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Response of Maize Productivity and Quality to Foliar Application and Irrigation Intervals

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ABSTRACT

During the 2020 and 2021 growing seasons, a field experiment was conducted at the Experimental Station, Mansoura University's Department of Agriculture, to examine the reaction of maize productivity and quality to foliar application (without foliar application, spraying with irrigation water, 200 ppm of salicylic, 5 ml/L of Agrispon and 5 ml/L of PotaMac-25) under irrigation intervals *i.e.* (irrigation every 14, 18 and 22 days). A strip-plot design with three replications was used to conduct the experiment. The highest values of all studied traits of maize were produced under irrigation every 14 days. Foliar spraying with 5 ml/L of PotaMac-25 in each spraying resulted in the highest values of all studied growth characters, yield and its attributes and grains quality of maize. The study's findings suggest that to achieve the highest levels of production and grain quality, it is best to irrigate maize plants every 14 days without causing them any water stress and to foliar-spray them with 5 ml/L of PotaMac-25. While, to maintain high productivity and grains quality at the same time save irrigation water, it could be suggested that irrigation maize plants every 18 days beside foliar spraying with PotaMac-25 at 5 ml/L under the local environmental circumstances of Egypt's Dakahlia Governorate's Mansoura District.

***Keywords*:** Maize, foliar application, Irrigation, productivity.

INTRODUCTION

The grain crop known as maize (*Zea mays* L.) is widely cultivated all over the world. After rice and wheat, maize is the world's most significant cereal crop, supplying nourishment for both people and animals. Maize grains are high in vitamins A, C, and E, as well as carbs and important minerals. They also include 7-9% protein and 5% oil. They are also high in dietary fibre and calories, making them an excellent source of energy. Starch from maize can be made into plastics, fabrics, adhesives, and many other chemical products. To narrow the consumption/production gap for maize, substantial emphasis should be placed on increasing maize productivity by improving yield per unit area. Maize is widely recognised for its high nutritional and other production input needs. Thereby, foliar application with antioxidant, natural fertilizer and potassium are among factors that reduce effects of water stress at the same time enhance maize productivity.

One of the key reasons limiting agriculture productivity in Egypt and lowering the effectiveness of using dry lands is drought and the stress it causes. Hence, it is feasible to employ semi-arid regions thanks to the identification of and usage of drought-tolerant crops and particular crop modification techniques. The maize crop needs enough water at all stages of physiological development in order to produce its maximum amount. However, much as with other cereal crops, there are key times in its growth where a lack of soil moisture significantly affects grain production and yield. Thus, efforts must be made to minimize agricultural yield loss caused by conditions that may be avoided. Abiotic stressors have the potential to reduce maize crop production by more than 50% (Cakmak, 2005). Drought, the most severe abiotic stress, impacts all aspects of plant growth and is primarily responsible for lowering maize output (Golbashy *et al.*, 2010). Seadh *et al.* (2014) showed that giving maize plants 6 irrigations (normal irrigation treatment) The greatest values of growth, yield, and its qualities, as well as grain quality traits, were generated. Nonetheless, missing the second and fifth irrigations was ranked second after standard irrigation treatment Abo-Marzoka *et al.* (2016) indicated that all studied parameters of maize were dramatically decreased when irrigation intervals were increased to 25 days from 15 days (control treatment). Gomaa *et al.* (2017) demonstrated that applying harsh water treatment reduced plant height and grain output while increasing the proline level in maize leaves. Rekaby *et al.* (2017) demonstrated that grain production of maize irrigated by 75 percent of water needs was 5 and 10% greater in the 1st and 2nd seasons, respectively, compared to 100 percent of water requirements. Song *et al.* (2019) reveal that exposing maize to severe and prolonged water stress episodes during the seedling stage might result in an unrecoverable yield loss. Ahmed *et al.* (2020) revealed that irrigation interval (10, 15 and 20 days) significantly affected all measured parameters. They also indicated that 15 days interval resulted in higher yield and saved irrigation water. Gomaa *et al.* (2021) showed that irrigation every 15 days produced the best production, as well as grains of the finest quality. The

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extremely significant of irrigation every 20 days efficiency of water utilization. Irmadamayanti *et al.* (2021) revealed that compared to other water treatment intervals, an irrigation interval treatment of providing water every 8 days offered superior growth and yields of maize (control, 14 days and 18 days). Zhu and Burney (2022) claimed that irrigation has significant effects on maintaining global food supply by allowing agricultural water demands to be satisfied even in drought situations. Irrigation could be crucial in a warmer environment by simultaneously reducing the stressors brought on by high temperatures and added water since it cools agricultural plants through transpiration.

Foliar fertilization has a definite role in agriculture and will see more use in the future. It is a common procedure to treat nutritional deficits in plants brought on by incorrect nutrient input from roots. Foliar fertilizations are used for three main purposes; 1- To correct a deficiency, 2- To maintain optimum nutrition of a particular nutrient and 3- To give a crop a nutritional boost at a critical stage in its life (Jezek *et al.*, 2015).

Salicylic acid (SA) is regarded as a hormone-like compound that has a significant role in controlling a variety of physiological processes in plants, including, stomata closure, ions uptake and transport, biosynthesis inhibition of ethylene, membrane permeability, transpiration, photosynthesis, flowering and abiotic tolerance (Ashraf *et al.* 2010). Application of SA increased plants' ability to withstand a variety of biotic and abiotic stressors, including salt, drought, and heat (Khan *et al.* 2010). Abo-Marzoka *et al.* (2016) indicated that salicylic acid and ascorbic acid significantly affected growth parameters of maize. Faheed *et al.* (2016) showed that foliar spraying of salicylic acid at a rate of 100 mg/L after 30 and 45 days of planting led to progressive and substantial improvements in all growth indices and grain production of maize.

Nowadays, natural and safe compounds that function as biostimulants for plants are being prioritized, with the goal of increasing plant production while avoiding negative and adverse effects on human health caused by the excessive use of synthetic agro-chemicals. Badawi *et al.* (2012) found that foliar spraying maize plants with Amino-total resulted in the highest values of studied growth characters and protein %. Nevertheless, Milagros foliar spraying produced the greatest results for the quantity of ears per plant, ear length & diameter, ear weight, rows number ear^{-1}, grains number row^{-1}, weight of ear grains, weight of 100-grains, and grain yield per unit area. Seadh *et al.* (2014) demonstrated that the best growth, yield, and grain quality features were achieved by spraying maize plants twice with Green Miracle, an anti-transparent substance, after 20- and 30-days following sowing. Brankov *et al.* (2020) foliar fertilizer with amino acids was discovered to be more beneficial to maize plants than fertilizer with phosphorus as its primary ingredient. By boosting fresh matter, leaf area index, and plant height, applied amino acids have demonstrated their benefits.

Potassium (K) participates in several critical actions in plants, including photosynthesis, photosynthate translocation, protein synthesis, ionic balance management, stomatal regulation, and water usage (Reddya *et al.*, 2004), osmoregulation and activation of enzymes (Mengel, 2007). Moreover, potassium improves plant resistance to stressors such as diseases, pests, cold, and water stress. (Marschner, 1995). Gomaa *et al.* (2021) demonstrated that applying potassium silicate as a foliar spray three times to maize produced the maximum grain production, as well as the highest grain quality. Wasaya *et al.* (2021) declared that foliar potassium sulphate applications at a 2% concentration outperformed other dosages by enhancing growth characteristics and chlorophyll content.

Therefore, the aim of this study is to ascertain how foliar applications of antioxidants, natural fertilizers, and potassium improve maize (White Single Cross Hybrid, Hytech-2031) productivity and grain quality in the Mansoura district of the Dakahlia Governorate while reducing the negative effects of water stress.

MATERIALS AND METHODS

During the growing seasons of 2020 & 2021, a field experiment was conducted at the Experimental Station, Mansoura University's Faculty of Agriculture. The main objective of this study was to study the response of maize (White Single Cross Hybrid, Hytech-2031) productivity & quality to foliar application treatments under irrigation intervals. The studied White Single Cross Hybrid, Hytech-2031 is produced and obtained from Misr Hytech Seed International Company, which characterized as very good stay green, strong stalks tolerant to lodging, late wilt and other stalk diseases, dual purpose which fits grain and silage, dent bold grains fill the cub up to the tip, long cylindrical ears, excellent husk cover which prevents bird damage and matures 115 – 120 days after sowing.

A strip-plot design with three replications was used to conduct the experiment. The vertical plots were assigned to three water stress treatments as irrigation intervals *i.e.* without water stress (irrigation every 14 days), control treatment, intermediate water stress (irrigation every 18 days) and intense water stress (irrigation every 22 days). During the growing seasons, the 1st irrigation (the Mohayah irrigation) was applied 18 days after planting, and the succeeding irrigations were applied at the aforementioned intervals. To prevent water from leaking into neighbouring plots, deeper canals were used to divide the vertical plots.

The horizontal plots were used for the five foliar spray treatments, *i.e.* without foliar application (control treatment), foliar application with irrigation water, salicylic acid at the rate of 200 ppm in each spraying, Agrispon at the rate of 5 ml/L in each spraying and PotaMac-25 at the rate of 5 ml/L in each spraying. Salicylic acid as antioxidant is Egypt's El-Nasr Pharmaceutical Chemicals Co. produced it, while El-Gomhouria Company for Trading Pharmaceutical Chemical & Medical provided it. Agrispon as a natural fertilizer and a growth stimulant is produced by Agriculture Science Inc., USA, and obtained from Global Green Planet, Egypt. Agrispon contains purine, adenine, zeatin, porphyrin, morphogen and glycosides, in addition the main amino acids that represent part of chlorophyll and involved in the composition of important plant enzymes that are important to activate the process of chlorophyll assimilation. PotaMac-25 as a source of potassium fertilizer is produced by Damak for Agricultural Development, Egypt and contains potassium (potassium carboxylate) 25% and carboxylic acids 60%. 200 liters/fed of foliar solution were sprayed twice, at the saturation point, after 30 and 45 days after planting on experimental plots using a hand sprayer. At a concentration of 0.02%, Tween-20 was utilised as a wetting agent. Each basic unit of the experiment consisted of 5th ridges (60 cm in width and 3.5 m in length). This resulted in an area of 10.5 m^2 (1/400 fed). In the first and second seasons, Egyptian clover (*Trifolium alexandrinum* L.) served as the crop in the winter. Before preparing the soil throughout the growing seasons, random soil samples from the experimental field area were obtained at a depth of 0 to 30 cm from the soil surface to measure the physical and chemical soil parameters. The soil of experimental site was classified as clayey sand (28.52%); Silt (30.24%); Clay (41.23%); Field capacity (32.47%); wilting point (16.00%); available water (16.37%); bulk density (1.15g cm^{-3}); pH (7.69); electrical conductivity (2.48 dSm^{-1}); CaCO3 (1.92%); organic matter (1.95%); available N (24.91 ppm); available P (14.17ppm) and exchangeable K (312.3 ppm) as averages over both growing seasons.

During the two growing seasons of 2020 and 2021, El-Mansoura district meteorological data (monthly temperature in degrees Celsius and relative humidity in percent) were displayed in Table 1. Two ploughings; levelling; compacting; ridging; and subsequent division into experimental units were used to properly prepare the experimental field (10.5 m^2).

During soil preparation, 150 kg/fed of calcium superphosphate (15.5% P2O5) was applied. At a rate of 120 kg N/fed, ammonium nitrate (33.5% N) fertilizer was applied in two equal parts, the first after thinning (before the 1st irrigation) and the second before the second irrigation. The initial application of nitrogen fertilizer included 50 kg/fed of potassium sulphate (48% K2O).

Table 1. The experimental site's monthly temperature (°C) and relative humidity (%) for the two growth seasons.

Month	Temperature (°C)				Relative humidity (%)			
	2020		2021		2020		2021	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
May	29.9	17.6	29.3	20.0	83.5	39.8	84.5	41.5
June	33.0	21.9	33.0	22.2	83.4	38.1	84.0	41.9
July	34.2	24.0	35.3	24.0	84.6	40.2	84.3	42.0
August	35.1	24.4	34.0	23.8	84.6	41.7	83.7	42.4
September	31.9	22.4	31.8	21.4	84.4	42.9	83.4	40.6

On one side of the ridge, on May 15 and May 18, in the growing seasons of 2020 and 2021, maize grains were manually seeded in hills 30 cm apart at a rate of 2 to 3 grains/hill using the dry sowing method (Afeer). The number of plants per hill had been decreased before the first watering. In line with the Ministry of Agriculture and Land Reclamation's recommendations, all other agricultural practices were maintained in maize fields, with the exception of the variables under investigation. According to Gardner *et al.,* (1985) five guarded plants were randomly selected from each plot after 100 days to measure the following growth characters: plant height (cm), ear height (cm), stem diameter (cm), and ear leaf area (cm2).

Five guarded plants and ears were randomly selected from each plot at harvest (115 days after planting) to assess yield and its characteristics as well as grain quality. These characteristics included ear length (cm); ear diameter (cm); number of rows/ear; number of grains/row; ear weight (g); ear grains weight (g); shelling percentage (%); and 100-grain weight (g). The grain yield (ardab/fed) was calculated using the weight of the grains in kilogrammes of each plot, corrected for the moisture content to 15.5%, and then translated to ardab per feddan (ardab = 140 kg). The outcome of the preceding sample's storable yield (t/fed) was weighted in kg/plot before being converted to tonnes per feddan. Crude protein and oil percentages were estimated in dried grains sample as described by A.O.A.C. (1990). Phosphorus percentage was determined in dried grains according to Jackson (1967). Potassium percentage was determined in dried grains according to Peterburgski (1968).

Using the MSTAT statistical programme, the generated data were statistically evaluated using ANOVA method for the strip-plot design as explained by Gomez and Gomez (1984). According to Snedecor and Cochran (1980), The differences between treatment means were examined using the Least Significant Difference (LSD) approach at the 5% level of probability.

RESULTS AND DISCUSSION

1- Irrigation Intervals Effects:

Concerning the effect of water stress as irrigation intervals *i.e.* without water stress (irrigation every 14 days, intermediate water stress (irrigation every 18 days) and intense water stress (irrigation every 22 days) on growth parameters; plant & ear height; stem diameter; ear leaf area; yield and its attributes (ear length; ear diameter; number of rows/ear; number of grains/row; ear weight; ear grains weight; shelling percentage; 100-grain weight; grain & stover yields/fed) and grains quality (crude protein; oil; phosphorus & potassium percentages) of maize, the obtained results indicate that all studied growth characters, yield and its attributes and grains quality were greatly impacted by irrigation intervals during the course of the two growing seasons (Tables 2 and 3).

Noteworthy, prolonging irrigation intervals by irrigation maize plants every 22 days, plant height was significantly Throughout the two seasons of this study, there was a decline in all growth characteristics, yield and its characteristics, and grain quality. The highest plant height, ear height, stem diameter, ear leaf area, number of rows per ear, number of grains per row, ear weight, ear grains weight, shelling percentage, 100-grain weight, grain and stover yields/fed, crude protein, oil, phosphorus, and potassium percentages of maize were produced without water stress (irrigation every 14 days) in both seasons (Tables 2 and 3). It was followed by intermediate water stress (irrigation every 18 days) in both seasons. The lowest values of plant height, ear height, stem diameter, ear leaf area, ear length, ear diameter, number of rows/ear, number of grains/row, ear weight, ear grains weight, shelling percentage, 100-grain weight, grain and stover yields/fed, crude protein, oil, phosphorus and potassium percentages of maize were derived from intense water stress (irrigation every 22 days) in both seasons. These improvements in yield, its characteristics, and grain quality seen after watering every 14 days to reduce irrigation stress may be attributable to the constant moisture supply provided to maize plants, which promotes vegetative development characteristics and results in taller plants. On the other hand, water stress during the vegetative stage hindered root development, which restricted deep water uptake and led to low growth (Çakir, 2004).

These outcomes are quite consistent with those attained by Seadh *et al.* (2014), Ahmed *et al.* (2020), Gomaa *et al.* (2021), Irmadamayanti *et al.* (2021) and Zhu and Burney (2022).

2-Effect of foliar application treatments:

The statistical analysis of the obtained data regards growth characteristics (plant height, ear height, stem diameter, and ear leaf area), yield and its properties (ear length; ear diameter; number of rows/ear; number of grains/row; ear weight; ear grains weight; shelling %; 100-grain weight; grain & stover yields/fed) and grains quality (crude protein; oil; phosphorus and potassium percentages) of maize show that studied foliar application treatments *i.e.* without foliar application (control treatment), foliar spraying twice after 35 and 50 days from sowing with irrigation water, salicylic acid at the rate of 200 ppm, 5 ml/L of Agrispon and 5 ml/L of PotaMac-25 exhibited significant effect on all studied growth characters, yield and its attributes and grains quality in both seasons (Tables 2 and 3).

It is evident that using 5 ml/L of PotaMac-25 during each spraying in both seasons resulted in the highest means of plant height, ear height, stem diameter, ear leaf area, number of rows/ear, number of grains/row, ear weight, ear grains weight, shelling percentage, 100-grain weight, grain and stover yields/fed, crude protein, oil, phosphorus, and potassium percentages of maize (Tables 2 and 3). It was followed by foliar spraying with 5 ml/L of Agrispon, then foliar spraying with salicylic acid at the rate of 200 ppm and foliar spraying with irrigation water two times after 35 and 50 days from sowing in both seasons. In general view of obtained data, the differences among foliar application with irrigation water, salicylic acid, Agrispon and PotaMac-25 were significant in both seasons. The lowest means of above mentioned traits of maize were resulted from without foliar application (control treatment) in both seasons.

These increases in yield and its characteristics, as well as the quality of the grains, by foliar application treatments twice, particularly with PotaMac-25 as a source of potassium fertiliser, may be attributable to the role of potassium in many crucial plant processes, such as photosynthesis, protein synthesis, control of ionic balance, regulation of plant stomata and water use, enzyme activation, and osmoregulation (Reddya *et al.*, 2004 and Mengel, 2007). In addition, the role of Agrispon as a source of amino acids that represent part of chlorophyll and involved in the composition of important plant enzymes that are important to activate the process of chlorophyll assimilation. Moreover, salicylic acid plays a significant role in controlling a number of physiological processes in plants, including stomata closure, ion uptake and transport, inhibition of ethylene biosynthesis, transpiration, membrane permeability, nitrate metabolism, stress tolerance, photosynthesis, and growth (Ashraf *et al.* 2010), It increased internode length, which in turn caused the plant's height to rise, reflecting better growth. These outcomes coincided with those that were mentioned by Brankov *et al.* (2020) and Wasaya *et al.* (2021).

Table 2. The impact of irrigation intervals, foliar spray treatments, and their interactions on maize plant and ear height, stem diameter, ear leaf area, ear length, ear diameter, number of rows, number of grains per row, and ear weight throughout the 2020 and 2021 growing seasons.

Characters Treatments		Plant height (cm)		Ear height (cm)		Stem diameter (cm)		Ear leaf area (cm^2)		Ear length (cm)		Ear diameter (cm)		Number of rows/ear		Number of grains/row		Ear weight (g)	
		2020	2021	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
A. Irrigation intervals:																			
Irrigation every 14 days		228.4	232.9	119.5	121.8	2.266	2.308	649.1	661.1	23.44	23.88	4.16	4.24	12.61	12.85	43.82	44.65	224.5	228.8
Irrigation every 18 days		226.0	230.3	117.3	119.6	2.252	2.294	585.2	596.1	22.57	23.05	3.58	3.65	12.26	12.50	43.13	43.95	223.7	228.0
Irrigation every 22 days		224.2	228.6	116.4	118.7	2.235	2.278	531.1	541.3	21.92	22.35	3.47	3.53	12.02	12.26	42.42	43.23	222.7	227.0
LSD at 5 %		1.8	1.9	2.5	2.1	0.012	0.013	23.9	22.6	0.27	0.25	0.26	0.28	0.31	0.30	0.16	0.15	0.6	0.5
B. Foliar application treatments:																			
Without		212.7	216.9	105.6	107.6	1.814	1.844	362.6	369.3	21.22	21.63	2.45	2.50	10.78	10.99	36.81	37.51	159.4	162.5
Water		221.4	225.6	107.5	109.6	1.911	1.948	426.4	434.4	21.31	21.71	3.40	3.46	11.91	12.15	39.50	40.26	171.8	175.1
Salicylic acid		227.3	231.7	119.0	121.2	2.058	2.094	593.4	604.6	22.20	22.65	3.51	3.57	12.95	13.20	42.00	42.80	204.2	208.1
Agrispon		232.1	236.6	123.1	125.4	2.708	2.762	722.3	736.4	23.63	24.09	4.21	4.29	12.60	12.84	46.53	47.39	274.9	280.5
PotaMac-25		237.5	242.2	133.8	136.3	2.764	2.818	837.6	852.7	24.86	25.39	5.12	5.21	13.25	13.51	50.78	51.77	307.9	313.4
LSD at 5 %		9.4	9.7	3.4	3.3	0.154	0.166	56.6	55.2	0.55	0.54	0.43	0.40	0.95	0.97	1.88	1.92	2.8	2.5
C. Interaction :																			
Irrigation every 14 days	Without	214.6	218.9	110.5	112.6	1.827	1.857	393.2	400.2	22.06	22.49	3.23	3.29	11.40	11.61	37.80	38.52	159.9	163.0
	Water	223.3	227.5	108.5	110.6	1.923	1.960	476.5	485.5	22.40	22.82	3.73	3.80	12.20	12.44	40.00	40.77	172.8	176.1
	Salicylic acid	230.6	235.1	119.9	122.2	2.070	2.107	656.1	668.5	23.00	23.44	4.03	4.11	13.06	13.32	42.80	43.61	205.0	209.0
	Agrispon	234.0	238.6	124.1	126.5	2.720	2.773	796.7	812.2	24.33	24.80	4.50	4.59	13.00	13.25	47.23	48.10	275.8	281.4
	PotaMac-25	239.6	244.4	134.8	137.4	2.790	2.843	922.9	939.2	25.40	25.88	5.30	5.39	13.40	13.66	51.26	52.27	308.8	314.3
Irrigation every 18 days	Without	212.6	216.8	103.5	105.5	1.813	1.843	353.2	359.9	21.30	21.71	2.10	2.14	10.70	10.90	36.83	37.53	159.6	162.7
	Water	221.6	225.8	107.5	109.6	1.910	1.947	423.3	431.2	21.26	21.67	3.30	3.36	11.80	12.04	39.60	40.36	171.8	175.1
	Salicylic acid	226.6	231.0	118.9	121.1	2.057	2.093	580.7	591.4	22.30	22.80	3.30	3.36	12.96	13.22	42.10	42.90	204.0	207.9
	Agrispon	232.0	236.5	123.1	125.4	2.707	2.760	722.7	736.8	23.33	23.79	4.10	4.17	12.60	12.84	46.53	47.39	274.8	280.4
	PotaMac-25	237.0	241.7	133.8	136.3	2.773	2.827	846.0	861.1	24.66	25.30	5.13	5.22	13.26	13.52	50.60	51.58	308.1	313.7
Irrigation every 22 days	Without	211.0	215.1	102.8	104.7	1.803	1.833	341.5	347.9	20.30	20.69	2.03	2.07	10.26	10.47	35.80	36.48	158.6	161.7
	Water	219.3	223.4	106.5	108.6	1.900	1.937	379.3	386.6	20.26	20.65	3.16	3.23	11.73	11.97	38.90	39.65	170.8	174.1
	Salicylic acid	224.6	228.9	118.2	120.4	2.047	2.083	543.5	554.1	21.30	21.71	3.20	3.25	12.83	13.08	41.10	41.88	203.5	207.4
	Agrispon	230.3	234.8	122.1	124.4	2.697	2.753	647.5	660.1	23.23	23.68	4.03	4.11	12.20	12.42	45.83	46.69	274.1	279.7
	PotaMac-25	236.0	240.6	132.8	135.3	2.730	2.783	743.9	757.9	24.53	25.00	4.93	5.02	13.10	13.35	50.50	51.48	306.8	312.3
LSD at 5 %		2.5	2.8	4.2	4.6	0.025	0.022	24.0	24.2	0.42	0.45	0.34	0.35	0.65	0.60	0.75	0.72	0.78	0.75

Table 3. The impact of irrigation intervals, foliar spray treatments, and their interactions on maize ear grains weight, shelling percentage, 100-grain weight, grain and stover yields/fed, crude protein, oil, phosphorus (P) and potassium (K) percentages during 2020 and 2021 seasons.

Characters Treatments		Ear grains weight (g)		Shelling (%)		100-grain weight (g)		Grain yield (ardab/fed)		Stover yield (t/fed)		Crude protein (%)		Oil (%)		P (%)		K (%)	
		2020	2021	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
A. Irrigation intervals:																			
Irrigation every 14 days		172.1	175.4	77.27	77.28	43.88	44.72	25.88	26.38	6.773	6.900	13.87	14.14	6.59	6.71	0.299	0.304	0.315	0.321
Irrigation every 18 days		171.2	174.5	77.17	77.18	43.32	44.15	24.96	25.43	6.019	6.133	13.65	14.04	6.04	6.15	0.281	0.286	0.301	0.307
Irrigation every 22 days		170.2	173.4	77.06	77.05	42.99	43.80	24.29	24.76	5.928	6.038	13.64	13.71	6.01	6.12	0.265	0.270	0.287	0.293
LSD at 5 %		0.28	0.25	0.07	0.08	0.85	0.82	0.77	0.79	0.153	0.160	0.11	0.15	0.16	0.15	0.009	0.008	0.002	0.003
B. Foliar application treatments:																			
Without		123.2	125.5	74.31	74.33	37.70	38.42	21.53	21.94	5.206	5.306	11.97	12.20	5.72	5.83	0.174	0.177	0.233	0.238
Water		138.4	141.1	76.44	76.45	38.73	39.47	21.95	22.38	5.740	5.850	12.79	13.02	5.51	5.62	0.233	0.238	0.254	0.259
Salicylic acid		156.5	159.6	76.67	76.65	41.77	42.55	23.40	23.86	6.294	6.408	13.59	13.85	5.69	5.80	0.268	0.273	0.284	0.290
Agrispon		202.9	206.8	77.48	77.49	47.95	48.85	28.01	28.53	6.748	6.878	14.43	14.68	6.49	6.61	0.337	0.342	0.334	0.340
PotaMac-25		234.8	239.3	80.93	80.96	50.84	51.81	30.33	30.91	7.212	7.343	15.82	16.06	7.64	7.79	0.396	0.403	0.399	0.406
LSD at 5 %		1.9	2.2	1.39	1.35	1.27	1.24	0.93	0.88	0.397	0.390	0.33	0.38	0.29	0.27	0.027	0.025	0.020	0.019
C. Interaction:																			
Irrigation every 14 days	Without	123.4	125.7	74.33	74.35	37.91	38.64	22.53	22.96	6.028	6.148	12.05	12.28	5.74	5.85	0.193	0.197	0.247	0.251
	Water	139.5	142.2	76.66	76.67	39.73	40.49	22.95	23.40	6.421	6.544	12.94	13.17	5.97	6.08	0.253	0.258	0.270	0.275
	Salicylic acid	157.6	160.7	76.89	76.87	41.53	42.34	23.96	24.43	6.962	7.089	13.68	13.94	6.38	6.50	0.280	0.285	0.297	0.302
	Agrispon	203.7	207.6	77.37	77.39	48.63	49.55	29.13	29.68	7.197	7.330	14.67	14.87	7.16	7.29	0.353	0.359	0.350	0.356
	PotaMac-25	236.1	240.7	81.10	81.12	51.62	52.60	30.84	31.43	7.258	7.391	16.00	16.45	7.71	7.85	0.413	0.421	0.410	0.418
Irrigation every 18 days	Without	123.1	125.4	74.40	74.42	37.81	38.53	21.53	21.94	4.962	5.059	12.00	12.22	5.73	5.83	0.173	0.176	0.233	0.238
	Water	138.5	141.2	76.40	76.40	38.73	39.48	21.95	22.38	5.421	5.524	12.80	13.04	5.30	5.40	0.233	0.238	0.257	0.261
	Salicylic acid	156.6	159.7	76.78	76.76	41.17	41.97	23.62	24.08	5.962	6.070	13.60	13.87	5.37	5.47	0.263	0.269	0.283	0.289
	Agrispon	203.0	206.9	77.30	77.31	47.93	48.83	27.12	27.59	6.527	6.656	14.37	14.65	6.16	6.28	0.337	0.342	0.333	0.339
	PotaMac-25	234.8	239.3	81.00	81.03	50.95	51.92	30.57	31.15	7.223	7.355	15.45	16.42	7.63	7.78	0.397	0.404	0.400	0.407
Irrigation every 22 days	Without	123.0	125.3	74.21	74.21	37.38	38.10	20.53	20.92	4.628	4.710	11.86	12.09	5.70	5.80	0.157	0.159	0.220	0.225
	Water	137.2	139.8	76.27	76.27	37.73	38.46	20.95	21.36	5.380	5.482	12.63	12.86	5.28	5.38	0.213	0.217	0.237	0.241
	Salicylic acid	155.3	158.3	76.33	76.32	42.61	43.36	22.62	23.07	5.957	6.064	13.47	13.73	5.33	5.43	0.260	0.265	0.273	0.279
	Agrispon	202.0	205.8	77.76	77.75	47.28	48.19	27.78	28.32	6.520	6.649	14.26	14.53	6.14	6.26	0.320	0.325	0.320	0.326
	PotaMac-25	233.4	238.0	80.70	80.71	49.95	50.90	29.57	30.14	7.153	7.284	16.02	15.32	7.59	7.73	0.377	0.384	0.387	0.394
LSD at 5 %		0.62	0.64	0.34	0.35	2.41	2.35	1.30	1.36	0.412	0.420	0.42	0.45	0.25	0.26	0.018	0.015	0.010	0.008

3- Effect of interaction:

Regarding the impact of irrigation intervals and foliar application treatments interactions on the growth characteristics of maize, such as plant & height; stem diameter; ear leaf area; yield and its characteristics, such as ear length; ear diameter; number of rows/ear; number of grains/row; ear weight; ear grains weight; shelling percentage; 100-grain weight; grain & stover yields/fed, and grains quality, such as crude protein; oil; phosphorus, and potassium percentage (Tables 2 and 3).

The highest values of most characteristics of maize were obtained from irrigation every 14 days and foliar spraying with PotaMac-25 at the rate of 5 ml/L two times after 35 and 50 days from sowing in both seasons (Tables 2 and 3). Intermediate water stress (irrigation maize plants every 18 days) beside foliar spraying with PotaMac-25 at the rate of 5 ml/L came in the second rank followed irrigation every 14 days (control treatment *i.e.* without water stress) in addition to foliar spraying with Agrispon at the rate of 5 ml/L in both seasons. Whereas, intense water stress (irrigation every 22 days) without foliar application resulted in the lowest values of studied traits of maize in both seasons.

CONCLUSION

Based on the study's findings, it can be concluded that for best output and grain quality, maize plants should get irrigation every 14 days without experiencing water stress, and two foliar applications of PotaMac-25 at a rate of 5 ml/L should be made after 30- and 45-days following planting. Under the local environmental circumstances of Egypt's Dakahlia Governorate's Mansoura District, it may be advised to water maize plants every 18 days (intermediate water stress) in addition to foliar spraying with PotaMac-25 at a rate of 5 ml/L in order to maintain high productivity and grain quality while conserving irrigation water.

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استجابة إنتاجية وجودة حبوب الذرة الشامية لمعاملات الرش الورقي تحت ظروف الإجهاد المائي

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الملخص

يهدف هذا البحث إلى استخدام الرش الورقي بمضادات الأكسدة والمركبات الطبيعية والبوتاسيوم في تقليل أثار الإجهاد المائي وفي نفس الوقت زيادة نمو ومحصول وجودة حبوب الذرة الشامية تحت الظروف البيئية بمنطقة المنصورة - محافظة الدقهلية – مصر، أقيمت التجارب الحقلية بمحطة التجارب والبحوث الزراعية بكلية الزراعة – جامعة المنصورة خلال موسمي 2020 و2021. نفذت التجارب فى تصميم الشرائح المتعامدة في ثلاث مكررات. حيث اشتملت الشرائح الرأسية على ثلاث معاملات للإجهاد المائي معبراً عنها بفترات الري وهي؛ بدون إجهاد مائي (الري كل 14 يومًا)، إجهاد مائي متوسط (الري كل 18 يومًا) وإجهاد مائي شديد (الري كل 22 يومًا). بينما احتوت الشرائح الأفقية على خمس معاملات للرش الورقي وهي؛ بدون رش ورقي (معاملة المقارنة)، الرش الورقي بماء الري، حمض الساليسيليك بمعدل 200 جزء في المليون، أجريسبون بمعدل 5 مل/لتر و PotaMac-25 بمعدل 5 مل/لتر. تشير النتائج المتحصل عليها أن أعلى القيم لجميع صفات النمو والمحصول ومكوناته وصفات جودة الحبوب نتجت من معاملة بدون إجهاد مائي لنباتات الذرة الشامية (الري كل 14 يوماً) والرش الورقي بمركب PotaMac-25 كمصدر للسماد البوتاسي بمعدل 5 مل/لتر. من النتائج التي تم الحصول عليها من هذه الدراسة يمكن التوصية بري نباتات الذرة الشامية كل 14 يومًا بدون إجهاد مائي والرش الورقي بمركب PotaMac-25 بمعدل 5 مل/لتر مرتين بعد 30 و 45 يومًا من الزراعة لتحقيق أقصى إنتاجية وجودة الحبوب. بينما للحفاظ على الإنتاجية والجودة العالية للحبوب وفي نفس الوقت توفير مياه الري، يمكن التوصية بري نباتات الذرة كل 18 يومًا (إجهاد مائي متوسط) بجانب الرش الورقي بمركب PotaMac-25 بمعدل 5 مل/ لتر تحت الظروف البيئية بمنطقة المنصورة - محافظة الدقهلية – مصر.