



Wheat Productivity In Relation To Salicylic Acid Under Water Stress

Gomaa, M. A., I.F. Rehab, M.A. Nassar and F. K. Farag

Plant Production Department, Faculty of Agriculture, Saba Basha, Alexandria University, Egypt.

E-Mail : dr_mahmoudgomaa@yahoo.com

ARTICLE INFO

Article History

Received: 21/8/2020

Accepted: 25/10/2020

Keywords:

Wheat, irrigation, Shandaweel, salicylic acid (SA), yield, quality.

ABSTRACT

The present study was carried out at Abess, Alexandria, Egypt, during the two seasons of 2018/2019 and 2019/2020 to study the effect of water stress and foliar application of salicylic rates on yield and quality of wheat. This experiment was laid out in a split plot system with three replications in both seasons. The main plots were water stress treatments (normal irrigation, skipping the first irrigation at the age of 50 days, skipping the second irrigation at the age of 70 days, and skipping the third irrigation at the age of 90 days from sowing), while salicylic acid (SA) concentration (water = control, 1 mM; 2 mM and 3 mM) distributed in a sub plot in both seasons. The obtained results showed that sowing wheat cultivar namely Shandaweel- 1 with foliar application of salicylic acid (SA) twice at 50 and 70 days after sowing (DAS) at the rate of 2 mM/l under normal irrigation or skipping one irrigation at the first or the second irrigation achieved the highest mean value of yield, yield components and protein (%) in grain under study conditions at Abess, Alexandria Governorate, Egypt.

INTRODUCTION

Wheat is grown all over the world and covers more of the earth's surface than any other cereal crop. It is an edible grain constituting the staple food for many countries. Wheat is the essential crop in Egypt and grows on an area of 1.41 million ha with an annual production of about 9.28 million tones and with an average yield of 6.58 tons/ha (FAO, 2018).

There is a lot of challenges facing wheat production in the arid region of Egypt, one of them is drought which is the most devastating abiotic stress factor worldwide. (Mardeh *et al.*, 2006). Growth of genotypes at goal growing environments and drought conditions and decreasing confounding impacts of other stresses in the breeding programs will progress selection on behalf of drought tolerance (Mwadingeni *et al.*, 2016).

Deficient water supply for irrigation will be the norm rather than the exception, and irrigation controlling will be differed from emphasizing production per unit towards exploiting the yield per unit of water consumed, the water productivity. To achieve with scarce supplies, deficiency irrigation, fixed as the water application below full crop evapotranspiration is the main tool to achieve the aim of decreasing irrigation water use. While shortage irrigation is widely practiced over millions ha for a number of reasons from passable network design to excessive irrigation expansion relative to catchment supplies, it has not received adequate attention in research. Its use is declining water consumption for production, and for irrigation of crops. There is potential for improving water productivity in several crops and there is enough information for defining the best shortage irrigation

strategy for numerous situations. Many cases on the successful use of regulated shortage irrigation, showing that it will not only rises water productivity but also farmer's profits (Feres and Soriano, 2007).

Drought is one of the most common environmental stresses that affect the growth and yield of many crops. Drought ruins to be the main challenge to agricultural researchers and plant breeders. Tolerance to water stress is a difficult character in which crop performance can be affected by many characteristics (Ingram and Bartels 1996). Tolerance can be allocated into two portions counting drought avoidance and dehydration tolerance (Kramer and Boy 1995). On the other side, water stress decreased the growth traits differently among various crops like wheat, barley, and rice among different growth stages. These crops yield reduced. The drought had larger detrimental effects during blooming, filling, and maturity stages. However, water stress reduced wheat performance during the growth cycle (Abid *et al.*, 2016; Baenziger 2016; Zhang *et al.*, 2018; Sallam *et al.*, 2019).

Salicylic acid is a growth regulator of phenolic nature, which contributes to the regulation of physiology in plants. Salicylic acid (SA) dramas a significant role in the defense response to abiotic stresses in numerous types of crops (Pasala *et al.*, 2016). Salicylic acid improved plant growth and photosynthetic capacity under saline conditions (Noreen *et al.*, 2012). The application of SA significantly increased dry weights/plants under saline conditions (Stevens *et al.*, 2006). On the other hand, Khodary (2004) found that salicylic acid could be encouraged salt tolerance in maize plants *via* accelerating their photosynthesis role and carbohydrate metabolism. On the otherwise, spraying cotton with salicylic acid (200 ppm) under salt conditions produced the development of growth and yield characters, and increasing of leaf chemical composition (El-Beltagi *et al.*, 2017). Using salicylic acid not only reversed the negative impact of water deficit conditions but also improved the growth and yield parameters of the canola plant. The highest seed yield /ha, protein, and oil yield were obtained with the applications of SA with irrigation every 35 days. The results reported that the application of antioxidants could alleviate the harmful effects of deficit irrigation of canola (El-Sabagh *et al.*, 2017). Plants responded to SA applications with or without salinity treatments showed improvement in plant height, the number of leaves and dry weight of leaves, and dry weight/stem, number and weight of pods/plant, the weight of seeds/plant. SA treated plants were the best in enhancing the growth as well as increased dry weight and protein (%) of soybean (El-Lethy *et al.*, 2017). Salicylic acid (SA) was found to be effective for the wheat population line by increasing their tolerance to drought and exhibited differences with respect to the salicylic acid doses. The characteristics, which were adversely affected as compared to the control treatments under drought conditions, were commonly positively affected by the salicylic acid (Öztürkci and Arpali, 2019).

The main objective of this study was to investigate the effect of irrigation treatments and foliar application of salicylic acid on wheat productivity and quality.

MATERIALS AND METHODS

Two field experiments were conducted out at the Experimental Farm, Faculty of Agriculture (Saba Basha), Alexandria University, Egypt during the two successive seasons of 2018/2019, and 2019/2020 to study the effect of irrigation treatments and foilar application of salicylic acid rates on the yield of wheat cv Shandaweel- 1.

The preceding crop was maize in the two seasons. The physical and chemical properties of experimental soil are presented in Table 1 which is determined according to the method described by Page *et al.* (1982).

Table 1. Physical and chemical properties of experimental soil in both seasons.

Soil properties	Season	
	2018/2019	2019/2020
A) Mechanical analysis:		
Clay %	40.00	38.00
Silt %	29.00	30.00
Sand %	31.00	31.00
Soil texture	Clay loam soil	
B) Chemical properties		
pH (1 : 1)	8.00	8.10
Ec (dS/m)	2.99	3.20
1) Soluble cations (1:2) (cmol/kg soil)		
K ⁺	1.53	1.54
Ca ⁺⁺	9.30	9.10
Mg ⁺⁺	10.30	12.00
Na ⁺	11.50	10.60
2) Soluble anions (1 : 2) (cmol/kg soil)		
CO ₃ ⁻ + HCO ₃ ⁻	2.80	2.70
Cl ⁻	16.40	17.00
SO ₄ ⁻	11.60	11.50
Calcium carbonate (%)	5.50	6.10
Total nitrogen %	1.10	0.92
Available phosphate (mg/kg)	3.10	3.20
Organic matter (%)	1.52	1.61

This experiment was laid out in a split-plot system in three replications in both seasons. The main plots were allocated by irrigation treatments (normal irrigation, skipping the first irrigation at the age of 50 days, skipping the second irrigation at the age of 70 days, and skipping the third irrigation at the age of 90 days), while salicylic acid (SA) the commercial salicylic acid (SA) obtained from El Jomhoureya Company – Cairo- Egypt was prepared at the concentration of (water = control, 1 mM; 2 mM and 3 mM) sprayed twice at the age of 50 and 70 days after sowing and were distributed at random within each subplot in both seasons.

In both seasons of 2018/2019 and 2019/2020, wheat grains at the rate of 168 kg/ha were sown in 15th and 10th November in 2018/2019 and 2019/2020 seasons, respectively. The area of each subplot was 10.50 m² (3.50 m long and 3.00 m width).

Phosphorus fertilizer was applied with soil preparation and added at a rate of 60 kg P₂O₅/ha in the form of calcium superphosphate. Mineral nitrogen fertilizer at 168 kg N/ha was in the form of urea (46 % N) applied at two doses the first dose was 112 kg N/ha applied with the first irrigation while the second dose was 56 kg N/ha applied with the second irrigation and K fertilizer was added at a rate of 60 kg K₂O/ha in the form of potassium sulphate applied during soil preparation and all the other cultural practices were applied according to the recommendation of the Ministry of Agriculture and Land Reclamation.

At harvest time, plant height (cm), number of spikes/m², number of grains/spike, 1000- grain weight (g), grain yield (t/ha), straw yield (t/ha), biological yield (t/ha), harvest index (%), and grain protein content (%) were recorded in both seasons.

All collected data were subjected to analysis of variance according to Gomez and Gomez (1984). All statistical analysis was performed using analysis of variance technique by means of CoStat (2005) computer software package.

RESULTS AND DISCUSSION

The results in Tables (2 and 3) showed the effect of irrigation treatments and foliar application of salicylic acid (SA) and their interaction on plant height, number of spikes/m², number of spikletes/spike, number of grains/spike, 1000- grain weight, grain yield, straw yield, biological yield, harvest index (HI) and grain protein content of wheat in both seasons 2018/2019 and 2019/2020.

Results presented in Tables (2 and 3) revealed that irrigation treatments significantly affected plant height, number of spikes/m², number of spikletes/spike, number of grains/spike, 1000- grain weight grain yield, straw yield, biological yield, harvest index (HI) and grain protein content, where normal irrigation recorded the highest mean values of these traits followed by the irrigation treatment skipping the first one, while when skipping the second irrigation gave the lowest ones in both seasons. These results are in the same line of those obtained by Wardlaw and Willenbrink (2000); Leilah and Alkhateeb (2005); Abid *et al.* (2016); Baenziger (2016); Zhang *et al.* (2018); Sallam *et al.* (2019) they indicated that water stress decreased wheat performance during the complete growth cycle and skipping one or two irrigation caused reducing in growth and yield of the crops.

Results in Tables (2 and 3) showed the significant effect of foliar application of SA on plant height, number of spikes/m², number of spikletes/spike, number of grains/spike, 1000- grain weight, grain yield, straw yield, biological yield, harvest index (HI) and grain protein content in both seasons, where the highest mean values of these characters recorded with foliar application of SA at the rate of 2 mM/l followed by 3 mM/l, meanwhile the lowest one recorded by the control treatment (spray water) in the two seasons. These findings are in agreement with those obtained by Khodary (2004); Turkyilmaz *et al.* (2005); Stevens *et al.* (2006); Noreen *et al.* (2012); Öztürkeci and Arpali (2019) they revealed the vital role of application of salicylic acid on growth and yield characters which increased under stress condition like salinity and drought.

Table 2. Plant height, number of spikes/m², number of spikletes/spike, number of grains/spike, 1000- grain weight of wheat as affected by irrigation treatments and salicylic acid (SA), and their interaction in both seasons.

Treatment	Plant height		Number of spikes/m ²		Number of spikletes/spike		Number of grains/spike		1000- grain weight	
	Seasons									
	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020
A- Irrigation treatments										
Normal	91.0	89.5	326.3	340.2	21.3	21.0	62.0	60.1	55.9	54.6
Skipping 1 st irrigation	86.9	85.8	330.4	345.1	20.2	19.3	57.9	56.2	53.4	51.7
Skipping 2 nd irrigation	81.6	79.3	312.6	331.2	18.1	17.2	50.6	50.8	49.2	45.9
Skipping the third irrigation	82.4b	81.3	280.3	299.8	13.2	13.2	43.1	42.0	52.3	48.8
LSD _{0.05} (A)	4.9	5.0	31.5	14.2	1.1	0.8	2.6	1.7	2.1	2.0
B- SA spray										
Water	77.9c	76.5	295.8	301.4	21.3	21.0	46.8	45.5	48.3	46.2
1 mM	87.7	85.9	310.7	342.1	20.2	19.3	55.9	54.5	56.6	52.4
2 mM	90.6	88.5	329.3	345.3	18.1	17.2	56.7	56.8	56.6	54.0
3 mM	85.9	85.1	313.8	327.3	13.2	13.2	54.2	52.3	51.2	48.4
LSD _{0.05} (B)	4.2	4.4	20.1	24.7	1.1	0.8	3.2	3.3	2.1	2.0
A x B	*	*	*	*	*	*	*	*	*	*

*: significant difference at 0.05 level of probability.

Table 3. Grain yield, straw yield, biological yield, harvest index (HI), and grain protein content of wheat as affected by irrigation treatments and salicylic acid (SA) and their interaction in both seasons.

Treatment	Grain yield (t/ha)		Straw yield (t/ha)		Biological yield (t/ha)		Harvest index (HI)		Grain protein (%)	
	Seasons									
	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020
A- Irrigation treatments										
Normal	5.9	5.0	9.1	8.6	15.0	13.6	39.3	36.8	9.2	9.4
Skipping 1 st irrigation	5.5	4.6	8.9	8.1	14.4	12.7	38.2	36.2	9.6	9.2
Skipping 2 nd irrigation	5.4	4.2	7.5	6.9	12.9	11.1	41.9	37.8	9.3	9.1
Skipping 3 rd irrigation	4.9	4.3	7.5	6.8	12.4	11.1	39.5	38.7	9.0	8.7
LSD _{0.05} (A)	0.4	0.3	0.2	0.4	0.3	0.5	1.8	1.9	0.2	0.3
B- SA spray										
Water	4.7	3.9	6.4	6.1	11.1	10.0	42.3	39.0	9.2	9.3
1 mM	5.4	4.6	8.5	7.7	13.9	12.3	38.8	37.4	9.1	8.7
2 mM	5.6	4.6	9.1	8.3	14.7	12.9	38.1	35.7	9.1	8.7
3 mM	6.0	4.9	9.0	8.3	15.0	13.2	40.0	37.1	9.7	9.7
LSD _{0.05} (B)	0.4	0.3	0.4	0.2	0.4	0.4	1.3	1.8	0.3	0.4
A x B	*	*	*	*	*	*	*	*	*	*

*: significant difference at 0.05 level of probability.

The results in Tables (4 and 5) showed that the interaction between of irrigation treatments and foliar application of salicylic acid (SA) significantly affected plant height, number of spikes/m², number of spikelets/spike, number of grains/spike, 1000- grain weight, grain yield, straw yield, biological yield, harvest index (HI) and grain protein content of wheat in both seasons 2018/2019 and 2019/2020, where the highest mean values of these traits achieved by the irrigated wheat plant as normal irrigation or skipping the first irrigation with foliar application of SA at the rate of 1 or 2 mM/l, while the lowest ones recorded with skipping the 2nd irrigation + the control treatment in both seasons.

These results showed that irrigation treatments and salicylic acid concentration under this study act dependently on the previously mentioned characters as shown in Table (4).

Table 4. The interaction effect between irrigation treatments and salicylic acid (SA) of plant height, number of spikes/m², number of spikletes/spike, number of grains/spike, and 1000- grain weight of wheat in both seasons.

Treatments		Plant height		Number of spikes/m ²		Number of spikletes/spike		Number of grains/spikes		1000- grain weight	
Irrigation treatment	SA spray	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020
Normal	Water	88.4	87.0	325.7	333.3	20.66	19.7	62.0	59.0	54.7	54.0
	1 mM	93.1	91.3	334.7	364.7	21.3	20.3	64.0	61.0	58.2	56.7
	2 mM	96.3	91.9	332.3	336.7	23.7	23.3	66.0	67.3	59.9	58.4
	3 mM	86.3	87.7	312.7	326	19.7	20.7	56.0	53.0	51.0	49.5
Skipping the first irrigation	Water	77.2	74.9	325.3	317	17.0	16.0	50.7	48.0	44.7	43.2
	1 mM	93.1	91.6	354.3	384.3	21.3	20.3	64.0	61.0	58.2	56.0
	2 mM	95.3	93.9	334.7	364.6	23.7	23.3	61.7	61.3	59.5	58.0
	3 mM	82.4	82.9	307.3	314.3	18.7	17.7	55.3	54.3	51.0	49.7
Skipping the second irrigation	Water	74.7	73.3	281.3	282	16.0	15.3	42.7	42.7	46.0	43.0
	1 mM	82.5	80.0	301.0	314.7	18.7	17.7	52.7	53.7	51.5	48.5
	2 mM	85.2	83.6	339.7	369.7	19.0	18.0	55.0	54.0	53.2	49.1
	3 mM	84.1	80.0	328.3	358.3	18.7	17.7	52.0	53.0	46.0	43.0
Skipping the third irrigation	Water	71.3	70.7	250.7	273.4	11.3	11.3	32.0	32.3	47.8	44.8
	1 mM	82.0	80.5	252.7	304.8	13.7	13.7	43.0	42.3	51.3	48.3
	2 mM	85.7	84.3	310.7	310.3	14.0	14.0	44.0	44.3	53.6	50.6
	3 mM	90.7	89.8	307.0	310.7	13.7	13.7	53.3	49.0	56.7	51.5
LSD _{0.05} (AxB)		8.5	8.7	40.3	49.3	2.7	2.6	6.4	6.6	4.2	4.1

Table 5. The interaction effect between irrigation treatments and salicylic acid (SA) of Grain yield, straw yield, biological yield, harvest index (HI), and grain protein content of wheat in both seasons.

Treatments		Grain yield (t/ha)		Straw yield (t/ha)		Biological yield (t/ha)		Harvest index (HI)		Grain protein (%)	
Irrigation treatment	SA spray	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020
Normal	Water	5.1	4.4	6.9	6.6	12.0	11.0	42.5	40.0	7.7	9.0
	1 mM	5.3	4.7	9.4	9.2	14.7	13.9	36.1	33.8	9.6	9.3
	2 mM	5.8	5.1	9.9	9.3	15.7	14.4	36.9	35.4	9.0	8.4
	3 mM	7.2	5.7	10.1	9.4	17.3	15.1	41.6	37.7	10.8	10.0
Skipping the first irrigation	Water	4.8	4.2	6.8	6.5	11.6	10.7	41.4	39.3	9.8	8.4
	1 mM	5.3	4.7	9.0	8.0	14.3	12.7	37.1	37.0	9.6	8.6
	2 mM	5.9	4.8	10.0	9.0	15.9	13.8	37.1	34.8	9.1	8.4
	3 mM	6.0	4.7	9.8	9.0	15.8	13.7	38.0	34.3	9.9	9.3
Skipping the second irrigation	Water	4.5	3.5	5.1	4.9	9.6	8.4	46.9	41.7	10.0	11.1
	1 mM	5.2	4.3	7.9	6.8	13.1	11.1	39.7	38.7	8.2	8.7
	2 mM	4.8	4.3	8.9	7.8	13.7	12.1	35.0	35.5	9.1	8.8
	3 mM	5.3	4.7	8.2	7.6	13.5	12.3	39.3	38.2	9.3	7.9
Skipping the third irrigation	Water	4.3	3.4	6.9	6.3	11.2	9.7	38.4	35.1	8.6	8.6
	1 mM	5.6	4.9	7.7	7.0	13.3	11.9	42.1	41.2	9.2	8.2
	2 mM	6.0	4.1	7.8	7.2	13.8	11.3	43.5	36.3	9.3	9.4
	3 mM	5.7	4.7	7.9	7.2	13.6	11.9	41.9	39.5	8.8	11.7
LSD _{0.05} (AxB)		0.8	0.5	0.7	0.5	0.8	0.7	5.1	3.6	0.5	0.9

CONCLUSION:

As a result of these two growing seasons field's study, it was concluded that yield and its components of wheat increased with sowing Shandaweel- 1 variety with foliar application of salicylic acid (SA) twice at 50 and 70 days after sowing (DAS) at the rate of 2 mM/l under normal irrigation or skipping one irrigation at the first or the second irrigation under study conditions at Abess, Alexandria Governorate, Egypt.

REFERENCES

- Abid, M., Tian, Z., Ata-Ul-Karim, S.T., Cui, Y., Liu, Y., Zahoor, R., Jiang, D., Dai, T. (2016). Nitrogen Nutrition Improves the Potential of Wheat (*Triticum aestivum* L.) to Alleviate the Effects of Drought Stress during Vegetative Growth Periods. *Frontiers in Plant Science*, 7, 981.
- AOAC (1995). Method of Analysis Association of Official Agriculture Chemists. 16th Ed. Washington, D. C, USA.
- Baenziger, P.S. (2016). Wheat Breeding and Genetics. Ref. Modul. Food Sci.,1-10.
- Chang, R.Z., Y.W. Chen, G.H. Shao and C.W. Wan (1994). Effect of salt stress on agronomic characters and chemical quality of seeds in soybean. *Soybean Sciences*. 13:101-105.
- CoStat-Cohort Software (2005). CoStat User Manual, version 3 Cohort Tucson, Arizona, USA.
- El-Beltagi, H.S., Ahmed, S.H., A.A.M. Namich and R.R. Abdel-Sattar (2017). Effect of salicylic acid and potassium citrate on cotton plant under salt stress. *Fresenius Environmental Bulletin*, 26:1091-1100.
- El-Lethy, S., R., M. Talaat Iman, A. Tarraf Shahira and Y. R. Abdel-Baky (2017). Effects of exogenous salicylic acid in soybean plants subjected to salt stress. *Sciences*, 7(04):956-966.
- El-Sabagh, A., K. A. Abdelaal, and C. Barutcular (2017). Impact of antioxidants supplementation on growth, yield and quality traits of canola (*Brassica napus* L.) under irrigation intervals in North Nile Delta of Egypt. *Journal of Experimental Biology and Agriculture Science*, 5(2):163-172.
- FAO (2018). Wheat, cultivated area and production. Food and Agriculture Organization of the United Nation.
- Gomez, K.A and A.A. Gomez (1984). Statistical procedures in agricultural research. 2nd edition. Wiley, New York.
- Ingram, J. and D. Bartels (1996). The molecular basis of dehydration tolerance in plants. *Annual Review of Plant Biology*, 47(1):377-403.
- Khodary, S.E.A. (2004). Effect of salicylic acid on the growth, photosynthesis and carbohydrate metabolism in salt-stressed maize plants. *International Journal of Agriculture and Biology*, 6:5-8.
- Kramer, P. J. and J. S. Boyer, 1995. Water Relations of Plants and Soils, Academic Press, New York, NY, USA.
- Leilah, A.A. and S.A. Alkhateeb (2005). Statistical analysis of wheat yield under drought conditions. *Journal of Arid Environments*, 61, 483–496.
- Mardeh, A. S. S., A. Ahmadi, K. Poustini and V. Mohammadi (2006). Evaluation of drought resistance indices under various environmental conditions. *Field Crops Research*, 98(2-3):222-229.
- Mwadingeni, L., H. Shimelis, E. Dube, M. D. Laing and T. J. Tsilo (2016). Breeding wheat for drought tolerance: Progress and technologies. *Journal of Integrative Agriculture*, 15(5):935-943.
- Fereres, E. and M.A. Soriano (2007). Deficit irrigation for reducing agricultural water use. *Journal of Experimental Botany*, 6: 1–13.
- Noreen, S., Ashraf, M., and N.A. Akram (2012). Does exogenous application of salicylic acid improve growth and some key physiological attributes in sunflower plants subjected to salt stress?. *Journal of Applied Botany and Food Quality*, 84:169-177.

- Öztürkci, Y. and D. Arpali (2019). The effects of salicylic acid on the growth and some physiological properties of bread wheat varieties under drought stress. *Iğdır Üniversitesi Fen Bilimleri Enstitüsü Dergisi*, 9(3):1737-1746.
- Page, A.L., R.H. Miller and D.R. Keeney (1982). *Methods of Chemical Analysis. Part 2: Chemical and Microbiological Properties* (2nd Ed.). American Society of Agronomy, Inc. and Sci. Soc. of America, Inc. Publi., Madison, Wisconsin, U.S.A.
- Pasala, R.K., M.I.R. Khan, P.S. Minhas, M.A. Farooq, R. Sultana, T.S.Per, P.P. Deokate, N.A. Khan and J. Rane (2016). Can plant bioregulators minimize crop productivity losses caused by drought, heat and salinity stress? An integrated review. *Journal of Applied Botany and Food Quality*, 89, 113-125.
- Sallam, A., Alqudah, A. M., Dawood, M. F., Baenziger, P. S., & Börner, A. (2019). Drought stress tolerance in wheat and barley: advances in physiology, breeding and genetics research. *International journal of molecular sciences*, 20(13):3137.
- Stevens, J., T. Senaratna and K. Sivasithamparam (2006). Salicylic acid induces salinity tolerance in tomato (*Lycopersicon esculentum* cv. Roma): associated changes in gas exchange, water relations and membrane stabilization. *Plant Growth Regulation*, 49: 77-83.
- Turkyilmaz, B., L.Y. Aktas and A. Guven (2005). Salicylic acid induced some biochemical and physiological changes in *Phaseolus vulgaris* L. *Sciences and Engineering Journal of Fırat Unıversity*, 17(2):319-326
- Wardlaw, I.F. and Willenbrink, J. (2000). Mobilization of fructan reserves and changes in enzyme activities in wheat stems correlate with water stress during kernel filling. *New Phytologist*, 148, 413-422.
- Zhang, J., Zhang, S., Cheng, M., Jiang, H., Zhang, X., Peng, C., Lu, X., Zhang, M. and Jin, J., 2018. Effect of drought on agronomic traits of rice and wheat: a meta-analysis. *International Journal of Environmental Research and Public Health*, 15(5):839-844.

ARABIC SUMMARY

إنتاجية القمح وعلاقتها بحامض الساليسليك تحت ظروف الإجهاد المائي

محمود عبد العزيز جمعة ، ابراهيم فتح الله رحاب ، محمد أحمد عبد الجواد نصار ، فرج خميس مفتاح فرج

قسم الإنتاج النباتي – كلية الزراعة – سابا باشا – جامعة الأسكندرية

القمح أكثر المحاصيل الغذائية أهمية في العالم. وتعتمد عليه ملايين من البشر في جميع مناطق العالم على الأغذية التي تصنع من حبوب القمح ويعتبر الغذاء الرئيسي لكثير من الدول النامية خاصة مصر. وتقل مياه الري في بعض أوقات موسم النمو مما يقلل من إنتاجية القمح ويعود بالضرر على المزارع نتيجة نقص المحصول. لذا أقيمت تجربتان حقلين خلال موسم زراعة 2019/2018 و 2020/2019 لدراسة تأثير فترات الري والرش الورقي لحامض الساليسليك والتداخل بينهما على إنتاجية محصول القمح وكان التصميم المستخدم هو تصميم تجريبي قطع منشقة مرة واحدة في عدد ثلاث مكررات . ووزعت المعاملات عشوائياً كما يلي:

أ- القطع الرئيسية: (معاملات الري):

1- الكنترول . إعطاء جميع الريات مواعيدها.

2- منع رية في عمر 50 يوم .

3- منع رية في عمر 70 يوم .

4- منع رية في عمر 90 يوم .

ب- القطع الشقية : الرش الورقي بحامض الساليسليك مرتين عند عمر 50 و 70 يوم بمعدل 200 لتر للفدان بالتركيزات الآتية:

1- بدون رش (مقارنة).

2- الرش الورقي بتركيز (1 ملليمول/لتر).

3- الرش الورقي بتركيز (2 ملليمول/لتر).

4- الرش الورقي بتركيز (3 ملليمول/لتر).

ولخصت أهم النتائج فيما يلي:

- وجد أن معاملات الري والرش الورقي لحامض الساليسليك والتداخل بينهما أثرت تأثيراً معنوياً على ارتفاع النبات
- عدد السنابل/م² - عدد السنبيلات / سنبل - عدد الحبوب / سنبل - وزن 1000 حبة - المحصول البيولوجي (طن / فدان) - محصول القش (طن/ فدان) - محصول الحبوب (طن / فدان) - دليل الحصاد ومحتوي البروتين في الحبوب خلال موسم الزراعة 2019/2018 و 2020/2019.
- حققت معاملة الري العادي أعلى قيم لهذه الصفات ومتبوعه بمعاملة الري (منع الري في عمر 50 يوم) في حين ان منع الري في عمر 70 يوم أثرت بالسلب على صفات محصول القمح حيق أعطت أقل القيم لها خلال موسمي الدراسة.
- وجد أن زيادة تركيز الرش بحامض الساليسليك حتى 2 أو 3 ملمول للتر حقق أعلى متوسطات قيم للصفات المدروسة في حين أن معاملة الكنترول (الرش بالماء) أعطت أقل القيم لهذه الصفات خلال موسمي الزراعة.
- حقق التداخل بين معاملة الري العادي او منع الري الأولى مع الرش بحامض الساليسليك 2 أو 3 ملمول للتر أعلى قيم للصفات تحت الدراسة في حين ان منع الري الثانية مع معاملة الكنترول حققت أقل القيم لها خلال الموسمي.

التوصية:

توصى الدراسة بزراعة صنف القمح شندويل-1 مع الري العادي أو منع الري الأولى مع الرش الورقي مرتين وبمعدل 2 ملليمول للتر من حامضي الساليسليك حيث أن ذلك حقق أعلى محصول حبوب ومكوناته وأعلى نسبة بروتين (%) خلال موسمي الدراسة وتحت ظروف منطقة أبيض - محافظة الأسكندرية - مصر وظروف المناطق المماثلة لها.