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Influence of Foliar Application of Potassium Humate and Proline on Wheat Growth and Productivity Grown in Saline Soil

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ABSTRACT

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Two field trials on wheat (*Triticum aestivum* L.; Variety Misr ¹), were conducted at Tag El-Ezz Agricultural Research Station, Agricultural Research Centre (ARC), Dakahlia Governorate, Egypt during two successive winter seasons of 2016/17 and 2017/18. The experimental area were located at 30° 95' 7034" N latitude and 31° 60' 0219' E longitude. The experiment treatments were included two factors 1) potassium humate (KH) at three levels (i.e. control, 3%, 6% of spraying solutions) and 2) proline (P) at three rates (i. e. control, 50, 100 mgl⁻¹). The two factors were layout in a split plot design with three replicates, where the potassium humate and proline treatments were located randomly in the main and sub plots, respectively. The obtained results indicated that addition of potassium humate 6% with proline at 100 mgl⁻¹ gave the highest values of N, P and K % in wheat grains and straw, protein content and also gave the highest grains yield, compared with control treatment, so that the combined treatment of potassium humate 6% with proline 100 mgl⁻¹ was considered as most suitable treatment for obtaining the highest wheat yield under these experimental conditions. In addition to reduce the negative effects of salt stress on wheat plants.

Keywords: Wheat, Soil fertility, Potassium humate, Proline, Saline soil and Salt stress.

INTRODUCTION

The most important human nutritional cereals in the majority of countries worldwide is wheat (*Triticum aestivum* L.,). This plant was moderately salt tolerant and often cultivated on recently recovered Egyptian salt affected soils. On the other hand, weight-reduction in wheat growth and productivity would limit or even prevent cultivation in such soils. The salinity stress was one of the biggest agricultural problems in arid and semiarid areas. Because of the osmosis and ionic stress at the cellular level and throughout the plant, salt stresses affect plant physiology. It causes a physiological drought by affecting the water relationship between plants and soil Munns, (2002).

Even though humic substances had a positive influence on vegetable visibility, those chemicals were widely used by farmers rather than by other substances such as pesticides and so on. Humic acid (HA) was significantly less molecular and more bioactive in weight. Delfine, et al. (2005) reported that foliar application of humic acid caused a transitional production of plant dry mass, grain yield and grain protein content. Asik, et al. (2009) stated that foliar application of humic acid increased the uptake of P, K, Mg, Cu and Zn on wheat plants. Khaled and Fawy (2011) found that foliar application in 0.1% humic acid treatment increased the dry weight, N, P, K, Ca, Mg, Na, Fe, Zn, and Mn amounts in plants which treated with 60 mM NaCl treatment compared with the control. Bakry, et al. (2013) concluded that foliar spraying wheat plants with humic acid at 13 mg/L significantly increased growth, yield components and grain yield. Kandil, et al. (2016) showed that foliar spraving with mixture of humic and amino acids resulted the highest

values of yield attributes and increased grain and straw yields, protein and carbohydrates contents in wheat grains. Desoky, *et al.*(2017) concluded that either of potassium or proline at the rate of 0.1 and 0.2 % increased yield and its components (dry weight of grains /plant, number of spikes/plant, number of grains/plant, number of grains/spike, and1000-grains weight).

Proline acts as an osmolyte and antioxidant that helps plants maintain cell turgor survival. It is a protein genic amino acid with high conformational rigidity that was required for primary metabolism. Since the first report on proline accumulation in wilting perennial rye grass, there had been a lot of progress Huang, *et al.* (2000).

Proline is one of the major amino acids produced and accumulated by salinity stress in the plant Marín Velázquez, et al. (2010). Aggarwal, et al. (2011) illustrated that, the exogenous application of proline increases the endogenous level of proline and intermediate enzymes in plants in bean. Proline is an amino acid that played an extremely positive role in plants which exposed to different stresses. In addition to being an outstanding osmolyte, proline played three main roles in stress, i.e. as a chelator for metals, antioxidant defence and signaling molecules. Proline functions as a radical scavenger, but not only as a compatible osmolyte. Proline therefore exhibited a dual role as an osmolyte and an antioxidant component. Proline accumulation in plants leads to the build-up in the human body Sperdouli and Moustakas (2012). Sakr, et al. (2012) who concluded that the proline exogenous applied osmoregulators can fully or partially counteract the harmful effect of salinity stress on growth and yield of canola.

Also, Kim and Nam (2013) reported that Proline permits osmotic adjustment, stabilizes the structure of proteins and cell membranes, acts as a protective agent for enzymes, and is a free radical scavenger and antioxidant. Kishor and Sreenivasulu (2014) stated that proline protected membranes and proteins against the destabilizing effects of dehydration and under stress conditions, it had some ability to scavenge free radicals generated. Helaly, *et. al.* (2017) pointed out that Proline is an amino acid and compatible solutes and played a crucial major role in osmoregulation and osmo tolerance.

The aim of the present study was to investigate the role of the interaction between potassium humate and proline and their levels on wheat growth and productivity. Also, for helping to alleviation salinity effects on wheat plants.

MATERIALS AND METHODS

Field Experiments:

The experiment was conducted in the Research Farm of Tag El-Ezz Agricultural Research Station, Agricultural Research Centre (ARC), Dakhalia Governorate, Egypt during two consecutive winter growing seasons of 2016/2017 and 2017/2018 with a view to the assessment of potassium humate and proline applications for the growth and the yield of wheat plant (*Triticum aestivum* L.; Variety Misr1). Split plot design was used with three replicates. The potassium humate and proline treatments were assigned at random in the main and sub plots, respectively. The experiments were included two factors:

1) potassium humate (i. e. control, 3 % and 6 % of the spraying solution) was assigned at the main plots and 2) Proline at rate of (i. e. 0, 50 and 100 mgl⁻¹) was assigned at the sub plots. Grains of wheat were obtained from wheat Research Department, Field Crop Research Institute, Agriculture Research Centre, Giza, Egypt. Recommended rates of wheat grains (60 Kg Fed⁻¹) were sown on plots with (4 m length x 3 m width) at the first week of November in both seasons. The normal cultural practices for wheat production were followed according to the instruction laid down according to the recommendation of the Minister of Agriculture and Land Reclamation (MALR) Tellioglu and Konandreas (2017). The P fertilizer was applied as calcium super phosphate (6.76 % P) in a rate of (100 kg Fed⁻¹) (285.71 g plot¹) from the recommended rate before cultivation. K fertilizer was applied as potassium sulphate (40 % K) on two doses, first at first irrigation and the other with the third irrigation in a rate of 50 Kg Fed⁻¹ (142.85g plot⁻¹). N fertilizer was applied as ammonium sulphate (20.6 %N) in a rate of 364 Kg Fed⁻¹ (1040.22 g plot⁻¹) for all treatments at two doses first at first irrigation and the other with the second irrigation. Potassium humate and proline added to the plants as foliar spray after 25 and 40 days from germination. Flood irrigation was applied as plants needed. Harvest day on May for the two seasons. The physical and chemical characteristics of the studied soil before planting are shown in (Table 1).

Table 1. F	Physical and	chemical pr	operties of the	experimental so	il at first and	second seasons.
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_	Physical properties									
properties	Soil Texture	Fine sand %	Coarse sand %	Silt %	Clay %	*EC (dsm ⁻¹)	HW %	Field capacity %	HC (cm/sec)	
1 st season	Clay loam	14.67	9.33	41	35	2.97	6.62	34.4	2.44	
2 nd season	Clay loam	13.4	10	42	34.6	2.68	6.88	36.8	2.78	
nnonontios	Chemical properties									
properties-	**pH	Organic matter (O.M %)	ganic matter Available nutrients							
1.4		· · · · ·	Ν	Р	K	Fe	Mn	Zn	Cu	
1 st season	8.50	1.16	48.5	8.50	300	13.4	10.1	1.3	0.78	
2 nd season	8.25	1.25	46.5	8.00	293	12.6	9.8	1.1	0.65	

* Soil Electrical Conductivity (EC) and soluble ions were determined in soil solution (1:5). ** Soil pH was determined in soil suspension (1:2.5).

Soil analysis

pH value was determined in 1: 2.5 soil: water suspension using a Gallenkamp pH meter (A. Gallenkamp Co.& Ltd., UK) and electric conductivity (EC) in 1: 5 soil: water extract was determined according to the reported procedures Sahlemedhin and Taye (2000). Mechanical analysis was determined following the international pipette method Ryan, *et al.* (2001). Available N, P, and K were determined by the method of Reeuwijk, (2002) and Haluschak, (2006). Organic matter was determined according to Walkley and Black chromic acid wet oxidation method according to Hesse, (1971). Available micronutrients in soil samples were extracted by diethylene triamine penta acetic acid (DTPA) solution by Lindsay and Norvell (1978) and determined using the atomic absorption spectrophotometer.

Plant analysis

At harvest time, selected plants was taken randomly to determine: plant height (cm), straw weight (g plant⁻¹), grains weight (g plant⁻¹). The whole plot was harvested and grains were threshed to determine grains yield and calculated to (ton fed⁻¹). The N, P and K were determined in plant according to Mertens, (2005a) and Mertens, (2005b). Proline was determined according to Bates, *et al.* (1973).

According to Moll, *et al.* (1982), P utilization efficiency (PUTE) was calculated as the ratio between grain

yield and the P uptake in above–ground biomass at harvest. While the P uptake efficiency (PUPE) was calculated as the ratio between the P uptake in above–ground biomass and soil P availability. P available was estimated as the sum of P availability at sowing (P–Olsen at the top 20 cm of soil) plus P fertilization rates. Finally, PUE was calculated as the product of PUTE (Grain yield (g m⁻²) / P uptake (g m⁻²)) and PUPE (P uptake (g m⁻²) / P available (g m⁻²)).

nutrient Use Efficiency (nUE) = grain yield per unit of nutrient supplied (from soil plus fertilizer).

nutrient Uptake Efficiency (nUPE) = the ability of crops to uptake nutrient from the soil).

nutrient- Harvest Index (nHI) = nutrient-uptake by grain/nutrient-uptake by above ground biomass.

Statistical analysis: Appropriate analysis of variance was performed using COSTATE Computer Software. The significant differences among the mean of various treatments were established by the Least Significant Differences method (LSD) according to Gomez and Gomez, (1984). The displayed parameters values are mean of the two seasons.

RESULTS AND DISCUSSION

Yield and Its components at Harvest Time

The collected data in (Table 2) illustrated the influence and interaction of potassium humate and proline on wheat plant height, spike height, straw weight and grains weight g plot⁻¹ and ton fed⁻¹. As indicated in (Table 2) potassium humate 6% gave the highest values of plant height (95.88 cm), spike height (11.12 cm), straw yield (3.93 ton fed⁻¹) and grains weight (3.65 ton fed⁻¹)

Foliar application of proline had a positive effect on plant characteristics. where proline 100 mgl⁻¹ showing maximum increase in (i.e. plant height, 96.22 cm; spike height, 11.03 cm; straw weight, 3.99 ton fed⁻¹ and grains weight, 3.66 ton fed⁻¹), Interaction effect of potassium humate and proline on plant characteristics were noted in (Table 2).

Data also revealed that potassium humate 6% with proline 100 mgl⁻¹, proved to be the most effective interaction in increasing plant height, spike height, straw weight and grains weight ton fed⁻¹ (102.33 cm; 12.13 cm; and 4.11 ton fed⁻¹; 3.80 ton fed⁻¹), respectively. However, potassium humate 0% with proline 0 mgl⁻¹ had less parameters.

This could be attributed to the influence related to humic acid application to plant foliage which affects the process of translocation of trace elements directly to metabolic sites in plant cell and thus maximizing the plants productive capacity. Also, potassium humate contains k element which act as water relations as osmotic adjustment and turgor regulation in plants. K-fed plants maintained higher leaf water potential, lower osmotic potential and turgor potential could alleviated salinity stress. Potassium plays a vital role such as meristematic growth, cation/anion balance, osmoregulation and stomatal movement Epstein and Bloom (2005).

This might be due to the effects of potassium humate as like hormone materials in addition to proline led to decrease the harmful of the dissolve reactive oxygen. Humic is known as plant germination and stimulators of growth humic materials act in a very similar way as growth hormones. The humic acid mechanism to enhance plant growth might increase the consumption of nutrients and reduce the absorption of certain toxic elements. However, some authoress proposed that the positive effect of humic acid should be explained by increasing cell membrane permeability, oxygen uptake, breathing, photosynthesis, and phosphorus uptake and root cell elongation of plant development factors Kulikova, *et al.* (2005) and Delfine, *et al* (2005). Omar, *et al.* (2020) show that the positive effects of potassium humate which have explained that humic acid can be used to increase the consumption and the height of plants, and fresh weight of nutrients by using it for low molecular weights, high oxygen content and many groups (OH) and (-COOH). In cell osmotic capacity, membrane stability and the detoxification of negative ions in plants under saline conditions, proline plays an important role on reduce salt stress on wheat plant. The results obtained are consistent with those reported by Shadadd, (2013), which may enhance the effects of proline therapies on the defence of the photosynthetic machinery, performance as a radical oxygen as well as antioxidant action (Heuer, (2003), Ashraf, *et al.* (2008), Taha and Osman (2018)).



Fig. 1. Effect of potassium humate and proline on relative increase of wheat grain yield.

To illustrate the relation between potassium humate and proline application on grain yield of wheat, the relative increase in grain yield was calculated and presented in fig.1. It could be noticed from this figure that solo application of potassium humate induced the lowest relative increase in grain yield (related to control treatment) which becomes slightly higher by increasing humate application rate. While application of proline alone (under 0 application of potassium humate) was more effective in this respect (whatever the rate of proline application). However, application of potassium humate along with proline enhanced its alleviating effect on grain yield, this effect becomes more pronounced by increasing either potassium humate or proline application to overcome the harmful effects of salinity on the plant growth and improving wheat yield.

Table 2. Effect of potassium humate and proline on average	of plant height	(cm), spike height	(cm), Straw v	weight and
grains weight g plot ⁻¹ and ton fed ⁻¹ on wheat plants.				

<u> </u>	unis weight	<u>s plot</u> and ton	a " h h h			a	a
Treatments		Plant height	Spike height	Straw weight	Straw weight	Grains weight	Grains weight
		(cm)	(cm)	(g)	(ton fed ⁻¹)	(g)	(ton fed ⁻¹)
			Main plot	s: potassium Hum	ate		
Humate 0%		86.22	9.62	211.82	3.56	192.39	3.23
Humate 3%		89.93	10.25	223.20	3.75	199.63	3.35
Humate 6%		95.88	11.12	234.26	3.93	217.13	3.65
LSD at 5%		1.57	0.04	3.22	0.05	3.06	0.05
			Subplots	: Foliar with prolin	e		
Proline 0 mgl ⁻¹		82.67	9.38	200.21	3.36	179.17	3.01
Proline 50 mg	gl ⁻¹	93.54	10.62	233.33	3.92	213.76	3.59
Proline 100 mgl ⁻¹		96.22	11.03	237.32	3.99	217.79	3.66
LSD at 5%	0	1.05	0.15	4.71	0.08	2.70	0.05
	Proline			Interact	ion effect		
	0 mgl ⁻¹	77.33	8.47	176.81	2.97	159.92	2.69
Humate 0%	50 mgl ⁻¹	90.00	10.13	227.49	3.82	206.94	3.48
	100 mgl ⁻¹	91.33	10.27	231.17	3.88	210.32	3.53
	0 mgl ⁻¹	82.67	9.70	203.94	3.42	175.20	2.94
Humate 3%	50 mgl ⁻¹	93.33	10.47	234.15	3.93	211.31	3.55
	100 mgl ⁻¹	95.00	10.70	236.21	3.97	217.06	3.65
	0 mgl ⁻¹	88.00	9.97	219.86	3.69	202.38	3.40
Humate 6%	50 mgl ⁻¹	97.30	11.27	238.34	4.00	223.02	3.75
	100 mgl ⁻¹	102.33	12.13	244.58	4.11	225.99	3.80
LSD at 5%		1.82	0.25	8.17	0.14	4.68	0.08

Results presented in (Table 3), illustrated that potassium humate 6% gave the highest increase in spike weight g, biological yield ton fed⁻¹, harvest index % and 1000 grain weight g. The lowest values was recorded with potassium humate 0%.

Concern of proline effect, proline 100 mgl⁻¹ gave the highest increase in spike weight g, biological yield ton fed⁻¹, harvest index % and 1000 grain weight g (345.19 g; 7.65 ton fed⁻¹; 48.11 % and 42.71 g), respectively as compared with control.

Data in the same table explained the interaction between potassium humate and proline data showed that potassium humate (6%) with proline (100 mgl⁻¹) significantly increased all the mentioned parameters. The maximum increment in all parameters was (366.89 g; 7.90 ton fed⁻¹; 48.34 % and 45.47 g), respectively. Proline application had been shown to enhance salt tolerance by improving the activity of certain antioxidant enzymes and protecting photosynthesis Ben Ahmed, et al. (2010), Kumar, et al. (2010). In addition, proline can interact and activate their biosynthetic paths with other stress metabolites and/or their precursors Jaleel, et al. (2009). Plant cells have a number of defence strategies to combat salinity stress-related oxidative injury. The strategies include antioxidants that degrade ROS in enzymes and in non-enzymes Mittler, (2002). The exogenous applications of antioxidants must be achieved to strengthen plant protection mechanisms against oxidation damage, in particular when plants are exposed to salinity stress Abdelhamid, et al. (2013).

The relation between potassium humate and proline application on biological yield (ton fed⁻¹) or 1000 grain yield (g) were illustrated in figures 2 and 3. These figures revealed a stronger positive relation between biological yield rather than that between 1000 grain yield. It could be noticed from these figure that application of potassium humate along with proline enhanced its alleviating effect on biological yield (ton fed⁻¹)or 1000 grain yield (g) this effect becomes more pronounced by increasing either potassium humate or proline application rate.



Fig. 2. The effect of potassium humate and proline application on biological yield (ton fed⁻¹) of wheat.



Fig. 3. The effect of potassium humate and proline application on 1000 grain weight (g) of wheat.

The relation between obtained data of grain yield (ton fed⁻¹) and biological yield (ton fed⁻¹) as well as the relation between grain yield and harvest index were illustrated in figures 4 and 5. These figures revealed a stronger positive correlation between grain yield and biological yield (r = 0.996) than that between grain yield and harvest index (r = 0.846).



Fig. 4. Relation between grain yield (ton fed⁻¹) and biological yield (ton fed⁻¹).



Fig. 5. Relation between grain yield (ton fed⁻¹) and harvest index

The biological yield refers to the total dry matter accumulation of a plant system. While improved harvest index represents increased physiological capacity to mobilize photosynthates and translocate them into organs having economic yield.

As harvest index = grain yield/ biological yield; so each increase in harvest index means increase in grain yield rather than straw yield.







Fig. 7. Relation between 1000 grain weight (g) and harvest index

The data presented in figure 6 and 7 illustrate a positive correlation between biological yield and harvest index (r = 0.829), as well as between 1000 grain weight and harvest index (r = 0.827), which revealed that under this experiment condition each treatment lead to an increase in harvest index induces this through a reduction in the weight of vegetative parts and through a direct contribution to the grain production.

In this respect, Donald, (1968) stated that "higher wheat grain yields can be achieved only by either increasing biological yield with a sustained harvest index, or by increasing harvest index alone". Wallace, *et al.* (1972) contended that "harvest index is an important aspect of differential partitioning of photosynthate and that improved HI represented an increased physiological capacity of the crop to mobilize photosynthate and translocate it to the organs of economic value". Donald and Hamblin (1976) proposed the following mathematical formula for grain yield, harvest index and biological yield.

Table 3. Effect of potassium humate and proline on average of Spike weight (g), biological yield (ton fed⁻¹) harvest index (%), 1000-grain weight (g) on wheat plants

on wheat plants.									
	Spike	Biological	Harvest	1000-grain					
S	weight	yield	index	weight					
	(g)	(ton fed ⁻¹)	(%)	(g)					
Ν	/lain: pota	assium huma	ite						
•	284.29	6.79	47.60	33.68					
1	313.92	7.10	47.16	36.86					
	335.53	7.58	47.85	42.46					
	9.46	0.08	0.57	0.71					
Sub: Foliar with proline									
ngl ⁻¹	261.33	6.37	47.23	29.54					
ngl ⁻¹	330.19	7.51	7.51 47.81						
mgl ⁻¹	345.19	7.65 48.11		42.71					
0	7.24	0.11	0.55	0.58					
Proline	Interaction effect								
0 mgl ⁻¹	224.21	5.66	47.52	23.07					
50 mgl ⁻¹	303.88	7.30	47.65	38.73					
100 mgl ⁻¹	324.77	7.42	47.64	39.23					
0 mgl ⁻¹	268.68	6.37	46.23	28.87					
50 mgl ⁻¹	338.10	7.48	47.44	41.20					
100 mgl ⁻¹	343.93	7.62	47.00	42.27					
0 mgl ⁻¹	291.09	7.09	47.52	36.70					
50 mgl ⁻¹	348.60	7.75	48.04	45.20					
100 mgl ⁻¹	366.89	7.90	48.34	45.47					
	12.54	0.18	n.s	1.01					
	s s ngl ⁻¹ ngl ⁻¹ Proline 0 mgl ⁻¹ 50 mgl ⁻¹ 100 mgl ⁻¹ 0 mgl ⁻¹ 50 mgl ⁻¹ 100 mgl ⁻¹ 100 mgl ⁻¹ 0 mgl ⁻¹ 100 mgl ⁻¹ 100 mgl ⁻¹ 100 mgl ⁻¹	$\begin{array}{c c c c c c c c c c c c c c c c c c c $	$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Sinke Biological Harvest weight yield index (g) (ton fed ⁻¹) (%) Main: potassium humate (%) Main: potassium humate (%) Main: potassium humate (%) 284.29 6.79 47.60 313.92 7.10 47.16 335.53 7.58 47.85 9.46 0.08 0.57 gl ⁻¹ 261.33 6.37 47.23 ngl ⁻¹ 345.19 7.65 48.11 7.24 0.11 0.55 Proline Interaction effect 0 mgl ⁻¹ 224.21 5.66 47.52 50 mgl ⁻¹ 303.88 7.30 47.64 47.64 0 mgl ⁻¹ 224.21 5.66 47.52 50 mgl ⁻¹ 338.10 7.48 47.44 100 mgl ⁻¹ 343.93 7.62 47.00 0 mgl ⁻¹ 2					

Chemical constituents of wheat plants at harvesting Time

Data in (Table 4) showed the effect of potassium humate and proline on average of N, P and K % in grains, their uptake and protein % on wheat plant. Potassium humate 6 % gave the highest values of N, P and K % (4.11, 0.427 and 2.22) and N, P and K uptake (8.99, 0.932 and 4.91), protein % (23.61) and proline mg100g⁻¹ dry weight (121.22). However, potassium humate 0% had the lowest values of all parameters. These results was agree with those by Asik, *et al.* (2009).

Concerning proline effect, the largest increase in all parameters recorded by proline 100 mgl⁻¹ where (N= 4.12, P= 0.436 and K= 2.24%) and gave also highest nutrients uptake (N uptake= 9.05, P uptake= 0.950 and K uptake= 4.92 g plant⁻¹), protein % (23.71) and proline mg100g⁻¹ dry weight (142.24%) in wheat plants.

The interaction showed also in (Table 4), it seemed that an increase in presence of potassium humate 6 % neither the proline from 50 mgl⁻¹ or 100 mgl⁻¹ resulted in relative increase of N, P and K %. And also, nutrients uptake. The highest values at potassium humate 6% with proline 100 mgl⁻¹ N, P and K% (4.86, 0.463 and 2.95), (N uptake= 10.98; P uptake= 1.046 and K uptake= 6.67 g plant⁻¹), protein %(27.95) and proline mg100g-1 dry weight (159.5). While potassium humate 0% with proline 0 mgl⁻¹ gave the lowest values of N, P and K% in grains (2.04, 0.285 and 0.54), (N uptake= 3.26; P uptake= 0.456 and K uptake= 0.86 g plant⁻¹), protein content (11.73 %) and proline mg100g⁻¹ dry weight (85.11). Humic foliar application significantly increased nutrients, this could be attributed to the influence of the application of humic acid to plant foliage affecting the translocation process of trace elements directly into plant cell metabolic sites and thus maximizing production capacity of plants. These findings coincide with those of Bakry, et al. (2014), concluded that exogenous proline with humic acid mitigates the detrimental effects of salt stress to increase the growth parameters and chemical constituents of three flax varieties. Proline had been proposed to have functions such as osmoregulation, membrane and protein stability maintenance, and growth. HA reduced the negative effects of salinity, increase absorption, chlorophyll synthesis, to better germinate, increase retention of fertilizer, to produce healthier plants. Several researchers reported that proline played a regulating role in participates in the development of metabolic reactions to environmental factors, such as catalectic (peroxidases) and polyphenol Öztürk and Demir (2002). The proposed functions of accumulated proline are osmoregulation, maintenance of membrane and protein stability, growth Hare, et al. (2003). It is concluded that exogenous proline with humic acid mitigates the detrimental exogenous application of proline modulates drought stress by stimulating the plant growth, which accomplished by inducing the antioxidant mechanism, alleviating oxidative damage, improving compatible solutes synthesis and accelerating proline accumulation, reflecting the improvement of photosynthesis and yield attributes Anjum, et al. (2011).

Data in (Table 5) indicated that the highest increase in N, P and K % in straw of wheat was recorded with potassium humate 6 % (N= 1.33; P= 0.382 and K= 3.57 %), respectively and N, P and K uptakes (N uptake= 3.12; P uptake= 0.901and K uptake= 8.40 g plant⁻¹), respectively. But potassium humate 0 % provide lower values.

Proline 100 mgl⁻¹ (N= 1.36; P= 0.384 and K= 3.58 %, respectively) and about nutrients uptake (N uptake= 3.22; P uptake= 0.910 and K uptake= 8.52 g plant⁻¹).

The recorded data (Table 5) showed the impact of the interaction effects values of potassium humate and proline on N, P and K % and its uptake. It's found that N, P and K % in straw with potassium humate 6% and proline 100 mgl⁻¹ had the highest increase. (N= 1.48; P= 0.459 and K= 3.98 %) and nutrients uptake (N uptake= 3.62; P uptake= 1.122 and K uptake= 9.73 g plant⁻¹), respectively compared to other concentrations of potassium humate and proline. However, the lowest result with the potassium humate 0% and proline 0 mgl⁻¹. The possibility of humic compounds to increasing uptake of certain nutrients can be attributed to this outcome. One natural antioxidant is humic acid (HA), the absorption of humic substances into the tissue of plants results in various biochemical consequences through increased absorption and maintenance of plant tissue levels of vitamins and amino acids. Agriculturalists use humic acid globally because it stimulates as plant enzymes and hormones. More and more by encouraging antioxidant activity it eliminates diseases, heat stress and frost damage El-Bassiouny, et al. (2014). Potassium humate was an effective fertilizer that improves wheat plant growth, yield, and chemical constituents. Potassium humate accelerates nutrient uptake, increases plant biomass, Kandil, et al. (2016).

Table 4. I	Effect of potassium	humate and proline	on average of N,	P and K% in gra	ains, their uptake,	protein % and
1	Proline (mg 100g ⁻¹	dry weight) on whe	eat plants.			

Treatments		Ň	P	K	N-uptake	P-uptake	K-uptake	Protein	Proline (mg100g ⁻¹		
Treatments		(%)	(%)	(%)	(g pĺant ⁻¹)	(g plant ⁻¹)	(g plant ⁻¹)	(%)	dry weight)		
				Main plo	ts: potassium hu	mate					
Humate 0%		2.74	0.359	1.11	5.39	0.702	2.24	15.77	105.27		
Humate 3%		3.35	0.399	1.51	6.81	0.801	3.13	19.26	109.91		
Humate 6%		4.11	0.427	2.22	8.99	0.932	4.91	23.61	121.22		
LSD at 5%		0.01	0.005	0.03	0.07	0.019	0.09	0.05	1.6		
				Sub: I	Foliar with prolin	ie					
Proline 0 mg	l ⁻¹	2.48	0.338	0.76	4.49	0.611	1.41	14.24	90.33		
Proline 50 m	gl ⁻¹	3.74	0.416	1.91	8.05	0.890	4.12	21.52	107.44		
Proline 100 n	ngl ⁻¹	4.12	0.436	2.24	9.05	0.950	4.92	23.71	142.24		
LSD at 5%	-	0.01	0.005	0.02	0.07	0.010	0.03	0.04	1.2		
	Proline		Interaction effect								
	0 mgl ⁻¹	2.04	0.285	0.54	3.26	0.456	0.86	11.73	85.11		
Humate 0%	50 mgl^{-1}	3.04	0.385	1.16	6.29	0.797	2.40	17.48	105.85		
	100 mgl ⁻¹	3.15	0.406	1.64	6.62	0.854	3.45	18.11	124.99		
	0 mgl ⁻¹	2.53	0.362	0.68	4.43	0.634	1.19	14.55	91.35		
Humate 3%	50 mgl^{-1}	3.54	0.411	1.92	7.48	0.868	4.06	20.36	106.86		
	100 mgl ⁻¹	4.31	0.438	2.14	9.35	0.951	4.64	24.78	142.24		
	0 mgl ⁻¹	2.86	0.367	1.07	5.79	0.743	2.17	16.45	94.39		
Humate 6%	50 mgl^{-1}	4.65	0.451	2.64	10.37	1.006	5.89	26.74	109.76		
	100 mgl ⁻¹	4.86	0.463	2.95	10.98	1.046	6.67	27.95	159.5		
LSD at 5%		0.02	0.009	0.04	0.13	0.019	0.06	0.07	0.07		

Table 5. Effect of potassium humate and proline on average of N, P and K % in straw and their uptake on wheat plants.

Treatments		Ν	Р	K	N-uptake	P-uptake	K-uptake	
1 reatm	ents	(%)	(%)	(%)	(g plant ⁻¹)	(g plant ⁻¹)	(g plant ⁻¹)	
]	Main	plots :p	otassiı	um humat	e		
Humic 0%		1.13	0.307	3.01	2.41	0.659	6.43	
Humic 3	%	1.20	0.325	3.19	2.69	0.729	7.16	
Humic 6	%	1.33	0.382	3.57	3.12	0.901	8.40	
LSD at 5%	Ď	0.04	0.007	0.03	0.09	0.014	0.09	
Sub: Foliar with proline								
Proline () mgl ⁻¹	1.05	0.281	2.84	2.10	0.566	5.72	
Proline 5	50 mgl ⁻¹	1.27	0.352	3.38	2.97	0.823	7.90	
Proline 100 mgl ⁻¹		1.36	0.384	3.58	3.22	0.910	8.52	
LSD at 5%		0.04	0.004	0.03	0.10	0.014	0.14	
	Proline	Interaction effect						
Llumata	0 mgl ⁻¹	1.01	0.252	2.65	1.79	0.445	4.68	
	50 mgl ⁻¹	1.14	0.331	3.13	2.59	0.753	7.12	
0%	100 mgl-1	1.23	0.337	3.24	2.84	0.779	7.49	
Llumata	0 mgl ⁻¹	1.03	0.289	2.83	2.10	0.589	5.77	
	50 mgl ⁻¹	1.27	0.341	3.33	2.97	0.798	7.80	
3%	100 mgl-1	1.36	0.351	3.53	3.21	0.829	8.34	
Ilumoto	0 mgl ⁻¹	1.10	0.302	3.05	2.42	0.664	6.71	
Humate	50 mgl ⁻¹	1.40	0.385	3.68	3.34	0.918	8.77	
0%	100 mgl-1	1.48	0.459	3.98	3.62	1.122	9.73	
LSD at 5%	ó	0.06	0.006	0.05	0.17	0.024	0.24	

Nitrogen, Phosphorous and Potassium uptake efficiency, use efficiency as well as their harvest index:

Soil salinity is a major constraint to increased crop yields in many areas of the world, through restricting plant growth and nutrients acquisition. Therefore, to study the effect of potassium humate and proline on alleviating the harmful effect of salinity on wheat yield; it is important to illustrate crops' grain yield sensitivities and nutrients use efficiency in order to sustain food production with a minimal environmental impact. Nutrients uptake efficiency is the ability of crops to uptake nutrient from the soil, while nutrient use efficiency represented the grain yield per kg of fertilizer applied to the crop Sandaña1 and Pinochet (2014).

To analyse the ability of wheat to absorb and utilize nutrients N, P and K uptake efficiency, use efficiency and harvest index of each nutrient were calculated and presented in figures (8, 9 and 10). The data revealed that all of these parameters were increased by increasing application rate of potassium humate and proline either individually or in combination. However the effect becomes more pronounced by application of higher rate of potassium humate along with higher rate of proline, revealing the ability of plant to transfer more dry matter to reproductive parts that contributing to increase yields.



Fig. 8. Effect of potassium humate and proline on efficincy and harvest index of Nitrogen





Fig. 10. Effect of potassium humate and proline on efficincy and harvest index of Potassium

CONCLUSION

It could be concluded that, wheat growth and yield components can be improved by adding the appropriate levels of foliar application of potassium humate at 6% with proline at 100 mgl⁻¹, and also taking into account the interactivity effects of these factors on wheat grains yield and productivity.

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تأثير الرش الورقى بهيومات البوتاسيوم والبرولين على نمو وإنتاجية القمح النامى فى الأراضى الملحية مها محمود عثمان '، إيمان محمود رشوان ' و أميرة محمد محمد الامشاطى ' ' قسم بحوث خصوبة الأراضى وتغذية النبات – معهد بحوث الأراضي والمياه والبينة – مركز البحوث الزراعية -الجيزة – مصر ' قسم المقننات المانية والرى الحقلى - معهد بحوث الأراضى والمياه والبينة – مركز البحوث الزراعية -الجيزة – مصر

تم إجراء تجربتان حقليتان على القمح (صنف مصر ١) في محطة بحوث تاج العز الزراعية ، مركز البحوث الزراعية ، محافظة الدقهلية ، مصر خلال موسمي شتاء متتاليين ٢٠١٦/ ٢٠١٧ و ٢٠١٧ / ٢٠١٨. كان موقع التجرية عند خط عرض "٢٠٩ ٥٩٠ شمالاً وخط طول ٢٠١٧ شرقاً. اشتملت معاملات التجربة على معاملتين ١) هيومات البوتاسيوم بثلاث مستويات (بيون رش ، ٣٪ ، ٦٪ من محلول الرش) ٢) والبرولين في ثلاث معدلات (بيون رش ، ٥٠ ، ١٠٠ ملليجرام لتر ⁻⁽). تم تنفيذ هذين العاملين في تصميم القطعة المنشقة بثلاث مكررات ، حيث تم توزيع معاملات هيومات البوتاسيوم والبرولين بشكل عشوائي في المعاملات الرئيسية والفرعية على التوالي. أشارت النتائج المتحصل عليها إلى أن إضافة هيومات البوتاسيوم 7٪ مع التر ولين بشكل عشوائي في المعاملات الرئيسية والفرعية على التوالي. أشارت النتائج المتحصل عليها إلى أن إضافة هيومات البوتاسيوم 7٪ أعلى قيم النيتر وجين ، الفوسفور والبوتاسيوم ألم محروب وقش القمح ومحتوى البروتين كما أعطت أيضا" أعلى محصول حبوب مقار نة بمعاملة الكنترول، ولذا تعتبر أعلى قيم النيتر وجين ، الفوسفور والبوتاسيوم أن معار ما لقمح ومحتوى البروتين كما أعطت أيضا" إلى محصول حبوب مقار نة بمعاملة الكنترول، ولذا تعتبر معاملة هيومات البوتاسيوم 7٪ مع علي التوالي. أنه القمح ومحتوى البروتين كما أعطت أيضا" أعلى محصول حبوب مقار نة بمعاملة الكنترول، ولذا تعتبر أعلى قيم النيتر وجين ، الفوسفور والبوتاسيوم ألم عرب المعاملة الأنسب للحصول على أعلى محصول قمح تحت ظروف هذه التجربة. بالإضافة إلى تقال معاملة هيومات البوتاسيوم 7 ٪ مع البرولين ١٠٠ ماليجر ألم التر - المعاملة الأنسب للحصول على أعلى محصول قمح تحت ظروف هذه التجربة. بالإضافة إلى تقال