (g)		Root dry weight (g)	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Irrigation intervals (days)														
D3	98.33A	100.30A	7.60A	7.47A	31.13A	31.67A	7.87A	8.12A	10.97C	19.42C	16.16A	18.68A	3.41A	3.97A
D6	75.13B	76.00B	5.53B	5.60B	22.20B	22.53B	5.69B	5.77B	19.25B	19.83B	12.66B	12.30B	2.71B	2.7B
D9	55.83C	65.43C	2.40C	2.60C	14.93C	15.33C	4.70C	4.74C	27.82A	21.11A	9.6 C	10.64C	2.00C	2.00C
Hydrogen peroxide and Salicylic acid														
Control	75.67C	76.11 C	5.00C	4.78B	21.89C	22.67C	5.96C	6.16C	18.89C	19.71C	12.19D	11.55E	2.63C	2.89 B
H_2O_2 1	79.56B	81.14 B	5.56B	5.89A	24.56B	25.11B	6.56B	6.75B	21.15B	22.13B	13.79B	15.27B	2.87B	3.03A
H_2O_2 2	68.56E	69.67 E	4.33D	4.33B	19.22D	19.56E	4.93E	5.00E	15.83E	16.32E	10.88E	12.38D	2.37D	2.755C
SA 1	85.06A	86.46 A	6.22A	6.22A	26.56A	26.78A	7.24A	7.32A	22.4 A	23.19A	14.41A	15.69A	3.02A	3.03A
SA 2	73.33D	74.56 D	4.78CD	4.89B	21.56C	21.78D	5.75D	5.81D	18.46D	19.25D	12.75C	14.49C	2.63C	2.89 B

1st and 2nd; first season and second season. Means were compared using Tukey's Honest Significant Difference test ($P \leq 0.05$); n = 3; Means with the same capital letters are no significantly different between different irrigation intervals or between different levels of "hydrogen peroxide and salicylic acid"

Table 3. The interaction effect between different irrigation intervals and different levels of hydrogen peroxide and salicylic acid on plant growth parameters of Delphinium plants during the 2016/2017 and 2017/2018 seasons

Irrigation Interval (Day)	Trts	Plant Height (cm)		N. of Branches		Plant fresh weight (g)		Plant dry weight (g)		Root length (cm)		Root fresh weight (g)		Root dry weight (g)	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
D3	Control	98. 7 c	100.0 c	7.3 bc	7.3 b	30.3 c	31.0 c	7.3 c	7.6 c	9.3 n	20.1 e	16.3 c	16.7 c	3.4 c	4.1 a
	H_2O_2 1	102. 3 b	103.7 b	7.7 ab	7.7 ab	34.0 b	34.7 b	8.6 b	9.1 b	13.2 l	20.8 d	17.2 b	20.1 ab	3.5 b	3.9 bc
	H_2O_2 2	89. 7 e	92.0 e	7.3 bc	7.0 b	26.3 e	27.0 e	6.37 e	6.6 d	7.2 o	15.76 j	14.3 e	16.5 c	3.1 e	3.8 c
	SA 1	106. 7 a	110.3 a	8.3 a	8.3 a	36.3 a	37.0 a	10.3 a	10.5 a	13.8 k	22.8 b	17.9 a	19.6 b	3.7 a	4.0 a
	SA 2	94.3 d	95.7 d	7.3bc	7.0 b	28.7 d	28.7 d	6.8 d	6.8 d	11.4 m	17.7 h	15.2 d	20.5 a	3.3 d	3.99 ab
D6	Control	75.3 h	75.7 h	6.0 d	5.3 c	22.0 gh	22.3 gh	5.6 gh	5.8 ef	19.2 h	19.4 f	12.4 h	10.6 h	2.7 h	2.8 e
	H_2O_2 1	78.0g	80.0 g	6.0 d	6.7 b	23.0 g	23.7 fg	5.9 fg	5.99 e	20.8 g	21.6 c	12.99 g	12.99 e	2.9 g	3.0 d
	H_2O_2 2	66.3 j	67.3 j	4.3 ef	4.3 de	19.7 i	20.3 i	5.4 hi	5.4gh	15.8 j	16.8 i	11.98 j	11.98 g	2.4 j	2.4 g
	SA 1	86.7 f	85.7 f	6.7 cd	6.7 b	25.0 f	25.0 f	6.1 ef	6.1 e	22.8 f	22.8 b	13.7 f	13. 7 d	3.0 f	2.9 e
	SA 2	69.3 i	71.3 i	4.7 e	5.0 cd	21.3 h	21.3 hi	5.5 hi	5.5 fg	17.7 i	18.5 g	12.2 i	12.2 fg	2.6 i	2.6 f
D9	Control	53.0 n	52.7 n	1.7 ij	1.7 h	13.3 m	14.7 k	4.98 j	5.0 h	28.1 c	19.6ef	7.9 n	7.3 j	1.8 n	1.8 j
	H_2O_2 1	58.3 l	59.8 i	3.0 gh	3.3 fg	16.7 k	17.0 j	5.2 ij	5.2 gh	29.4 b	23.98 a	11.0l	12.8 ef	2.2 l	2.1 h
	H_2O_2 2	49.7 o	49.67o	1.3 j	1.7 h	11.7 n	11.3 l	3.0 k	3.0 i	24.6 e	16.4 i	6.4 o	8.70 i	1.6 o	2.0 i
	SA 1	61.8k	63.4k	3.7 fg	3.7 ef	18.3 j	18.3 j	5.3 hij	5.3 gh	30.7 a	23.98 a	11.7 k	13.8 d	2.3 k	2.2 h
	SA 2	56.3 m	56.7 m	2.3 hi	2.7 g	14.7 l	15.3 k	4.99 j	5.1gh	26.3 d	21.54c	10.8 m	10.7 h	2.1 m	2.1 hi

1st and 2nd; first season and second season. Means were compared using Tukey's Honest Significant Difference test ($P \leq 0.05$); n = 3; Means with the same small letter show no significant interaction between different irrigation intervals and different levels of "hydrogen peroxide and salicylic acid"

Generally, the superior influence of Salicylic acid treatments on stimulating the flower parameters may be due to the role of SA as a growth regulator which participates in the regulation of physiological processes in plants like, stimulating flowering in a range of plants, increases flower life, controls ion uptake by roots and stomatal conductivity **(Hayat *et al*., 2007).** Salicylic acid-induced flowering by acting as a chelating agent **(Oata, 1975 and Pieterse and Muller, 1977).** This view was supported by **(Raskin *et al*., 1987)** who reported that salicylic acid functioned as endogenous growth regulators of flowering and florigenic effects. Salicylic acid as a manager of blooming time interacts with both photoperiod-dependent and self-governing pathways **(Martínez *et al*., 2004).** The molecular mechanisms of salicylic acid involved in the bud- stimulating behaviors just like phenolic nature substances because of this harmonic behavior could act as natural regulators or act together with growth substances, by the reason metabolism of indole-3-acetic acid can be shifted in presence of phenolic chemicals **(Grambow and Schwich, 1983)**. Salicylic acid has an outstanding correlation size of flower by cell elongation and cell expansion **(Raskin, 1992).** In addition, increase flavonoids contents in the inflorescence lead to enhancing flower length and width influenced positively the flower size and plant growth **(Kim *et al*., 2009).** Spray application of SA has been reported to prolong flower vase-life by increasing the activity of the ROS-scavenging enzyme catalase and improving the water balance **(Cocetta and Ferrante, 2018).** Increasing the number of flowers and flower longevity leads to an increase in flowering duration. Also, increasing flower diameter may lead to an increase in flower fresh and dry weight. Current results of Salicylic acid were in harmony with those reported by **Mohamed *et al*. (2017)** on strawberry, **Luo *et al*. (2017)** on *Rosa chinensis* and *Brunfelsia calycina*, **Mahroof *et al*. (2017)** on *Zinnia elegans* and **Shahmoradi and Naderi (2018)** on winter jasmine plants.

Lokhande *et al*. (2003) reported that the transition of a plant from vegetative growth to reproductive stage increase the levels of antioxidants and ROS suggesting that plants must undergo an oxidative stress during the flowering process, and the flowering time was negatively correlated with H_2O_2 content, so they proposed a hypothesis that H_2O_2 is a possible factor in flower induction. In addition, plans include a set of internal factors such as hormones (ABA and GA) and antioxidants (ASA and GSH), which participate in the regulation of flowering **(Barth *et al*., 2006 and Chai *et al*., 2012).** Flowering time can be clarified with differences in ASA redox state and ROS levels, but only in some mutants. The relationship between oxidative metabolism, ASA, and flowering has gone further with the studies of **(Kumar *et al*., 2016)** in orchids. Many studies have provided evidence that H_2O_2 activating many other important signal molecules (Ca^{2+}, ethylene, SA, JA, ABA) of plants **(Dempsey and Klessig, 1995).** Also, it is known that the effect of H_2O_2 depends on the dosage **(Liao *et al*., 2012),** thus it is possible that the concentration of H_2O_2 applied in this experience was having a positive effect on flowers. The obtained results of H_2O_2 were in harmony with **Chai *et al*. (2012)** on *Arabidopsis thaliana*, **Liao *et al.* (2012)** on *hybrid lily* and **Rahimian-Boogar *et al.* (2016)** on tuberose.

The effect of interaction between the different irrigation intervals and different levels of "hydrogen peroxide and salicylic acid" on flower growth characters were significant during both seasons (Table 3). The statistical analysis revealed that the highest mean values of the number of days to flowering, flowering duration, flower diameter, number of flowers per plant, flower fresh weight and flower dry weight of Delphinium were achieved at the combined treatment between irrigation every three days and the application with 100 ppm Salicylic acid in both seasons. The estimated percentages increase in number of days to flowering, flowering duration, flower diameter, number of flowers per plant, flower fresh weight and flower dry weight were 3.06 and 3.46%, 20.5 and 18.07%, 5.65 and 6.87%, 10.42 and 7.81%, 7.55and 5.21% and 15 and 12.25 % compared to the control treatment. However, the lowest mean values of flowering parameters of Delphinium were achieved at combined treatment between irrigation every nine days and spray plants with 2500 ppm H_2O_2 in both seasons.

Table 4. The main effect of different irrigation intervals and different levels of "hydrogen peroxide and salicylic acid" on flowering growth parameters of Delphinium plants during the 2016/2017 and 2017/2018 seasons

Irrigation Interval Days	Number of Days to Flowering		Flowering Duration (days)		Flower Diameter (cm)		Flowers Number per Plant		Flower Fresh Weight (g)		Flower Dry Weight (g)	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Irrigation Intervals (days)												
D3	163.60 A	164.00 A	55.47A	56.87 A	3.98A	3.87 A	47.80 A	46.60 A	2.13 A	2.11 A	1.00 A	0.97 A
D6	144.73 B	145.67 B	42.67B	43.60 B	2.94 B	2.83 B	36.73 B	35.27 B	1.80 B	1.76 B	0.68 B	0.65 B
D9	126.33 C	127.40 C	27.20C	28.53 C	2.00 C	1.90 C	23.20 C	22.00 C	1.23 C	1.17 C	0.38 C	0.36 C
Hydrogen Peroxide and Salicylic Acid												
Control	143.89 C	145.00 C	40.11D	41.22 C	2.93 C	2.82 C	35.22 C	34.11 C	1.69 C	1.64 C	0.67 C	0.64 C
H_2O_2 1	147.22 B	147.11 B	42.89B	45.33 B	3.14 B	3.07 B	37.89 B	37.00 B	1.81 B	1.79 B	0.75 B	0.73 B
H_2O_2 2	138.89 D	140.11 D	36.11 E	37.00 D	2.58 E	2.48 E	31.00 E	29.33 E	1.52 D	1.48 D	0.56 E	0.54 E
SA 1	150.67 A	151.78 A	48.78A	49.67 A	3.33 A	3.23 A	40.67 A	39.22 A	1.90 A	1.86 A	0.82 A	0.79 A
SA 2	143.78 C	144.44 C	41.00C	41.78 C	2.87 D	2.73 D	34.78 D	33.44 D	1.69 C	1.63 C	0.63 D	0.61 D

1st and 2nd; first season and second season. Means were compared using Tukey's Honest Significant Difference test ($P \leq 0.05$); n = 3; Means with the same capital letters are no significantly different between different irrigation intervals or between different levels of "hydrogen peroxide and salicylic acid"

Table 5. The interaction effect between different irrigation intervals and different levels of "hydrogen peroxide and salicylic acid" on flowering growth parameters of Delphinium plants during the 2016/2017 and 2017/2018 seasons

Irrigation Interval Days	Trts	Number of Days to Flowering		Flowering Duration (days)		Flower Diameter (cm)		Flowers Number per Plant		Flower Fresh Weight (g)		Flower Dry Weight (g)	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
D3	Control	163.67 c	163.67 c	53.67 c	55.33 c	4.07 c	3.93 c	48.00 c	47.00 c	2.12 c	2.11 c	1.00 c	0.98 c
	H_2O_2 1	166.00 b	165.67 b	58.00 b	61.67 b	4.17 b	4.10 b	49.33 b	49.00 b	2.18 b	2.17 b	1.06 b	1.03 b
	H_2O_2 2	158.33 e	159.67 e	50.00 e	49.67 e	3.53 e	3.43 e	42.33 e	41.33 e	2.01 e	2.00 e	0.87 e	0.86 e
	SA 1	168.67 a	169.33 a	64.67 a	65.33 a	4.30 a	4.20 a	53.00 a	50.67 a	2.28 a	2.22 a	1.15 a	1.10 a
	SA 2	161.33 d	161.67 d	51.00 d	52.33 d	3.83d	3.70d	46.33 d	45.00 d	2.08 d	2.06 d	0.93 d	0.89 d
D6	Control	144.67 h	146.33 h	42.33 h	43.67 h	2.93 h	2.83 h	37.00 h	35.67 h	1.82 g	1.79 h	0.68 h	0.64 h
	H_2O_2 1	148.67 g	148.67 g	45.00 g	46.67 g	3.10g	3.03g	38.67 g	37.33 g	1.90 f	1.87 g	0.77 g	0.75 g
	H_2O_2 2	138.00 j	138.67 j	37.67 j	38.67 j	2.57 j	2.43 j	32.67 j	30.33 j	1.58 i	1.52 j	0.53 j	0.51 j
	SA 1	151.33 f	152.00 f	47.67 f	48.33 f	3.33 f	3.23 f	40.67 f	39.67 f	1.98 e	1.97 f	0.84 f	0.80 f
	SA 2	141.00 i	142.67 i	40.67 i	40.67 i	2.77 i	2.60 i	34.67 i	33.33 i	1.72 h	1.65 i	0.58 i	0.56 i
D9	Control	123.33 n	125.00 n	24.33 n	24.67 n	1.80n	1.71n	20.67 n	19.67 n	1.11 m	1.02 n	0.34 n	0.31 n
	H_2O_2 1	127.00	127.00	25.67m	27.67m	2.17 l	2.07 l	25.67 l	24.67 l	1.36 k	1.31 l	0.43 l	0.40 l
	H_2O_2 2	120.33 o	122.00 o	20.67 o	22.67 o	1.65o	1.57o	18.00 o	16.33 o	0.96 n	0.91 o	0.28 o	0.25 o
	SA 1	132.00 k	134.00 k	34.00 k	35.33 k	2.37 k	2.27 k	28.33 k	27.33 k	1.43 j	1.39 k	0.48 k	0.46 k
	SA 2	129.00 l	129.00 l	31.33 l	32.33 l	2.0m	1.9m	23.33m	22.00m	1.26 l	1.19 m	0.37 m	0.37 m

1st and 2nd; first season and second season. Means were compared using Tukey's Honest Significant Difference test ($P \leq 0.05$); n = 3; Means with the same small letter show no significant interaction between different irrigation intervals and different levels of "hydrogen peroxide and salicylic acid"

Chemical characters

Photosynthesis pigments

Regarding the main effect of different irrigation intervals on chlorophyll a, chlorophyll b, and total chlorophyll, data in Table (6) indicated that chlorophyll a, chlorophyll b and total chlorophyll of Delphinium were significantly decreased with decreasing level of irrigation up to the lowest one in both seasons. The greatest reduction was obtained under severe drought stress, in both seasons. The estimated percentages decrease in chlorophyll a, chlorophyll b and total chlorophyll were 40.15 % and 46.44%, 31.49 and 12.82% and 37.32 and 36.03% compared to the control treatment and for the first and second season, respectively.

Drought stress causes a reduction in photosynthesis pigments, this reduction might be due to the reduction in cell division and elongation and more leaf senescence resulting from reduced turgor pressure **(Shao *et al*., 2008)** resulting in a reduction in leaf area. When the leaf area is small, the capacity to light trap decreases. This led to an imbalance between light capture and its utilization then reduction in photosynthesis rate **(Khalid, 2006 and Shao *et al*., 2008).** Also, water shortage inhibits photosynthesis by causing stomatal closure and metabolic damage. Stomatal closure may encourage the over-reduction of photosynthetic electron chain and increases the production of reactive oxygen species (ROS) such as superoxide anion (O^{-2}) which leads to the formation of H_2O_2, OH^- and other ROS **(Iannone *et al*. 2009).** Also, stomatal closure causing a decline in leaf CO_2 concentration that might, in turn, resulting in a reduction in the concentration of $NADP^+$ available to accept electrons from PSI and/or PSII and so generation of ROS, like H_2O_2. Stomata of the leaves that are slightly deficient in water opened more slowly in light and close faster in the dark **(Nuruddin, 2001).** The obtained results are in harmony with those reported by **Celikkol *et al*. (2010)** on peanut (*Arachis hypogaea* L.), **Mooussa (2011)** on soybean, **Sibomana *et al.* (2013)** on Tomato plants and **Sohrabi *et al*. (2012)** on chickpea.

Concerning the main effect of different rates of hydrogen peroxide and salicylic acid on photosynthesis pigments, data in Table (6) indicated that foliar spray with the low concentrations of salicylic acid at 100 ppm on Delphinium plants significantly increased the given photosynthesis pigments parameters i.e. chlorophyll a, chlorophyll b and chlorophyll a and b in both seasons. The results revealed also that there were insignificant differences between spraying Delphinium plants with salicylic acid at 100 or 200 ppm on chlorophyll a in the second season and H_2O_2 at 1250 ppm or salicylic acid at 100 or tap water on chlorophyll b in the second season. Generally, the superior influence of Salicylic acid treatments on stimulating plant photosynthesis pigments may be due to the role of SA in enhancing net photosynthetic rate which could be due to improving the functional state of the photosynthetic machinery in plants either by the mobilization of internal tissue nitrate or by chlorophyll biosynthesis **(Shi *et al*., 2006).** Also, exogenous application of SA may participate in the regulation of many physiological processes in plants, such as stomatal closure induced by drought stress, ion uptake and transport **(Gunes *et al*., 2005)**, photosynthesis and growth. **(Khan *et al*., 2003).** Suitable concentrations of salicylic acid inhibit chlorophyll degradation and enhancement photosynthesis by inhibition of chlorophyll oxidase enzyme activity **(Belkhadi *et al*., 2010).** Many studies have shown that exogenous SA improves plant adaptation to stresses by various mechanisms such as improved photosynthetic capacity **(Arfan *et al*., 2007).** The aforementioned results of Salicylic acid are in good accordance with those postulated by **Fariduddin *et al*. (2003)** on *Brassica juncea*, **Khodary (2004)** on maize, **Szepesi (2006)** on *Lycopersicon esculentum* Mill. and **Yildirim *et al*., (2008)** on cucumber.

The superior influence of H_2O_2 treatments on stimulating plant photosynthesis pigments may be due to the role of H_2O_2 as a key regulator in a broad range of physiological processes, such as senescence **(Peng *et al*., 2005),** stomatal movement and photosynthesis **(Noctor and Foyer, 1998).** Also, H_2O_2 plays a positive role in inducing the expression of the antioxidant system and reducing the oxidative damage of cellular membranes **(He *et al*. 2009).** Moreover, hydrogen peroxide is produced predominantly in plant cells during photosynthesis and photorespiration **(Ślesak *et al*., 2007).** The obtained results of H_2O_2 are in harmony with **Ashfaque *et al*. (2014)** on wheat, **Goldani *et al*. (2012)** on *Origanum majorana* L, **He *et al*. (2009)** on wheat, and **Semida (2016)** on onion.

The effect of interaction between the different irrigation intervals and different levels of "hydrogen peroxide and salicylic acid" on chlorophyll a, chlorophyll b and chlorophyll a+b were significant during both seasons (Table 7). The statistical analysis revealed that the highest mean values of chlorophyll a was obtained at spraying Delphinium plants with 100 ppm Salicylic acid in both seasons and 200 ppm Salicylic acid in the second season only under 3 days irrigation interval. The highest mean values of chlorophyll b were obtained at spraying Delphinium plants with 200 ppm Salicylic acid and 1250 ppm H_2O_2 under 3 days irrigation interval in the first and second season, respectively. While, the highest mean values of total chlorophyll was obtained when spraying Delphinium plants with 100 ppm Salicylic acid and 1250 ppm H_2O_2 and spraying with 100 ppm Salicylic acid under 3 days irrigation interval in the first and second season, respectively.

Hydrogen peroxide (H_2O_2) and total phenolic contents

Regarding the main effect of drought stress (different irrigation intervals) on H_2O_2 and total phenolic components contents in leaves, data in Table (6) displayed clearly that H_2O_2 and total phenolic components content were significantly increased with decreasing level of irrigation up to the lowest one in both seasons. The greatest increment was obtained under severe drought stress, in both seasons. The estimated percentages increase in H_2O_2 and total phenolic components contents were (65.35 % and 67.86 %) and (153.16 and 169.39 %) compared to the control treatment and for the first and second season, respectively.

The increment of hydrogen peroxide under drought stress may be due to that drought stress cause a loss of balance between the production of reactive oxygen species (ROS), such as hydroxyl radicals ($OH^{\cdot}$), superoxide ($O_2^{\cdot-}$), singlet oxygen ($O_2^{\cdot}$) and hydrogen peroxide (H_2O_2), and their scavenging potential **(Smirnoff, 1998).** Water shortage causing stomatal closure which encourages over-reduction of photosynthetic electron chain and increases the production of reactive oxygen species (ROS) such as superoxide anion (O^{-2}) which leads to the formation of H_2O_2, OH^- and other ROS **(Iannone *et al*., 2009).** Acceleration of reactive oxygen species (ROS) production in all plant parts, reflected on the restricted entry of CO_2 in the leaves during drought stress, limits CO_2 fixation and accelerates the photorespiratory pathway and finally leads to excessive H_2O_2 accumulation in the peroxisome **(de Carvalho, 2008).** On the other hand, it is well known that phenolic compounds are the most widespread substantial groups of plant secondary metabolites synthesized by plants and increase as a result of the plants' adaptation to stressed conditions and these compounds have proven to be potential antioxidants that can protect cells from attack by free radicals by scavenge ROS **(Quan *et al*., 2016)** and prevent lipid peroxidation, protein denaturation and DNA damage **(Król *et al*., 2014).** Moreover, many studies have indicated that stress increases phenolic compounds accumulation **(Król et al., 2014)** and the accumulation is associated with antioxidant activity **(Zhou *et al*., 2014 and Lee *et al*., 2017).** Nowadays, it could be concluded that researchers believe that the increase in antioxidant enzymes increases plant tolerance to environmental stresses **(Esfandiari *et al*., 2008).** The obtained results of increasing H_2O_2 under drought stress are in harmony with **Mohamed and Akladious (2014)** on soybean plants, **Orabi *et al*. (2018)** on canola plants, and **Tartoura (2010)** on wheat. Also, current results were in good accordance with those postulated by **Król *et al*. (2014)** on *Vitis vinifera* L., and **Habibi (2018)** on *Aloe vera.*

Concerning the main effect of different rates of hydrogen peroxide and salicylic acid on H_2O_2 and total phenolic components content, data in Table (6) indicated that foliar spray Delphinium plants with 100 and 200 ppm significantly decreased H_2O_2 content in both seasons. The lowest value of H_2O_2 content was observed at the low concentrations of salicylic acid 100 ppm in both seasons. Moreover, the highest concentration of H_2O_2 (2500 ppm) significantly increased total phenolic components content in Delphinium plants leaves, in both seasons. Generally, salicylic acid supplementation prevented the accumulation of H_2O_2 in drought-stressed plants due to the up-regulation of H_2O_2 scavenging enzymes such as glutathione peroxidase (GPX), glutathione S-transferase (GST) and catalase (CAT) than those under drought treatment without SA **(Li *et al*., 2014 and Rohman *et al*., 2015).**

Exogenous application of elicitors such as hydrogen peroxide (H_2O_2) was shown to promote an increase in phenolic content and antioxidant capacity in lentil sprouts but was also associated with lower plant growth and development as well as yield. Because elicitors can enhancement the content of phenolic compounds but can also affect the parameters of growth, development and yield of plants **(Swieca, 2015).** The obtained results of salicylic acid in decreasing H_2O_2 content are in harmony with those postulated by **Hassanein *et al*. (2014)** on wheat, **Farouk *et al*. (2018)** on *Zea mays* L, **Hasanuzzaman *et al*. (2014)** on *Brassica napus*. The obtained results of H_2O_2 in increasing the content of the phenolic component were in harmony with **Hassanein *et al*. (2014)** on wheat, **Guler and Pehlivan (2016)** on soybean and **Espinosa-Villarreal *et al*. (2017)** on amaranth plants. The effect of interaction between the different irrigation intervals and different levels of "hydrogen peroxide and salicylic acid" on H_2O_2 and total phenolic components contents in leaves were significant during both seasons (Table 7). The statistical analysis revealed that the highest mean values of H_2O_2 content in leaves was achieved at the interaction between irrigation every nine days and spray plants with tap water and the highest mean values of total phenolic components contents in leaves was achieved at the interaction between irrigation every nine days and the application with 2500 ppm H_2O_2 in both seasons. On the other hand, the lowest mean value of H_2O_2 content in leaves was achieved at the interaction between irrigation every three days and the application with 100 ppm Salicylic acid and the lowest mean value of total phenolic components contents in leaves was achieved at the interaction between irrigation every three days and spray plants with tap water in both seasons.

Table 6. The main effect of different irrigation intervals and different levels of "hydrogen peroxide and salicylic acid" on chemical characters of Delphinium plants during the 2016/2017 and 2017/2018 seasons

Irrigation Interval Days	Chlorophyll a (mg/gm F.wt)		Chlorophyll b (mg/gm F.wt)		Chlorophyll a + b (mg/gm F.wt)		H_2O_2 in Leaves (µmol/g f wt)		Total Phenols (mg/g d wt.)	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Irrigation intervals (days)										
D3	2.59 A	2.67 A	1.178 A	1.17 A	3.765 A	3.83 A	4.82 C	4.76 C	7.28 C	6.60 C
D6	2.21 A	2.29 B	1.063 B	0.98 B	3.275 B	3.26 B	6.44 B	6.41 B	12.18 B	11.66 B
D9	1.55 B	1.43 C	0.807 C	1.02AB	2.360 C	2.45 C	7.97 A	7.99 A	18.43 A	17.78 A
Hydrogen peroxide and salicylic acid										
Control	2.11 ABC	1.95 B	0.960 B	1.12 A	3.07 BC	3.06 C	7.91 A	7.90 A	7.19 E	6.93 E
H_2O_2 1	2.22 AB	2.03 B	1.042AB	1.25 A	3.26AB	3.28 B	6.04 C	6.01 C	14.75 B	14.26 B
H_2O_2 2	1.93 C	1.89 B	0.959 B	1.02AB	2.887 C	2.90 D	6.66 B	6.62 B	16.35 A	15.62 A
SA 1	2.38 A	2.44 A	1.078 A	1.14 A	3.453 A	3.57 A	5.60 E	5.59 E	11.46 D	10.86 D
SA 2	1.96 BC	2.34 A	1.042AB	0.75 B	2.998 C	3.08 C	5.84 D	5.79 D	13.41 C	12.40 C

1st and 2nd; first season and second season. Means were compared using Tukey's Honest Significant Difference test ($P \leq 0.05$); n = 3; Means with the same capital letters are no significantly different between different irrigation intervals or between different levels of "hydrogen peroxide and salicylic acid"

Table 7. The interaction effect between different irrigation intervals and different levels of "hydrogen peroxide and salicylic acid" on chemical characters of Delphinium plants during the 2016/2017 and 2017/2018 seasons

Irrigation Interval Days	Trts	Chlorophyll a (mg/gm F.wt)		Chlorophyll b (mg/gm F.wt)		Chlorophyll a + b (mg/gm F.wt)		H_2O_2 In leaves (µmol/g f wt)		Total phenols (mg/g d wt.)	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
D3	Control	2.72 ab	2.68 ab	0.998 cde	1.07 abcde	3.719 ab	3.74 bc	5.22 j	5.17 h	4.26 m	4.46 i
	H_2O_2 1	2.69 ab	2.32 bc	1.215 ab	1.51 a	3.906 a	3.82 b	4.82 k	4.77 i	8.83 j	7.67 g
	H_2O_2 2	2.29 bcd	2.15 bcde	1.123 bc	1.41 ab	3.418 bc	3.55 d	5.12 j	5.08 h	10.03 i	8.83 g
	SA 1	2.86 a	3.05 a	1.245 ab	1.36 abc	4.108 a	4.40 a	4.25 m	4.17 k	5.80 l	5.67 h
	SA 2	2.36 bc	3.15 a	1.309 a	0.52 e	3.673 ab	3.66 c	4.67 l	4.60 j	7.50 k	6.37 h
D6	Control	2.25 bcd	2.21 bcd	1.027 cd	1.02 abcde	3.274 bc	3.22 f	8.41 b	8.33 b	6.48 kl	6.21 h
	H_2O_2 1	2.14 cd	2.24 bcd	1.229 ab	1.14 abcd	3.371 bc	3.37 e	6.03 g	5.92 f	14.30 f	13.72 e
	H_2O_2 2	2.21 bcd	2.23 bcd	0.909 def	0.81 cde	3.116 cd	3.04 g	6.61 f	6.62 e	15.74 e	15.00 d
	SA 1	2.25 bcd	2.63 abc	1.192 ab	0.84 bcde	3.444 bc	3.45 e	5.47 i	5.52 g	11.48 h	10.81 f
	SA 2	2.21 bcd	2.12 cde	0.956 de	1.08 abcde	3.168 cd	3.19 f	5.69 h	5.64 g	12.92 g	12.57 e
D9	Control	1.36 e	0.95 g	0.854 ef	1.28 abc	2.213 f	2.23 k	10.10 a	10.20 a	10.82 hi	10.11 f
	H_2O_2 1	1.82 d	1.54 f	0.681 g	1.11 abcd	2.503 ef	2.64 i	7.26 d	7.34 c	21.13 b	21.40 b
	H_2O_2 2	1.28 e	1.28 fg	0.844 ef	0.84 bcde	2.127 f	2.12 l	8.24 c	8.17 b	23.28 a	23.04 a
	SA 1	2.01 cd	1.65 ef	0.797 fg	1.22 abc	2.808 de	2.86 h	7.10 e	7.09 d	17.11 d	16.11 d
	SA 2	1.29 e	1.75 def	0.861 ef	0.64 de	2.152 f	2.39 j	7.16 de	7.14 d	19.82 c	18.25 c

1st and 2nd; first season and second season. Means were compared using Tukey's Honest Significant Difference test ($P \leq 0.05$); n = 3; Means with the same small letter show no significant interaction between different irrigation intervals and different levels of "hydrogen peroxide and salicylic acid"

CONCLUSIONS

From the aforementioned results, water stress by widening the irrigation intervals adversely affected the growth of Delphinium plants. The application of low concentrations of SA or H_2O_2 caused significant increases in the growth parameters and chemical composition of Delphinium plants. Thus, it could be concluded that the application of low concentrations of SA or H_2O_2 might help plants to tolerate drought stress from prolonging periods between irrigation.

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