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THE ROLE OF PRIMING SEEDS WITH SALICYLIC ACID IN IMPROVING SOME VEGETATIVE GROWTH CHARACTERISTICS OF SWEET CORN UNDER WATER STRESS CONDITIONS

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ABSTRACT

A field experiment was carried out with the aim of studying the role of seed priming with salicylic acid in some vegetative growth characteristics of sweet corn (*Zea mays* L. var. Saccharata) under water stress conditions for the two autumn seasons 2018 and 2019. Use of a Randomized Complete Block Design (R.C.B.D.) according to the spilt-plot arrangement with three replications. The main-plots included three levels of water stress, which are irrigation after depleting 30, 50 and 70% of the available water, with symbols W_1, W_2 and W_3 respectively. The seed priming concentrations with salicylic acid represented 50, 100, and 150 mg L^{-1}, symbolized as SA_1, SA_2, and SA_3, respectively, as well as the two comparison treatments for dry seeds and soaking in distilled water, symbolized by CO_0 and CO_1, respectively, by the Sub-plots. The seeds were soaked for 24 hours, and then dried to their original moisture. The results showed that there were no significant differences between the two irrigation treatments after depleting 30 and 50% of the available water, with regard to the number of days to 50% tasseling, plant height, number of leaves, leaf area, dry weight of the plant, the rate of crop growth for both seasons. Whereas, irrigation after depleting 70% of the available water led to a decrease in all the studied characteristics. While the seed priming treatments with salicylic acid (SA) had a significant effect on most of the studied traits, except for the number of days to 50% tasseling, as the treatment of SA_1 at a concentration of 50 mg L^{-1} was significantly superior to the highest average plant height of 149.20 and 154.76 cm. The number of leaves is 13.05 and 13.42 leaf plant^{-1}, the leaf area is 3886.33 and 4017.33 cm^2 plant^{-1}, the dry weight of the plant is 156.20 and 159.43 g plant^{-1} and the crop growth rate is 3.12 and 2.98 g m^2 day^{-1} compared to the comparison treatment (dry seeds) respectively, For the two seasons. The interaction of water stress and salicylic acid also significantly affected the characteristic of plant height, leaf area and plant dry weight for both seasons. Therefore, we recommend the possibility of irrigation after depleting 50% of the available water without a significant effect on the characteristics of vegetative growth, as well as the possibility of priming sweet corn seeds with salicylic acid at a concentration of 50 mg L^{-1} soak to improve their ability to withstand water stress conditions.

Keywords : Sweet corn, Water stress, Salicylic acid.

Introduction

The problem of water shortage is the important factor at present and in the future to limit the expansion of all social and economic life activities in various fields and their development, especially in the field of agriculture, especially in the arid and semi-arid regions in which Iraq is located, which is currently facing a scarcity in the quantities of water flowing to the Tigris and Euphrates and fluctuation Their level from one season to another, with low or falling rain rates at times other than times needed by the plant, high temperatures and rates of evaporation, and this is accompanied by weakness in the process of managing water and soil resources, as well as the increasing demand for food due to the development in the current and future population growth. All these factors have affected a lot Significant scarcity of this water in recent years.

As for the researchers' point of view, it is expected that by 2025, 65% of the world's population will live under the influence of environments that suffer from lack of water (Nezhadahmadi *et al*., 2013), and this indicates that there is a real risk of distributing the available water resources. Therefore, researchers and specialists in the agricultural field have always sought. The use of some appropriate agricultural applications that aim to eliminate or overcome the physiological symptoms that occur on plants growing in harsh environments such as drought or ground water deficit to help them withstand stress (water deficit).

Therefore, the tendency to use the technology of seed priming before planting with one of the solutions of plant growth regulators, which is one of the important applications in dry and semi-arid regions, which helped in creating an adaptive response in advance of various stresses, including water shortage, and then reducing the damage caused by this stress in the morphological aspects. Which results in reducing the size of the plant and its leaf area due to its events, the opposite biological effect and the arrival of plants to their natural growth state necessary to raise their bio-efficiency without any damage to their botanical characteristics. Moreover, this technology is simple to apply and low in costs.

Recent studies have indicated the importance of using salicylic acid to give it good results in increasing plant tolerance to water stress, as it is an environmentally safe and low-economic compound, and as it is one of the plant hormones that has important physiological roles in enhancing plant resistance by the mechanism of acquired systemic resistance and increasing antioxidant enzymes against environmental factors. The hardness surrounding the plant, as well as its role in the various structural and functional areas that occur within the plant tissues, such as regulating plant growth, stimulating cell division and differentiation, accelerating the formation of carbonate pigments and delaying leaf aging (Hayat and Ahmad, 2007). Rehman *et al.* (2015) indicated that priming yellow corn seeds with SA acid at concentrations of 0, 50, 100 and 150 mg L^{-1}, it was noted that the concentration of 50 mg L^{-1} was superior to the rest of the other concentrations by giving it the highest average plant height, leaf area, dry matter yield, and crop growth rate compared to the comparison treatment, Which gave the lowest average for these characteristics sequentially. It was also found from the results of Mehboob *et al.* (2018) that priming yellow corn seeds with salicylic acid caused a significant increase in plant height, dry matter yield and crop growth rate under water stress conditions as compared to the comparison treatment.

Materials and Methods

A field experiment was carried out in the experimental field of the Field Crops Department - College of Agricultural Engineering Sciences - University of Baghdad (Jadriya) for the autumn seasons 2018 and 2019. In order to study the effect of graded priming concentrations of priming seeds with salicylic acid in association with water stress on some vegetative growth characteristics of the sweet corn crop of variety 403 KSC obtained from the SPCRI. The experiment was designed according to a Randomized Complete Block Design (R.C.B.D) with a spilt-plot arrangement with three replications. The main-plots included irrigation treatments after depleting 30, 50 and 70% of the available water, and they were symbolized W_1, W_2 and W_3 respectively. Whereas the Sub-plots included seed priming treatments with Salicylic acid (SA) at a concentration of 50, 100, and 150 mg L^{-1} for a 24-hour soaking period, symbolized as SA_1, SA_2 and SA_3 respectively, as well as the two comparison treatments for dry seeds and soaking in distilled water, which are symbolized by CO_0 and CO_1 respectively. Soil service operations were carried out and the land was divided into slabs with dimensions of 2.5 m * 2 m, with a distance of 70 cm between one line and another and a distance of 20 cm between one side and another, with a plant density of 71428 plants ha^{-1}. Then urea fertilizer (46% N) was added with an average of 696 kg ha^{-1} in two batches, the first at the stage of 6 true integrated leaves and the second at the beginning of tasseling. Whereas triple superphosphate fertilizer (46% P_2O_5) was added with an average of 436 kg ha^{-1} at once mixed with soil before planting (Ministry of Agriculture, 2011). The bush was also removed by manual weeding whenever needed with the preventive control of plants from infestation by the corn stalk borer insect (Sesamia cretica L.) by using liquid diazinon pesticide with an average of 1.5 m L^{-1} water in two batches, the first at the stage of 4-5 leaves and the second at the beginning tasseling (Al-Ameri, 2011). Sweet corn seeds were sown on 7/28/2018 for the first season and 7/15/2019 for the second season.

Soil water retention capacity was estimated by estimating the relationship between the structural tensile strength of the soil sample and the moisture content at the tensile 0, 33, 100, 500, 1000 and 1500 kPa, through which according to the available water content of the soil from the difference between the moisture content at the field capacity and the wilting point. The volumetric method was adopted to measure the moisture content, monitor the soil moisture changes, and determine the date of irrigation according to the level of depletion for the irrigation treatments. By taking soil samples mediated by Auger a day before irrigation and after irrigation two days from a depth of 0-20 cm during the vegetative growth phase, and then increasing the depth of hydration to 40 cm during the flowering phase and the stage of formation of ears and to the end of the experiment and placed in aluminum cans and weighed wet in a Micro water oven For a period of 12 minutes after the drying time was calibrated with samples dried in an electric oven according to the method suggested by (Zein, 2002) to dry the samples, then weighed after drying and the moisture content was measured according to the formula (Hillel, 1980).

$$P_w = (M_{sw} - M_s/M_s) * 100 \quad ...(1)$$

P_w = the percentage of gravitational moisture,

M_{SW} = mass of wet soil (g), Ms = mass of dry soil (g).

Irrigation method

Irrigation was done by plastic tubes connected to an electric pump. Equal amounts of irrigation water were added when planting to the field capacity of all panels to ensure field emergence. Moisture tightening treatments 30, 50 and 70% of the available water were implemented when the plant reached the stage of 6 true integrated leaves (Hanway, 1971), and the irrigation quantities were at a depth of 20 cm for the depletion treatments W_1, W_2 and W_3 (60, 100 and 140) L / 5 m^2, and the amount of water for a depth of 40 cm was (120, 200 and 280) L / 5 m^2 and until the last water when the plants reached Physiological maturity stage. The depth of added water was calculated to compensate for the depleted moisture according to an equation (Allen *et al.*, 1998).

$$d = (\theta_{fc} - \theta_I) * D \quad ...(2)$$

d = depth of added water (mm), θ_{fc} = volumetric humidity at field capacity (cm^3 cm^{-3}), I = Volumetric humidity before irrigation (cm^3cm^{-3}), D = the depth of the soil which is equal to the depth of the effective root system (mm).

The volumetric water content was calculated based on the bulk density of the soil, as in the following equation:

$$\theta = pw * \ell_b \quad ...(3)$$

θ = moisture content based on volume, Pw = moisture content based on weight, ℓ_b = Soil bulk density (mg m^{-3}).

After that, the volume of water to be added to each plot was calculated according to the following equation:

$$V = d \times A \quad ...(4)$$

V = the volume of water to be added (liters),

A = the irrigated area (m^2).

Preparation of an SA priming solution:

salicylic acid 99% ($C_7H_6O_3$) was prepared from Alpha - Chemika of (Indian origin) and the standard solution was prepared in the Tissue Culture Laboratory - College of Agricultural Engineering Sciences - University of Baghdad -

Al-Jadriya, dissolving 1 g of Salicylic acid powder with 2.5 ml of ethanol At a concentration of 50% as a catalyst for dissolution with stirring on the plate Stirrer Magnetic device at a temperature of 50 C° until the material melts homogeneously, then complete the volume to liter to obtain a concentration of 1000 mg L^{-1} as the standard solution (the original solution). The required priming concentrations of 50, 100 and 150 mg L-1 were prepared for priming seeds for 24 hours. According to the following dilution formula:

$$N_1 \times V_1 = N_2 \times V_2 \qquad ...(5)$$

N_1 = concentration of the original solution. V_1 = volume of the original solution. N_2 = required concentration. V_2 = required volume.

As for the studied traits:

1. Number of days to 50% tasseling (Days)

The period was calculated from the date of planting (the date of the first irrigation) to the emergence of tassel until the completion of the emergence of 50% tassel of five plants per experimental unit from the middle lines, according to the field observation.

2. Plant height (cm)

It was measured from the soil surface level to the lower node of the tassel for an average of five plants randomly selected from the mean lines of each experimental unit after the tassel flowering was completed.

3. Number of leaves (leaf plant^{-1})

The total number of leaves is calculated from the first effective green leaf at the bottom of the plant to the highest leaf in it from the average of five plants taken randomly from the two middle lines for each experimental unit.

4. Leaf area (cm^2)

The leaf area was measured at the stage of 50% tassel from an average of five plants randomly taken from the mean lines of the experimental unit using the following equation:

Leaf area = square of the length of the leaf under the ear * 0.65 (Elsahookie, 1990).

5. Plant dry weight (g plant^{-1})

Calculated from the average weight of five plants at the stage of 50% tassel taken randomly with all its components (except for the root) then it was cut and dried naturally on the air, taking into account its flipping until Weight stability.

6. Crop growth rate (gm^{-2} day^{-1})

It was extracted from dividing the average dry matter at this stage by the period from planting to 50% tassel.

Statistical analysis

The experiment data were analyzed statistically according to the Randomized Complete Block Design R.C.B.D., with the arrangement of split- plots. The lowest significant difference (L.S.D) was selected at the level of 0.05 for comparison between the arithmetic means of the coefficients using the Genstat statistical program (Steel and Torrie, 1980).

Results

The results of Tables 1, 2, 3, 4, 5 and 6 showed a significant effect of the available water depletion treatments in all the studied traits, which are the number of days to 50% tasseling, plant height, number of leaves, leaf area, plant dry weight and crop growth rate for the two seasons respectively. The two treatments W_1 and W_2 (after depleting 30 and 50% of the available water) recorded the highest average number of days to 50% tasseling, plant height, number of leaves and leaf area, plant dry weight, and crop growth rate was (52.64 and 55.44) and (50.76 and 53.86) Days, (153.18 and 156.18) and (146.04 and 149.76) cm, (14.12 and 14.42) and (13.33 and 13.65) leaf plant^{-1}, (4082.00 and 4174.20) and (3755.20 and 3839.60) cm^2 plant^{-1}, (162.18 and 164.96) and (148.76 and 151.84) g plant^{-1}, (3.08 and 2.97) and (2.92 and 2.81) g m^{-2} day^{-1}, respectively, for the two seasons and they did not differ significantly between them. Whereas, W_3 (depletion of 70% of available water) recorded the lowest average for all of these characteristics, amounting to (47.18 and 50.64) days, (125.04 and 126.42) cm, (10.46 and 10.78) leaf plant^{-1}, (2876.20 and 2958.60) cm^2 plant^{-1} and (122.44 and 125.38) g plant^{-1} and (2.59 and 2.47) g m^2 day^{-1} respectively for the two seasons.

The results of Tables 2, 3, 4, 5 and 6 also indicate that there is a significant effect of the seed priming treatments with salicylic acid in all the studied traits except for the characteristic of the number of days to 50% tasseling successively for the two seasons. The results of the aforementioned tables showed that priming the seeds with salicylic acid increased the studied growth characteristics. The treatment of SA_1 was significantly superior to the rest of the other treatments, SA_2 and SA_3, in giving the highest average plant height of 149.20 and 154.76 cm, with an increase of 10.43 and 13.85% compared to the comparison treatment CO_0 (dry seeds) respectively for the two seasons (Table 2). The priming of seeds before planting also increased the number of leaves for the sugar corn crop (Table 3). As the SA_1 treatment recorded the highest average number of leaves, reaching 13.05 and 13.42 leaf plant^{-1}, with an increase of 5.66 and 6.76% compared to the CO_0 treatment respectively for the two seasons. While the results shown in (Table 4) showed that the seed priming treatments with salicylic acid led to a significant increase in the mean leaf area compared with the CO_0 comparison treatment, which recorded the lowest average leaf area of the plant reaching 3268.66 and 3343.33 cm^2 plants^{-1} respectively for the two seasons. Whereas, the average leaf area reached its highest level when treating SA_1, giving the highest average for this characteristic was 3886.33 and 4017.33 cm^2 plant^{-1}, with an increase of 18.89 and 20.15% compared to the CO_0 treatment respectively for the two seasons. The results of Table (5) also showed the effect of all seed priming concentrations with salicylic acid used significantly in increasing the dry weight of the shoots, and the highest mean was 156.20 and 159.43 g plant^{-1} respectively when treating SA_1 with an increase of 16.42 and 16.37% compared to the comparison treatment CO_0 The lowest average for this characteristic was 134.16 137.00 g m plant^{-1}, respectively for the two seasons. While the results showed in (Table 6) that the crop growth rate was affected by the seed priming treatments with salicylic acid before sowing, as the SA_1 treatment recorded the highest average crop growth rate of 3.12 and 2.98 g m^{-2} day^{-1} with an increase of 18.18 and 17. 78%, compared to the CO_0 treatment, which gave the lowest mean for this characteristic were 2.64 and 2.53 g m^{-2} day^{-1}, respectively, for the two seasons. The results of the aforementioned tables also indicated that there was a significant effect of the interaction between the available water depletion treatments and the seed priming treatments with salicylic acid in the characteristic of plant height, leaf area and dry weight of the plant for both seasons respectively.

Discussion

It is evident from the results of the aforementioned tables (1, 2, 3, 4, 5 and 6) that the higher soil moisture parameters (lower stress) represented by the level W_1 (depletion of 30% of the available water) and the treatment W_2 (depletion of 50% of the available water) did not differ significantly between them. As it led to the improvement of all the characteristics of the vegetative growth of the sweet corn crop, as the availability of appropriate moisture in the soil has a major role in the growth and depth of the roots, and then the absorption and distribution of water and nutrients within the parts of the plant and its reflection on the growth and division of plant cells, the activity of enzymes in them and the regularity of the carbon representation process, Hence increasing the dry matter accumulation of the plant. While the values of all vegetative growth indicators decreased in the aforementioned tables, with a decrease in the amount of water added at the W_3 level (after depleting 70% of the available water), as the number of days to 50% tasseling (Table 1). This may be due to the lack of water with high temperature, increased wind speed and low relative humidity increased the speed of the physiological processes that take place inside the plant, which induces it to accelerate towards early flowering, which is one of the plant mechanisms to withstand water stress and is expressed by the plant's escape from stress, The ability of plants to complete their life cycle before exposure to serious water stress (Fang and Xiong, 2015), and this result coincides with the results of Murtadha *et al.* (2018) and Abdulameer (2018) who found that the number of days to 50% tasseling decreased with decreasing amounts of irrigation water. It was also noted that the morphological indicators of growth were affected by water stress, the height of the plant was reduced (Table 2). This reduction may be attributed to the decrease in the number of days to 50% tasseling (Table 1) within which the stage in which the stem elongated falls, as well as the reduction of the content of Relative water (unpublished data) that determines the division and expansion of cells and the decrease in vegetation density in this treatment as a result of reducing the number and area of leaves (Table 3 and 4), which allowed the penetration of light into the vegetative cover, which led to the failure to give growth hormone (auxin) the opportunity in Work on elongation of phalanges due to its optical breakdown affecting negatively on plant height (Essa, 1990). This result is consistent with the findings of Abduladheem (2017), Abdulameer (2018), Wang *et al.* (2018), Majda and Robert (2018) and Hassan (2019) who indicated a decrease in the average height of yellow corn plants under conditions of water stress. As for the decrease in the number of plant leaves when exposed to water stress, this is due to the apparent decrease in the difference in the number of days to 50% tasseling (Table 1) in which the growth and expansion of the leaf affected by the lack of soil moisture and the high temperature that differed between the two seasons, affected the length of The period allocated to the growth and elongation of phalanges to hold the stem and stimulate the vegetative shoots to produce leaves, so the number of emerging leaves in the plant decreased (Hakim *et al.*, 2018), as well as the lower plant height (Table 2), which caused a reduction in the number of leaves, and yellow corn plants adopt a wilting mechanism. Lower leaves and falling off during water stress is a type of plant adaptation and a means for plants to reduce transpiration to withstand stress (Prasad *et al.*, 2008), and this confirms the findings of Song *et al.* (2018), Majda and Robert (2018), Huang *et al.* (2018), Peng *et al.* (2018). who indicated that the number of plant leaves was reduced by the effect of water stress. As for the leaf area represents a basic factor in the process of carbon representation and its reduction when exposed to water stress (Table 4) when treating depletion W_3, this is due to the decrease in the number of days to 50% tasseling (Table 1) and the number of plant leaves and their relative water content that resulted To reduce its growth rate and its inability to elongate and expand, which in turn is the reason for the decrease in the dry weight of the plant (Table 5) represented by the height of the plant and the number of leaves (Tables 2 and 3) respectively, and this result confirmed what was mentioned by Ronaghi *et al.* (2017) and Abdulameer (2018) and Zhao *et al.* (2018), Zhang *et al.* (2018) and Hassan (2019) that the decrease in plant height, number of leaves and leaf area led to a decrease in the average dry matter aggregation of yellow corn plants when exposed to water stress. It was also noted that the morphological indicators of plant growth were negatively affected due to the lack of available water, which resulted in slow growth and expansion of plant cells, which was reflected in the amount of the intercepting surface of the falling solar radiation, which is an essential part of the carbon representation process, which negatively affected the accumulation of dry matter (Table 5) Which led to its reduction and then the decrease in the growth rate of the crop, as plant growth and development depend on the form of plant parts and their growth according to the age of the plant, the stage of growth and the level of stress. This result is in agreement with the results of Abduladheem (2017), Abdulameer and Ahmed (2019), Hassan (2019) who found a lower yield growth rate for yellow maize when subjected to water stress. Through the results in the aforementioned tables, it was also noted that the seed priming treatments with salicylic acid contributed to a significant increase in all the studied traits except for the number of days to 50% tasseling, which did not show clear significant differences. priming the seeds with salicylic acid led to improvement The vegetative growth of the sweet corn crop may be attributed to its positive role in regulating physiological processes and its contribution to priming flowering process and the emergence of flower buds and the speed of their development in combination with other plant hormones, controlling the opening and closing of stomata, delaying leaf aging, absorption of ions and nutrients, carbon metabolism and hormonal balance (Khan *et al.* 2003), In addition to its role in preserving the chloroplast structure from the catabolism resulting from free radicals (Hayat and Ahmed, 2007 and Kumar *et al.* 2010, Fahad and Bano, 2012 and Al-Khafaji, 2014), and what is reflected in it is an increase in growth characteristics, including plant height and number of leaves in Plant and increase the division and elongation of leaf cells, and then increase the leaf area, dry weight of the plant and the rate of crop growth (Tables 2, 3, 4, 5 and 6) respectively, and this appears when the SA_1 seed priming treatment gave the highest values for the characteristics mentioned in the tables shown later, superior to the rest of the concentrations.

Other than salicylic acid which gave the lowest averages for all studied characteristics. The results of the experiment also showed the superiority of the interaction factors between the study workers in their effect on some characteristics of vegetative growth, such as plant height, leaf area, and plant dry weight.

Conclusions

We conclude from this that the treatment of W_2 (depleting 50% of the available water) gave the same effect on the studied characteristics and without significant difference than the treatment of W_1 (depleting 30% of the available water). The growth of the sweet corn crop, and here the functional role of the seed priming technology with salicylic acid becomes clear for its role in reducing the harmful effects of water stress by improving the increase in the efficiency of metabolism and activating the important enzymes in various biological processes, which led to the improvement of the vegetative growth of the sweet corn plant represented by plant height and number Leaves, leaf area, dry weight, and crop growth rate, which was reflected in the formation of an in depth root group to absorb the largest amount of water and nutrients and transfer them to the plant.

Table 1 : Effect of irrigation and Salicylic Acid treatments and their interactions on number of days to 50% tasseling (Days) in autumn seasons of 2018 and 2019.

	Irrigation	Salicylic Acid mg L^{-1}					Mean
		CO_0	CO_1	$SA_1 = 50$	$SA_2 = 100$	$SA_3 = 150$	
Autumn season 2018	W_1 =30%	53.30	53.00	52.40	52.10	52.40	52.64
	W_2 =50%	51.20	50.60	50.50	50.60	50.90	50.76
	W_3 =70%	47.20	47.60	46.60	47.40	47.10	47.18
	Mean	50.56	50.40	49.83	50.03	50.13	
L. S. D. (P = 0.05)		W = 1.91		SA = N.S.		W * SA = N.S.	
	Irrigation	Salicylic Acid mg L^{-1}					Mean
		CO_0	CO_1	$SA_1 = 50$	$SA_2 = 100$	$SA_3 = 150$	
Autumn season 2019	W_1 =30%	56.20	55.60	55.20	54.60	55.60	55.44
	W_2 =50%	54.20	54.00	53.60	53.70	53.80	53.86
	W_3 =70%	50.90	50.10	50.70	50.80	50.70	50.64
	Mean	53.76	53.23	53.16	53.03	53.36	
L. S. D. (P = 0.05)		W = 1.62		SA = N.S.		W * SA = N.S.	

Table 2 : Effect of irrigation and Salicylic Acid treatments and their interactions on plant height (cm) in autumn seasons of 2018 and 2019.

	Irrigation	Salicylic Acid mg L^{-1}					Mean
		CO_0	CO_1	$SA_1 = 50$	$SA_2 = 100$	$SA_3 = 150$	
Autumn season 2018	W_1 =30%	149.00	151.00	158.00	155.60	152.30	153.18
	W_2 =50%	140.30	139.30	155.00	152.00	143.60	146.04
	W_3 =70%	116.00	119.30	134.60	132.30	123.00	125.04
	Mean	135.10	136.53	149.20	146.63	139.63	
L. S. D. (P = 0.05)		W = 8.23		SA = 1.84		W * SA = 8.01	
	Irrigation	Salicylic Acid mg L^{-1}					Mean
		CO_0	CO_1	$SA_1 = 50$	$SA_2 = 100$	$SA_3 = 150$	
Autumn season 2019	W_1 =30%	149.60	149.00	166.00	161.00	155.30	156.18
	W_2 =50%	143.60	134.60	162.00	159.60	149.00	149.76
	W_3 =70%	114.60	122.60	136.30	134.30	124.30	126.42
	Mean	135.93	135.40	154.76	151.63	142.86	
L. S. D. (P = 0.05)		W = 8.03		SA = 1.01		W* SA = 7.82	

Table 3 : Effect of irrigation and Salicylic Acid treatments and their interactions on number of leaves in autumn seasons of 2018 and 2019.

	Irrigation	Salicylic Acid mg L^{-1}					Mean
		CO_0	CO_1	$SA_1 = 50$	$SA_2 = 100$	$SA_3 = 150$	
Autumn season 2018	W_1 =30%	13.90	13.90	14.40	14.23	14.16	14.12
	W_2 =50%	13.10	13.03	13.70	13.43	13.40	13.33
	W_3 =70%	10.06	10.13	11.06	10.66	10.43	10.46
	Mean	12.35	12.35	13.05	12.77	12.66	
L. S. D. (P = 0.05)		W = 1.13		SA = 0.15		W* SA = N.S.	
	Irrigation	Salicylic Acid mg L^{-1}					Mean
		CO_0	CO_1	$SA_1 = 50$	$SA_2 = 100$	$SA_3 = 150$	
Autumn season 2019	W_1 =30%	W_1 =30%	W_1 =30%	14.80	14.50	14.56	14.42
	W_2 =50%	W_2 =50%	W_2 =50%	14.06	13.83	13.70	13.65
	W_3 =70%	W_3 =70%	W_3 =70%	11.40	11.16	10.76	10.78
	Mean	12.57	12.59	13.42	13.16	13.00	
L. S. D. (P = 0.05)		W = 1.32		SA = 0.22		W* SA = N.S.	

Table 4 : Effect of irrigation and Salicylic Acid treatments and their interactions on leaf area (cm^2) in autumn seasons of 2018 and 2019.

	Irrigation	Salicylic Acid mg L^{-1}					Mean
		CO_0	CO_1	$SA_1 = 50$	$SA_2 = 100$	$SA_3 = 150$	
Autumn season 2018	$W_1 = 30\%$	3667.00	4060.00	4377.00	4202.00	4104.00	4082.00
	$W_2 = 50\%$	3479.00	3727.00	4118.00	3736.00	3716.00	3755.20
	$W_3 = 70\%$	2660.00	2747.00	3164.00	3005.00	2805.00	2876.20
	Mean	3268.66	3511.33	3886.33	3647.66	3541.66	
L. S. D. (P = 0.05)		W = 348.45		SA = 68.13		W * SA = 340.22	
	Irrigation	Salicylic Acid mg L^{-1}					Mean
		CO_0	CO_1	$SA_1 = 50$	$SA_2 = 100$	$SA_3 = 150$	
Autumn season 2019	$W_1 = 30\%$	3738.00	4156.00	4524.00	4282.00	4171.00	4174.20
	$W_2 = 50\%$	3544.00	3815.00	4250.00	3808.00	3776.00	3839.60
	$W_3 = 70\%$	2748.00	2824.00	3278.00	3076.00	2862.00	2958.60
	Mean	3343.33	3598.33	4017.33	3722.00	3603.00	
L. S. D. (P = 0.05)		W = 452.87		SA = 102.94		W * SA = 345.88	

Table 5 : Effect of irrigation and Salicylic Acid treatments and their interactions on plant dry matter (g) in autumn seasons of 2018 and 2019

	Irrigation	Salicylic Acid mg L^{-1}					Mean
		CO_0	CO_1	$SA_1 = 50$	$SA_2 = 100$	$SA_3 = 150$	
Autumn season 2018	$W_1 = 30\%$	149.30	156.00	179.30	166.30	160.00	162.18
	$W_2 = 50\%$	141.60	147.30	154.30	151.60	149.00	148.76
	$W_3 = 70\%$	111.60	116.60	135.00	130.00	119.00	122.44
	Mean	134.16	139.96	156.20	149.30	142.66	
L. S. D. (P = 0.05)		W = 13.93		SA = 3.71		W * SA = 13.04	
	Irrigation	Salicylic Acid mg L^{-1}					Mean
		CO_0	CO_1	$SA_1 = 50$	$SA_2 = 100$	$SA_3 = 150$	
Autumn season 2019	$W_1 = 30\%$	151.80	158.40	182.70	169.20	162.70	164.96
	$W_2 = 50\%$	144.80	150.80	157.10	154.80	151.70	151.84
	$W_3 = 70\%$	114.40	119.00	138.50	133.20	121.80	125.38
	Mean	137.00	142.73	159.43	152.40	145.40	
L. S. D. (P = 0.05)		W = 15.61		SA = 2.44		W * SA = 11.82	

Table 6 : Effect of irrigation and Salicylic Acid treatments and their interactions on crop growth rate (g m^{-2} day^{-1}) in autumn seasons of 2018 and 2019.

	Irrigation	Salicylic Acid mg L^{-1}					Mean
		CO_0	CO_1	$SA_1 = 50$	$SA_2 = 100$	$SA_3 = 150$	
Autumn season 2018	$W_1 = 30\%$	2.80	2.94	3.42	3.19	3.05	3.08
	$W_2 = 50\%$	2.77	2.91	3.05	2.99	2.92	2.92
	$W_3 = 70\%$	2.36	2.44	2.89	2.74	2.52	2.59
	Mean	2.64	2.76	3.12	2.97	2.83	
L. S. D. (P = 0.05)		W = 0.30		SA = 0.11		W * SA = N.S.	
	Irrigation	Salicylic Acid mg L^{-1}					Mean
		CO_0	CO_1	$SA_1 = 50$	$SA_2 = 100$	$SA_3 = 150$	
Autumn season 2019	$W_1 = 30\%$	2.70	2.85	3.30	3.09	2.92	2.97
	$W_2 = 50\%$	2.67	2.79	2.92	2.88	2.82	2.81
	$W_3 = 70\%$	2.24	2.37	2.73	2.62	2.40	2.47
	Mean	2.53	2.67	2.98	2.86	2.71	
L. S. D. (P = 0.05)		W = 0.21		SA = 0.23		W* SA = N.S.	

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