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EFFECT OF POLYMER AND FULVIC ACID ON WHEAT (*TRITICUM AESTIVUM* (L.) PRODUCTIVITY IN SANDY SOILS UNDER ENVIRONMENTAL STRESSES IN EGYPT

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Field experiments were carried out at Experimental Farm of the Desert Research Center, El-Kharga Oasis, New Valley Governorate, during the two consecutive seasons of 2019/ 2020 and 2020/ 2021. The experiments were conducted to study the effect of application of super absorbent polymer (SAP) (0, 30, 60, and 90 kg fed^{-1} and foliar spraying with fulvic acid (FA) at (0, 2, 4, and 6 g L^{-1}) on yield and yield components and grain chemical composition on wheat (*Triticum aestivum* L.) cv. (Misr - 2). under sandy soil conditions. Results showed that yield as well as the components and quality traits of wheat were significantly affected by SAP in both seasons. The highest value of these traits was obtained with using the highest rate of SAP, 90 kg fed^{-1}. Increasing the levels of FA from 0 to 6 g L^{-1} caused significant increases in all studied wheat traits during both seasons. The highest yield and its components were obtained with 4 g L^{-1} and the lowest were with control treatment of FA in both seasons. The highest values of these traits i.e. nitrogen, phosphorous, potassium, protein, and carbohydrates were obtained with FA (6 g L^{-1}), while the lowest was with control treatment in both seasons. Raising SAP and FA levels up to 90 kg fed^{-1} and 6 g L^{-1} led to a significant increase in all studied parameters in both seasons.

Keywords: wheat, super absorbent polymer (SAP), fulvic acid, yield

INTRODUCTION

Wheat is the most widely grown food crop in the world. In Egypt, wheat is one of the most important winter crops, occupying over 30% of the total cultivated area. Its production is about 7.5 million tons per year (Ministry of Agriculture, Egypt 2019). The difference between the production and consumption of wheat represents about 40% of the national demands imported from foreign markets. For these reasons, efforts should be directed for increasing and improving the wheat productivity, in order to reduce this gap. Therefore, the desert fringes of the Nile Valley and Delta cab be reclaimed.

The new reclaimed sandy soil in Egypt is considered a large part of the desert, which is exposed to a combination of environmental stress conditions including temperature fluctuations, low water availability and nutrient deprivation (El-Ramady et al., 2013). In this respect, one of the most suitable locations is the New Valley region with its Oases, which represents large land resources and good hope for agriculture expansion, which located in the Western Desert of Egypt. It represents 38% (376000.51 km^2) of the total area of Egypt and has about 3.5 million feddan available to cultivation.

Increasing productive lands is one of the major targets of the Egyptian agricultural policy. The productivity of sandy soils is mostly limited by several agronomic obstacles. Also, water availability is often the important limiting factor determining the cultivated area in such sandy soils. It has very low specific surface area caused its inert chemical and biological conditions. The fertility levels of such soils are very poor with respect to their physical, chemical, and biological properties. The use of soil conditioners like super absorbent polymer (SAP) has a great potential to exploit the existing water in the soil for agricultural crops by increasing their production. When polymers are incorporated into the soil, it is presumed that they retain large quantities of water and nutrients, which are released as required by the plant (Kolybaba et al., 2006). Thus, plant growth could be improved with a limited water supply (Islam et al., 2011). The incorporation of super absorbent polymer in soil enhances seed germination and emergence, crop growth and yield and reduce the irrigation requirement of wheat plants (Yazdani et al., 2017). For most plants, less than 5% of the water absorbed by roots is used for crop growth while the remaining 95% is transpired (Prakash and Ramachandran, 2010). Super absorbent polymers can hold 400-1500 g of water per dry gram. The use of super absorbent polymers has great importance for their role in the increase of water absorption capacity and retention of water shortage conditions and the decrease of bad effects of drought stress (Rostampour, 2015). Islam et al. (2011) obtained significant increase in grain yield and 1000-grain weight of wheat with the application of polymer 200 kg ha^{-1} as compared to control. The maximum grain yield of wheat (1.954 ton f^{-1}) was obtained with the application of polymer at 90 kg f^{1} which was significantly higher over control by 25.7%. The higher grain yield with the application of polymer 90 kg f^{-1} might be attributed to improved yield components viz., higher number of tiller $plant^{-1}$, number of grains $spike^{-1}$, spike length, weight of grains $spike^{-1}$ and 1000-grain weight. Super absorbed polymer stored water and nutrient are released slowly as required by plant to improve growth under limited water supply (Yazdani et al., 2017). Also, Yang et al. (2020) have found that the water evaporation rate was decreased in sandy soil by adding super absorbent polymer compared to the soil without SAP. The application of SAP resulted in significantly improved effective tillers by 19.61%, spike length by 15.70%, 1000 grain weight by 26% over control (Khodadadi, 2018).

Spraying with fulvic acid is considered one of the most important practices that reduce the negative effects of drought in desert environments. Such stress may lead to reduce plant growth by affecting various physiological and biochemical processes, such as photosynthesis, respiration, translocation, ion uptake, carbohydrates, nutrient metabolism and growth promoters (Jaleel et al., 2017). Anjum et al. (2018) demonstrated that spraying wheat plants with fulvic acid can decrease the water stress impacts or the stress imposed by hot, dry winds during spike development with increase the grain yield by 36%. Li et al. (2019) reported that foliar application of fulvic acid increased chlorophyll and water content of wheat leaves. It also increased the number and length of root hairs, photosynthesis, reduced stomata opening status and transpirations, thus leading to growth stimulation and water loss reduction. Furthermore, fulvic acid as metabolic anti-transpirations is an organic acid, nontoxic, cheap and did not cause pollution problems as a result of extensive use (Nardi et al., 2012). Furthermore, Hanaa et al. (2019) indicated that spraying of wheat plants by fulvic acid led to a significant increase in all the studied traits, as the highest values for these traits were obtained when spraying at a rate of 6 g L^{-1} without significant difference with the 3 g L^{-1} of fulvic acid. Whereas, the percentage of increases compared to control were 32% in plant height 34% in number of grain $spike^{-1}$, 39% in 1000 grain weight and 43% in grain yield. Application of fulvic acid as foliar sprays can improve the growth of plant foliage, roots and yield by increasing plant growth processes within the leaves, as an increase in carbohydrates content of the leaves and stems occurs (Khatab et al., 2013). Abd El-Kader (2016) stated that the spraying of wheat with fulvic acid at a concentration 4 g L^{-1} significantly increased 1000 grain weight, grain yield and biological yield of wheat by 8.62, 26.47, and 69.91%, respectively, compared with control treatment. The study was conducted to study the effect of polymer and fulvic acid spraying and their combinational interaction on wheat productivity.

MATERIALS AND METHODS

1. Location, Soil Properties and Climate of Experimental Site

A field experiment was carried out in a sandy soil at Agricultural Experiment Station at EL-Kharga Oasis (27°47.7 42 N, 30°24.7 63 E) that dependent of Desert Research Center (DRC), New Valley Governorate, during the two winter growing seasons of 2019/ 2020 and 2020/ 2021. The study was conducted to study the effect of polymer and fulvic acid spraying and their combinational interaction on wheat productivity. The physical and chemical soil characteristics of the studied site were determined according to Klute (1986), as recorded in table (1). The chemical analysis of irrigation water was carried out using the standard method of Page et al. (1982) and presented in table (2). As well, the metrological data of the region during the growing seasons are shown in table (3).

Table (1). Physical and chemical properties of the experimental soil in the two successive years 2019/2020 & 2020/2021.

Season	Particles (%)			Texture	(ppm)	pH	Available cations					Available anions (meq/l)			
	Sand	Silt	Clay				P (ppm)	K (ppm)	Na (ppm)	Ca (meq/l)	Mg (meq/l)	$CO_3^{=}$	HCO_3^-	Cl^-	SO_4^{--}
2019/ 2020	79.5	13.1	7.4	Sandy	734	7.7	0.40	31	4.54	3.50	2.79	-	4.11	8.3	7.29
2020/ 2021	78.1	14.0	7.9		714	7.6	0.42	35	4.15	3.71	3.24	-	4.87	9.6	7.34

Table (2). Chemical analysis of irrigation water in the two successive years 2019/2020 & 2020/2021.

Season	pH	E.C. (ds/m)	S.A.R	Soluble cations (meq/l)				Soluble anions (meq/l)			
				Ca^{++}	Mg^{++}	Na^+	K^+	$CO_3^{=}$	HCO_3^-	$SO4^{=}$	Cl^-
2019/ 2020	7.70	1.17	6.58	13.68	2.74	11.82	0.37	-	5.43	4.37	9.47
2020/ 2021	7.84	1.12	5.14	15.32	2.93	10.51	0.48	-	5.69	4.76	10.24

2. Experimental Treatments

The experiment included 16 treatments which were the combinations between four rates of polymer in the form super absorbent polymers (SAP) and four concentrations of fulvic acid as a foliar application:

2.1. Super absorbent polymer (SAP)

Polymer was used as broadcast a soil conditioner in the form of super absorbent polymer (SAP) at the rates of 0.0, 30, 60 and 90 kg fed^{-1}. As the rate of 30 kg fed^{-1} of SAP means adding 75 g /experimental unit (10.5 m^2), mixed well with the recommended rate of calcium superphosphate fertilizer (15.5% P2O5) as the rate of 100 kg fed^{-1} and potassium sulfate fertilizer (48% K2O) as the rate of 50 kg fed^{-1} which is equal to 250 g calcium superphosphate + 125 g potassium sulfate). Therefore, 60 kg of SAP means adding 150 g of polymers to each experimental unit (10.5 m^2) that is mixed with the same previous rates of mineral fertilizers, and similarly a rate of 90 kg fed^{-1} of polymers means adding 225 g of polymer per experimental unit (10.5 m^2) and mixing it with the same rates as the previous mineral fertilizer where mixed completely into the top 10 cm soil layer during soil preparation.

2.2. Fulvic acid (FA)

At tillering, elongation and heading stages i.e. 35, 55, 75 days after sowing dates respectively of wheat, fulvic acid (70%) was sprayed onto the entire plant canopy with electrical sprayer rates 0.0, 2, 4 and 6 g L^{-1} in the afternoon, while in the conventional treatments (control), plants were sprayed with equal amounts of tap water only.

Table (3). The meteorological data of EL-Kharga Oasis during wheat growing in the two successive seasons 2019/ 2020 & 2020/ 2021.

Season	Month	Temperature		Mean Humidity (%)	Average Evapo-transpiration Reference (mm)	Rain (mm/month)
		Maximum °C	Minimum °C			
2019/ 2020	**November**	29.1	11.3	42.5	5.5	-
	December	26.2	14.5	49.3	4.1	-
	January	26.7	9.0	44.1	4.8	-
	February	26.1	11.7	41.2	5.2	-
	March	31.8	15.1	33.5	6.3	-
	April	37.9	19.8	27.0	7.6	-
2020/ 2021	**November**	29.6	11.4	43.6	5.7	-
	December	26.5	14.9	50.7	4.6	-
	January	27.1	9.7	45.4	5.1	-
	February	27.4	12.2	42.8	5.4	-
	March	32.0	16.5	32.1	6.7	-
	April	39.2	22.6	28.4	8.4	-

3. Agricultural Practices

Wheat (Misr2 cv.) was sown on the 15th of November in both seasons. A recommended nitrogen dose of 75 kg fed^{-1} was supplied in two equal doses: the first, during tillering stage and the second at the heading stage, as ammonium sulfate (21% N). Phosphate dose of 100 kg fed^{-1} as basal as triple superphosphate (15.5% P_2O_5) and potassium dose of 50 kg fed^{-1} as potassium sulphate (48% K_2O) plus the addition of 5 m^3 poultry manure/ fed were supplied during the soil preparation at sowing. The growth periods of wheat plants were 144 and 141 days in 2019/2020 and 2020/2021 growing seasons, respectively. The irrigation system used was sprinkler irrigation, the experimental unit was 10.5 m^2 (3 m x 3.5 m). All recommended common agricultural practices were adopted throughout the two experimental seasons till the harvest; the preceding summer crop was peanut in both seasons.

4. Sampling and Measurements

At harvest, Samples of 10 plants plot^{-1} were taken randomly from the middle of plot for each treatment to determine the following characters: 1- yield and its components: number of spikes/ m^2, spike length cm, spikes weight g, number of grains spike $^{-1}$, 1000-grain weight g, grain yield kg fed^{-1}, straw yield kg fed^{-1} and harvest index (%) and 2- chemical composition of wheat grains (quality traits): percentages of N, P, K, protein and total carbohydrates %.

Whereas, at harvest grain yield (Kg) of each plot were recorded and then transformed into yield Kg fed^{-1}.

- Harvest index (%) was computed by using the formula as followed, HI (%) = Grain yield / Biological yield x 100.
- Total nitrogen was determined using modified micro-Kjeldahl method as described by Peach and Tracey (1956). The crude protein content was calculated by multiply by 5.7 to obtain the crude protein percentage.
- Total available carbohydrates were extracted according to Smith *et. al.,* 1964 and estimated calorimetrically by phenol-sulphuric acid method as described by Montogomery (1961).
- Potassium content percentage was determined photo-metrically using flame photometer model concerning as described by Johnson and Ulrich (1959).
- Phosphorus content percentage determined using the method described by John (1970).

5. Experimental Design and Data Analysis

The experiment was laid out in split plot design with three replications. Where, the main plots were occupied with fulvic acid foliar treatments, the sub plots allotted with polymers treatments. All the obtained data were subjected to analysis of variance according to the method described by Gomez and Gomez (1984). Means comparison were done using least significant difference (LSD) at 5% level of probability.

RESULTS AND DISCUSSION

1. Effect of Super Absorbent Polymer (SAP)

Data in table (4) show that yield and its components and quality traits of wheat were significantly affected by SAP in both seasons excluding, number of spikes m^{-2} and number of grains $spike^{-1}$ don't reach to significant in both seasons. The highest values of these traits were obtained when using the highest rate of SAP, 90 kg fed^{-1} without significant difference with the 60 kg fed^{-1} in regard to yield and its components parameters in both seasons. Whereas, The application of this rate of SAP (90 kg fed^{-1}) scored an increase in spike length by 52.29 and 54.65%, spike weight by 92.57 and 97. 42%, 1000-grain weight by 21.47 and 13.62%, grain yield by 47.41 and 49.44%,

Table (4). Effect of super absorbent polymer (SAP) on yield and its components and quality of wheat during 2019/ 2020 and 2020/ 2021 growing seasons in sandy soils under New Valley conditions.

Characters / SAP (kg $f.^{-1}$)	No. of spikes m^{-2}	Spike length (cm)	Spike weight (g)	No. of grains $spike^{-1}$	1000-grain weight (g)	Grain yield (kg $f.^{-1}$)	Straw yield (kg $f.^{-1}$)	Harvest index (%)	WUE (kg/ m^3)	N (%)	P (%)	K (%)	Protein (%)	Total carbohydrates (%)
						2019/ 2020								
0	367.1	7.63	2.02	39.22	37.21	1740	2868	37.76	0.510	1.46	0.174	0.261	8.41	54.10
30	374.6	9.34	2.74	40.12	40.62	1968	3076	39.02	0.632	1.89	0.215	0.297	10.84	60.41
60	392.6	11.41	3.80	43.64	44.87	2538	3740	40.32	0.719	2.02	0.247	0.321	12.75	63.78
90	398.3	11.62	3.89	44.71	45.20	2565	3775	40.46	0.751	2.27	0.286	0.338	13.18	65.23
LSD at 5%	NS	0.25	0.11	NS	0.51	30	36	1.12	0.034	0.18	0.29	0.10	0.33	1.55
						2020/ 2021								
0	359.3	7.21	1.94	39.01	36.96	1689	2847	36.06	0.497	1.45	0.168	0.255	8.36	53.99
30	368.4	9.02	2.66	39.80	39.21	2005	3189	38.60	0.617	1.83	0.203	0.286	10.52	59.84
60	390.8	10.98	3.72	42.95	43.92	2517	3694	40.42	0.690	1.94	0.234	0.303	12.61	63.17
90	394.1	11.15	3.83	43.11	44.10	2524	3721	38.55	0.722	2.25	0.275	0.323	13.00	64.71
LSD at 5%	NS	0.21	0.15	NS	0.23	35	39	1.17	0.074	0.16	0.31	0.14	0.28	1.42

straw yield by 31.62 and 30.70%, harvest index by 7.15 and 6.91%, WUE by 47.25 and 45.27%, nitrogen content of grains by 55.48 and 55.17%, phosphorus content of grains by 64.37 and 63.69%, potassium content of grains by 29.50 and 26.67%, protein content of grains by 56.72 and 55.05% and carbohydrates content of grains by 20.57 and 19.86% in the first and second growing seasons, respectively as compared with control.

The significant enhancement of these traits as a result of using the highest rate of SAP may be due to the fact that 90 kg fed^{-1} may be sufficient in soil retaining the amount of water that ensures reaching the highest possible growth rate and the highest percentage of dissolved nutrients in the water which reflects positively on increasing these values (Islam et al., 2011 and Haghighi and Afifi, 2014). These findings might be attributed to that SAP could absorb and store water up to several times of their own weight. Due to the drying up of the environment, the water retained in the SAP is gradually discharged and thus the soil would remain moist for a long time. This property has great importance in confronting water shortage and reducing the harmful effects of drought stress in desert areas which reflects positively on improving growth and development and increasing yield components and quality of the crop under sandy soils conditions. The positive response of sunflower productivity to SAP application was described by several investigators (Najafi et al., 2010; Wu and Liang, 2017; Yazdani et al., 2017; Khodadadi, 2018; Podolska, 2018 and Shukra et al., 2019).

2. Effect of Fulvic Acid Foliar Application (FA)

Data in table (5) show that increasing spraying levels of FA from 0.0 (control treatment) to 6 g L^{-1} caused a significant increase in all studied wheat traits during both seasons. The highest values of yield and its components traits were obtained at spraying by 4 g L^{-1} of FA, and the lowest was with control treatment in both seasons. When spraying with this rate of FA, the no. of spikes m^{-2} increased by 14.07 and 13.31%, spike length by 70.75 and 69.90%, spike weight by 84.51 and 82.29%, no. of grains spike^{-1} by 26.60 and 18.83%, 1000-grain weight by 29.85 and 28.18%, grain yield by 67.81 and 64.66%, straw yield by 42.20 and 40.94%, harvest index by 10.96 and 9.27% and WUE by 23.70 and 22.36% in 2019/ 2020 and 2020/ 2021 growing seasons respectively, as compared with control treatment. On the other hand, with regard to the grain content of nitrogen, phosphorous, potassium, protein and carbohydrates, the results showed that the highest values of these traits have been obtained at spraying by high level of

Table (5). Effect of foliar application of fulvic acid (FA) on yield and its components and quality of wheat during 2019/ 2020 and 2020/ 2021 growing seasons in sandy soils under New Valley conditions.

Characters / FA (g L^{-1})	No. of spikes m^{-2}	Spike length (cm)	Spike weight (g)	No. of grains $spike^{-1}$	1000-grain weight (g)	Grain yield (kg $f.^{-1}$)	Straw yield (kg $f.^{-1}$)	Harvest index (%)	WUE (kg/ m^3)	N (%)	P (%)	K (%)	Protein (%)	Total carbohydrates (%)
2019/ 2020														
0	355.4	6.94	2.13	36.41	35.24	1652	2775	37.32	0.557	1.550	0.167	0.253	8.91	55.98
2	371.6	9.13	2.87	39.70	38.96	1865	2996	38.37	0.610	1.976	0.188	0.282	11.36	59.52
4	405.8	11.85	3.93	43.91	45.76	2789	3946	41.41	0.689	2.217	0.221	0.310	12.75	64.38
6	388.7	11.64	3.72	41.63	42.38	2448	3727	39.64	0.720	2.362	0.280	0.331	13.58	66.54
LSD at 5%	5.1	0.19	0.17	0.84	1.20	68	85	1.14	0.028	0.089	0.042	0.010	0. 75	1.21
2020/ 2021														
0	342.6	6.91	2.09	35.89	34.85	1647	2733	36.90	0.541	1.502	0.160	0.249	8.89	55.83
2	365.4	9.00	2.80	39.43	37.84	1793	2964	37.69	0.590	1.974	1.174	0.271	10.82	58.74
4	388.2	11.74	3.81	42.65	44.67	2712	3852	40.32	0.662	2.184	0.207	0.302	12.61	62.38
6	362.6	11.52	3.66	40.67	40.19	2385	3693	39.42	0.700	2.334	0.261	0.317	13.30	64.90
LSD at 5%	4.5	0.16	0.14	0.91	1.39	86	72	0.84	0.031	0.097	0.051	0.013	0.61	1.13

FA (6 g L^{-1}), and the lowest were with control treatment in both seasons. Whereas, nitrogen increased by 52.39 and 55.39%, phosphorous by 67.66 and 63.13%, potassium by 30.83 and 27.31%, protein by 52.41 and 49.61% and carbohydrates by 18.86 and 16.25% in the first and the second seasons respectively, as compared with control treatment (nil FA). Fulvic acid has maximum influence on chemical reactions because of the presence of more electronegative oxygen atoms, which enhances membrane permeability (Pascual et al., 2015).

The reason of the superiority of fulvic acid spray compared with control treatment could be due to its role in stimulating plant growth which acts as a respiratory chemical mediator and that leads to an increase in the biological activity of the plant as a result of the increase in the effectiveness of the enzymatic system and cell division and elongation and then an increasing the plant growth (Kumar et al., 2020). In this respect, Xudam et al. (2107) demonstrated that spraying of wheat plants with fulvic acid can decrease the water stress or the stress imposed by hot, dry winds during filling grains and it can increase the grain yield by 28.0%. Anjum et al. (2018) have reported that fulvic acid increased chlorophyll, photosynthesis, water content of wheat leaves, reduced stomata opening status and transpirations thus leading to growth stimulation and water loss reduction finally increased yield and quality under drought conditions. In support of these results, Abd El-Kader (2016) stated that the spraying of wheat with fulvic acid at concentration 4 g L^{-1} significantly increase of 1000 grain weight, grain yield and biological yield of wheat at 8.62, 26.47 and 69.91% respectively compared with control treatment. These results agree with Li et al. (2005), Nardi et al. (2012), Khatab et al. (2013), Abd El-Kader (2016), Anjum et al. (2018), Hanna et al. (2019) and Li et al. (2019).

3. The Interaction Between Super Absorbent Polymer and Fulvic Acid Foliar Treatments

The remarkable influence of the interaction between super absorbent polymer and fulvic acid foliar application on all studied traits were obtained, except no. of grains spike^{-1} and harvest index in the second season only don’t reach to significant as shown in table (6). Herein, the results indicated that adding a high rate of SAP and spraying wheat plants by 4 g L^{-1} of FA gave the maximum values of yield and its components without significant difference with the 60 kg fed^{-1} in both seasons. On the other hand, and with regard to the quality traits under study, the highest values for them haveobtained through the application of both the highest rate of SAP (90 kg fed^{-1}) and the highest rate of FA (6 g L^{-1}) spraying in both seasons. Furthermore, the interaction between without SAP and nil FA foliar application treatment has given the minimal values in both seasons.

Table (6). Effect of the interaction between super absorbent polymer (SAP) and foliar application with fulvic acid on yield and its components and quality of wheat during 2019/ 2020 growing seasons in sandy soils under New Valley conditions.

Factors: FA ($g\ L.^{-1}$)	SAP ($kg\ f.^{-1}$)	No. of spikes m^{-2}	Spike length (cm)	Spike weight (g)	No. of grains $spike^{-1}$	1000-grain weight (g)	Grain yield ($kg\ f.^{-1}$)	Straw yield ($kg\ f.^{-1}$)	HI (%)	WUE ($kg\ m^{-3}$)	N (%)	P (%)	K (%)	Protein (%)	Total carbohydrates (%)
		2020/ 2021													
0	0	351.0	7.01	1.90	37.10	35.91	1625	2787	36.33	0.509	1.426	0.164	0.247	8.61	54.86
	30	355.5	7.92	2.26	37.50	37.03	1826	2961	37.60	0.569	1.616	0.182	0.263	9.69	57.84
	60	366.7	8.90	2.79	39.07	39.39	2082	3214	38.56	0.606	1.671	0.197	0.271	10.74	59.50
	90	368.4	8.98	2.85	39.15	39.48	2096	3232	38.58	0.622	1.831	0.218	0.281	10.93	60.43
2	0	362.4	8.11	2.37	39.22	37.40	1698	2902	36.88	0.544	1.712	0.671	0.263	9.59	56.32
	30	366.9	9.01	2.73	39.62	38.53	1899	3077	38.15	0.604	1.902	0.689	0.279	10.67	59.29
	60	378.1	9.99	3.26	41.19	40.88	2155	3329	39.11	0.640	1.957	0.704	0.287	11.72	60.96
	90	379.8	10.08	3.32	41.27	40.97	2169	3348	39.12	0.656	2.117	0.725	0.297	11.91	61.89
4	0	373.8	9.48	2.88	40.93	40.82	2157	3346	38.69	0.580	1.817	0.188	0.279	10.49	58.14
	30	378.3	10.38	3.24	41.33	41.94	2359	3521	39.96	0.640	2.007	0.205	0.294	11.57	61.11
	60	389.5	11.39	3.79	42.90	44.34	2616	3783	40.82	0.706	2.062	0.221	0.303	12.61	62.78
	90	391.2	11.45	3.82	42.98	44.40	2629	3792	40.94	0.711	2.222	0.241	0.313	12.81	63.71
6	0	361.0	9.37	2.80	39.84	38.58	1994	3267	37.65	0.599	1.897	0.215	0.286	10.93	59.90
	30	365.5	10.27	3.16	40.24	39.70	2195	3441	38.92	0.659	2.087	0.232	0.302	12.01	62.87
	60	376.7	11.25	3.69	41.81	42.06	2451	3694	39.88	0.695	2.142	0.248	0.310	13.06	64.54
	90	378.4	11.34	3.75	41.89	42.15	2466	3712	39.90	0.692	2.302	0.268	0.320	13.25	65.47
LSD at 5%		0.6	0.07	0.04	NS	0.08	12	13	NS	0.008	0.027	0.010	0.005	0.12	0.33

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تأثير البوليمر وحمض الفولفيك على إنتاجية القمح في التربة الرملية تحت ظروف الإجهادات البيئية في مصر

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أقيمت تجربتان حقليتان بالمزرعة البحثية بالخارجة التابعة لمركز بحوث الصحراء بمحافظة الوادي الجديد خلال موسمي ٢٠١٩/ ٢٠٢٠ و ٢٠٢٠/٢٠٢١. لدراسة تأثير اضافة معدلات من البوليمر والرش بحامض الفولفيك على إنتاجية القمح في الأراضي الرملية بمحافظة الوادي الجديد. أظهرت النتائج تأثر المحصول ومكوناته وصفات الجودة للقمح معنويًا بمعدلات البوليمر في كلا الموسمين باستثناء عدد السنابل/ م^2 وعدد حبوب السنبلة لم تتأثر معنويًا بهذه المعاملة في كلا الموسمين. تم الحصول على أعلى قيم لهذه الصفات عند استخدام أعلى معدل من البوليمر (٩٠ كجم/ ف) بدون فرق معنوي مع ٦٠ كجم/ ف فيما يتعلق بصفات المحصول ومكوناته في كلا الموسمين. أدت زيادة مستويات الرش بحامض الفولفيك من صفر (معاملة المقارنة) إلى ٦ جم/ لتر إلى زيادة معنوية في جميع صفات القمح المدروسة خلال الموسمين. تم الحصول على أعلى قيم للمحصول وصفات مكوناته عند الرش بمعدل ٤ جم/ لتر من حامض الفولفيك، وأقلها كانت مع معاملة المقارنة في كلا الموسمين. من ناحية أخرى، فيما يتعلق بمحتوى الحبوب من النيتروجين، الفوسفور، البوتاسيوم، البروتين والكربوهيدرات، أظهرت النتائج أن أعلى قيم هذه الصفات تم الحصول عليها عند الرش بأعلى مستوى من حامض الفولفيك (٦ جم/ لتر) وأقلها كانت مع معاملة المقارنة في الموسمين. فيما يتعلق بالتفاعل بين عاملي الدراسة، أظهرت النتائج تأثر جميع الصفات المدروسة معنويًا ماعدا عدد حبوب السنبلة ودليل الحصاد في الموسم الثاني فقط لم يصلا إلى درجة المعنوية. أشارت النتائج إلى أن إضافة أعلى معدل من البوليمر ورش نباتات القمح بمعدل ٤ جم/ لتر من حامض الفولفيك أعطت أعلى القيم للمحصول ومكوناته دون اختلاف معنوي مع المستوى الأقل (٦٠ كجم/ ف) في كلا الموسمين. من ناحية أخرى، فيما يتعلق بصفات الجودة، تم الحصول على أعلى القيم لها من خلال استخدام أعلى معدل من البوليمر (٩٠ كجم/ ف) وأيضًا أعلى معدل رش بحامض الفولفيك (٦ جم/ لتر) في كلا الموسمين. وبخلاف ذلك، أعطى التفاعل بين معاملتي المقارنة لكل من البوليمر والرش بحامض الفولفيك أقل القيم في كلا الموسمين.