Wheat (*Triticum aestivum* L.) Productivity and Quality Under Different Levels of Humic Acid, Mineral and Bio- fertilization

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ABSTRACT: Two field experiments were carried out at the Experimental Farm of the Faculty of Agriculture (Saba- Basha), Alexandria University, Egypt, during 2015/2016 and 2016/2017 seasons, to study three humic acid levels (0, 3 and 6 kg/ha) and mineral with biofertilization treatments (100% NPK, 75% NPK + rhizobacterin, 75% NPK + phosphorein, 75% NPK + potasiumage, 50 % NPK + rhizobacterin+ phosphorein, 50 % NPK + rhizobacterin+ potasiumage, 50 % NPK + phosphorein+ potasiumage and 25 % NPK + rhizobacterin+ phosphorein + potasiumage) and their interaction on yield, its components and quality of wheat cv. "Sids 12". Split plot design with three replications was used. Humic acid levels were allocated to the main plots, mineral NPK with biofertilization were assigned to sub plots. The obtained results indicated that increasing humic acid up to 6 kg/ha significantly increased most studied characters in both seasons. However, mixed (25 % NPK + rhizobacterin + phosphorein + potasiumage), generally, surpassed other macronutrients with biofertilization treatments for all studied characters in both seasons. Interaction humic acid x biofertilization had significant effect on spike length, number of spikes/m^2, number of spikelets/spike, 1000- kernel weight (g), grain, straw and biological yields (t/ha) in the two seasons, crude protein, N, P and K percentage, in the first season.
Key words: humic acid, mineral, biofertilization, wheat yield, yield components.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is an important cereal crop which belongs to the grass family of *Poaceae*. It is one of the most important cereal crops in Egypt and all over the world especially developed countries as Egypt and Libya. Wheat provides 37 % of the total calories for the people and 40 % of the protein in the Egyptian diet. Government in Egypt aimed to face the human needs. In this respect, it can be increased the wheat production by horizontal and vertical extension. Wheat cultivation in Egypt is about 1.3 million ha and the average yield of wheat reached about 6.6 t/ha. On the other wise, the cultivated area in the World reached about 220.1 million ha with an average of 3.4 t/ha (FAO, 2016).

Humic acid is a complex molecule of polymeric organic acid of aromatic structure substituted by carboxyl, phenolic, hydroxyl and alkyl groups linked together through ether linkage (Sutton and Sposito, 2005). Humic acid might benefit plant growth by chelating unavailable nutrients and buffering pH (Julie and Bugbee, 2006). It contains 51-57% organic C, 4-6% N and 0.2-1% P, that may stimulate microbial activity, soil enzymatic activities thereby improve physicochemical and biological environment of soil which enhances plant growth (Zancani *et al.,* 2009). Humic acid, can meet the nutrient requirement of wheat production under desert soil conditions. Such appropriate management of organic and biofertilizers reduces the potential disadvantages in comparison to the mineral fertilizers (Ahmed *et al*., 2011). Humic acid (HA) is the active constituent of organic fertilizers (Karakurt *et al.,* 2009). Significant increases in grain yield of maize (*Zea mays* L.) and soybean (*Glycine max* L. Merr.) with humic product application (Olk *et al*., 2013).

Nitrogen fertilization had a vital role to increment yield component and yield attributes in various crops, especially wheat. Concerning the effect of nitrogen fertilizer levels on wheat grain yield and its attributes (Ahmed *et al.,* 2011). Nitrogen fertilizers are very important but due to its high solubility nature it causes severe damage to the plants and the surroundings therefore a nano phosphorus zeolite was used with urea and there was considerable increase in the uptake of nitrogen efficient urea with controlled release (Manikandan and Subramanian, 2013).

Phosphorus (P) plays a vital role in photosynthesis, respiration, energy storage, transfer, division of cell, elongation of cell and many processes in the plants (Singh, 2003). Phosphorus has direct effects on plant leaf area expansion and tillering have also been proposed in wheat (Rodry-guez *et al.,* 1999). Phosphorus stimulates root development and growth in the seedling stage and thereby it helps to establish the seedling quickly. It increases the number of tillers in cereal crop and also increases the ratio of grain to straw. It strengthens the straw of cereal crops and thus helping to prevent lodging (Das, 2004).

K increases growth and improves drought resistance, maintains turgor, reduces water loss and wilting reduces respiration, preventing energy losses, enhances translocation of sugars and starch, produces grain rich in starch, increases protein content of plants, builds cellulose and reduces lodging, helps retard crop diseases. Potassium plays significant roles in enhancing crop quality. Available K improve physical quality, and disease resistance, and the feeding value of grain and forage crops (Rehm *et al.,* 1983). Potassium (K) is a multifunctional and high mobility element with direct and indirect influence on almost all biochemical and physiological processes. Potassium is associated with movement of water, nutrients, and carbohydrates in plant tissue. If K is deficient or not supplied in adequate amounts, growth is stunted and yields are reduced. Various research efforts have shown that K stimulates growth, increases protein production, improves the efficiency of water use and improves resistance to diseases and insects. Potassium has greater ability to produce tolerance in plant body. Hence, potassium can improve production and quality (Cakmak, 2010).

Biofertilizer is considered a sustainable way of increasing crop yields and economize their production as well (Wali, 2010). Bio-fertilization is very safe for human, animal and environment to get lower pollution and saving fertilization cost. In addition, their application in soil improves soil and minimizes the sole use of chemical fertilizers (Jalilian *et al.*, 2012). Using biofertilizer in agriculture have greater impact on organic agriculture and also on the control of environmental pollution, soil health improvement and reduction in input use. In addition, the presence effect of humic substances and biofertilizers in soil increase nutrient absorption by augmenting the availability of nutrients in addition to improvement of the physical structure of soil (Reddy *et al.,* 2014).

The aim of this investigation was designed to study the effect of humic acid levels, mineral (NPK) with biofertilization and their interaction on yield, its components and grain characters of wheat.

MATERIALS AND METHODS

Two field experiments were conducted at the Experimental Farm of the Faculty of Agriculture (Saba- Basha), Alexandria University, Egypt, during 2015/2016 and 2016/2017 seasons to study the effect of humic acid levels and mineral NPK with biofertilization on growth, yield, yield attributes and grain quality traits of wheat (cv. Sids 12).

Maize (*Zea may*, L.) was the preceding summer crop in the two seasons. Physical and chemical soil characters analysis of the surface layer (0 to 30 cm) depth of the experimental site were determined before sowing according to Chapman and Pratt (1978) and illustrated in Table (1).

The experimental design was split plot design with three replications. Application of humic acid levels were allocated to the main plots, mineral NPK with biofertilization were allocated randomly to the sub plot. The size of each sub plot was (10.5 m^2), 3.5 m long and 3.0 m width. The treatments were illustrated as follows:

A) Main plot (Humic acid levels)

- Untreated
- 7.2 kg HA/ha
- 14.4 kg HA/ha

B) Sub-plots (Mineral NPK – biofertilization)

- 100 % NPK mineral fertilizer.
- 75% NPK + Rhizobacterin.
- 75% NPK + Phosphorein.
- 75% NPK + Potasiumage.
- 50% NPK + Rhizobacterin + Phosphorein.
- 50% NPK + Rhizobacterin + Potasiumage.
- 50% NPK + Phosphorein + Potasiumage.
- 25% NPK + Phosphorein + Potasiumage + Rhizobacterin.

Table (1). Some Physical and chemical properties of the experimental soil in 2015/ 2016 and 2016/2017 seasons

Soil properties	Seasons	
	2015/ 2016	2016/2017
A- Mechanical analysis		
Sand	14.50	14.70
Silt	42.10	42.10
Clay	43.40	43.20
Soil texture	Clay loam	Clay loam
B- Chemical properties		
pH (1:1)	7.70	7.60
EC (1:1) dS/m	3.40	3.50
1- Soluble cations (1:2)		
K^+	1.40	1.45
Ca^{++}	14.20	15.40
Mg^{++}	11.30	11.50
Na^+	13.60	13.80
2- Soluble anions (1:2)		
CO^-_3+ HCO^-_3	2.80	2.90
CL^-	19.70	19.80
SO^-_4	12.40	12.50
Calcium carbonate (%)	6.70	6.90
Total nitrogen (%)	1.10	1.20
Available P (mg/kg)	3.70	3.60
Organic matter (%)	1.50	1.60

Nitrogen fertilizer was added in the form of ammonium nitrate (33.5 % N) at rates of (168 kg N/ha=100% N) & (84 kg N/ha = 50% N) and (42 kg N/ha = 25 % N), were added at two equal doses the first one at sowing time and the second before the first irrigation immediately (25 days after sowing). Super phosphate fertilizer (15.5% P_2O_5) was applied before sowing at rates of (100%= 57.6 kg P_2O_5/ha, 75%= 43.2 kg P_2O_5/ha, 50%= 28.8 kg P_2O_5/ha, and 25%= 14.4 kg P_2O_5/ha). Potassium sulphate fertilizer (48.5 % K_2O) was applied with the first irrigation as soil application (100% = 57.6 kg K_2O / ha, 75% = 43.2 kg K_2O / ha, 50% = 28.8 kg K_2O / ha and 25% = 14.4 kg K_2O /ha). The humic acid from K- humate at rates of (0, 7.2 and 14.4 kg/ ha) were applied at sowing time in both seasons.

Inoculation with Rhizobacterin, a nitrogen fixing bacteria (*Azotobacter choroccocum* and *Azospirellum braselines*). With phosphorein (*Bacillus megtherium phosphacterium) a* phosphorus dissolving bacterium and potasiumage of potassium mobilizing bacteria were performed by coating wheat grains with each product individually using a sticking substance (Arabic gum) just before sowing. The biofertilizer was produced by General Organization for Agriculture Equalization Ministry of Agriculture and Land – Reclamation, Egypt (Abou- El- Naga, 1993).

Sowing dates were November 2nd and November 10th in both seasons, respectively while seeding rate was 168 kg/ha (cv. Sids12).

At harvest time the following characters were studied in both growing season, spike length (cm), number of spikes/m^2, number of spikelets/spike, 1000- grain weight (g), Grain yield (t/ha), Straw yield (t/ha), and biological yield (t/ha).

The PK percentages were determined in the dry grains. Their dry weights were determined following drying in a drying chamber to a constant weight at 75^{o}C for 72 hours according to Tandon (1995). After dryness, the grain samples were milled and stored for analysis as reported. However, 0.5g of the grains powder was wet-digested with H_2SO_4 – H_2O_2 mixture according (Lowther 1980) and the following determinations were carried out in the digested solution to determine the following: Grain Phosphorus content (%) which was determined by the Vanadomolyate yellow method as given by Jackson (1973) and the intensity of colour developed was read in spectrophotometer at 405nm, and Potassium which was determined according to the method described by Jackson (1973) using Beckman Flame photometer.

Total nitrogen was determined in digested grain material calorimetrically by Nessler`s method (Chapman and Pratt, 1978). Nessler solution (35 IK/100 ml dw. + 20 g HgCl2 / 500 ml dw) +120 g NaOH / 250 ml dw. Reading was achieved using wave length of 420 nm and N was determined as percentage as follows: N % = NH4 % x 0.776485.

Protein percentage was determined by estimating the total nitrogen in the grains and multiplied by 5.75 to obtain the grain protein percentage according to AOAC (1990).

All the data collected were subjected to statistical analysis of variance as described by Gomez and Gomez (1984). The treatment means were compared using L.S.D. test at 0.05 level of significant.

RESULTS AND DISCUSSION

A- Yield and its components:

Results presented in Tables (2 to 4) showed that humic acid levels application had significant effect on yield and its components (i.e. spike length, number of spike/m^2, number of spikelets/spike, 1000- grain weight, grain, straw and biological yields) in the two seasons. Increasing humic acid rates up to 6 kg/ha led to gradual and significant increase in the previous traits by 15.27 and 12.18 % for spike length, 12.10 and 14.20% for number of spike/m^2, 12.89 and 10.44% for number of spikelets/spike, 12.07 and 12.05% for 1000- grain weight (g), 12.42 and 12.22 % for grain yield/ha, 11.03 and 11.67% for straw yield/ha and 12..04 and 12.00% for biological yield/ha in the first and second seasons, respectively. These increases in the yield components were due to the favorable effect of humic acid for improving early plant growth and increasing dry matter accumulation in wheat plants. These results generally agreed with those obtained by Serenella *et al.* (2002), Zandanadi *et al.* (2007) and Rahmat *et al*. (2010).

Results shown in Tables (2 to 4) indicated that wheat mixed inoculation treatment (25% NPK + rhizobacterin + phosphorein + potasiumage) was significantly superior than all other treatments in both seasons. Mixed biofertilizer produced taller spikes (17.19 and 19.08%), high number of spike/m^2 (345.71 and 395.60%), number of spikelets/spike (44.39 and 51.07%), 1000-grain weight (59.23 and 65.22%), grain yield/ha (6.74 and 7.75%), straw yield/ha (9.18 and 10.63%) and biological yield/ha (15.63 and 17.88%). These increases might be due to the stimulating effect of micro-organisms that produce plant phytohormonas as IAA, GAs and CKs which promote plant growth cell division, hence encouraging the photosynthesis and assimilates accumulation (El-Khawas 1990). These results were in agreement with those obtained by Basha (2004), Ibrahim *et al*. (2004) and Zaki *et al*. (2013).

The interaction between humic acids rates and biofertilization was significant for spike length, number of spike/m^2, number of spikelets/spike, 1000- grain weight, grain yield, straw yield and biological yield in both seasons (Table 2 and 4). The presented date in Table (3 and 5) revealed that humic acid application at rate (6 kg/ha) gave the highest mean values of these traits with mixed biofertilizer inoculation (25 % NPK + rhizobacterin + phosphorein + potassmage), while the lowest ones recorded by untreated treatment with 100% NPK treatment in both seasons.

Table (2). Yield characters of wheat c.v. Sids 12 as affected by humic acid and mineral- biofertilization in both seasons

Treatments	Spike length (cm)		Number of spikes/m^2		Number of spikelets/spike		1000- grain weight (g)	
	Seasons							
	2015/2016	2016/2017	2015/2016	2016/2017	2015/2016	2016/2017	2015/2016	2016/2017
A) Humic acid								
Untreated	14.36c	15.85c	266.33c	261.48c	35.63c	40.94c	43.27c	48.03c
7.2 kg HA/ha	15.79b	17.52b	295.07b	352.09b	39.19b	45.04b	47.92b	52.94b
14.4 kg HA/ha	17.35a	19.30a	322.37a	370.75a	43.43a	49.58a	52.24a	58.31a
B) Mineral-biofertilization								
100% NPK	15.02f	16.70e	262.02f	299.02g	34.06f	31.47f	41.57d	46.11d
75% NPK +Rhizobacterein	15.15e	16.76d	266.08f	299.21g	35.60e	46.97d	43.37d	48.17d
75% NPK +Phosphorein	15.58ef	17.25c	289.27d	332.49e	38.84d	44.62e	45.98c	51.05c
75% NPK +Potasiumage	15.42e	17.10c	273.63e	314.84f	38.08d	43.91e	45.51c	49.94c
50% NPK +Rh.+Phosphorein	16.11c	17.76c	311.49b	350.66c	40.95c	48.89b	49.61b	55.06b
50% NPK +Rh.+Potasiumage	15.65d	17.52c	293.49c	337.51d	40.27c	46.13c	46.70c	51.48c
50% NPK + Phosph.+Potasiumage	16.55b	18.38b	311.88b	359.47b	41.45b	47.09b	51.67b	57.36b
25% NPK +Rh.+Phosph. +Potasiumage	17.19a	19.08a	345.71a	397.56a	44.39a	51.01a	59.23a	65.22a
Interactions								
A×B	*	*	*	*	*	*	*	*

- Means of each factor designated by the same letter are not significantly different at 5% using least significant difference (L.S.D.)
- * significant differences at 5%, levels of probability.

Table (3). The interaction effect between humic acid and mineral- biofertilization of on values of yield characters for wheat c.v. Sids 12 in both seasons

Humic acids (kg/ha)	Mineral-biofertilization	Spike length (cm)		No. of spikes/m^2		No. of spike lets/spike		1000- grain weight (g)	
		2015/2016	2016/2017	2015/2016	2016/2017	2015/2016	2016/2017	2015/2016	2016/2017
Untreated	100% NPK	13.63	15.14	255.67	271.02	30.12	34.41	37.05	41.79
	75% NPK +Rhizobacterein	13.73	15.08	240.67	276.38	32.27	37.1	39.32	43.64
	75% NPK +Phosphorein	14.10	15.53	262	301.3	35.17	40.44	41.49	46.07
	75% NPK +Potassmage	14.00	15.50	248	285.2	34.61	39.8	40.92	45.42
	50% NPK +Rh. +Phosph.	14.60	16.21	282.33	324.68	38.58	44.37	45.01	49.96
	50% NPK +Rh. + Potass.	14.20	15.72	266	305.9	36.5	41.47	42.33	46.98
	50% NPK + Phosph. + Potass.	15.00	16.65	282.67	327.17	37.57	41.2	46.81	51.99
	25% NPK+Rh.+Phosph. + Potass.	15.63	17.02	313.33	360.32	40.23	46.26	52.62	58.41
7.2	100% NPK	14.94	16.64	259.23	298.12	33.13	38.1	41.49	45.97
	75% NPK +Rhizobacterein	15.11	16.77	265.53	305.36	35.49	40.01	43.23	48.08
	75% NPK +Phosphorein	15.54	17.25	288.2	331.6	38.68	44.48	45.93	50.99
	75% NPK +Potassmage	15.36	17.05	272.8	313.72	38.07	43.77	45.01	49.48
	50% NPK +Rh. +Phosph.	16.06	17.82	310.57	357.15	42.44	48.80	19.51	54.96
	50% NPK +Rh. + Potass.	15.57	17.28	292.6	336.19	40.15	46.17	46.56	51.68
	50% NPK + Phosph. + Potass.	16.5	18.31	310.93	357.63	41.33	47.3	51.52	57.19
	25% NPK+Rh.+Phosph. + Potass.	17.2	19.09	344.67	396.36	44.25	50.89	60.08	65.15
14.4	100% NPK	16.49	18.31	285.16	329.93	38.92	41.88	45.56	50.57
	75% NPK +Rhizobacterein	16.62	18.44	292.09	335.4	39.04	44.44	47.57	52.8
	75% NPK +Phosphorein	17.1	18.97	317.02	364.57	42.65	49.93	50.5	56.08
	75% NPK +Potassmage	16.9	18.76	300.08	345.8	41.84	48.16	49.51	54.92
	50% NPK +Rh. +Phosph.	17.66	19.25	341.56	392.88	46.68	53.68	54.32	60.23
	50% NPK +Rh. + Potass.	17.12	19.02	321.86	370.14	44.16	50.78	51.21	56.86
	50% NPK + Phosph. + Potass.	18.15	19.98	343..03	353.48	43.46	52.27	56.68	62.89
	25% NPK+Rh.+Phosph. + Potass.	18.75	21.14	379.13	416.00	48.68	55.98	64.99	72.11
LSD at 0.05		**0.55**	**0.60**	**7.70**	**7.20**	**2.20**	**2.10**	**2.50**	**2.70**

Table (4). Grain, straw and biological yields (t/ha) of wheat c.v. Sids 12 as affected by humic acid and mineral-biofertilization in both seasons

Treatments	Grain yield (t/ha)		Straw yield (t/ha)		Biological yield (t/ha)	
	Seasons					
	2015/016	2016/017	2015/016	2016/017	2015/016	2016/017
A) Humic acid						
Untreated	5.15[c]	5.91[c]	7.43[c]	8.57[c]	12.58[b]	14.44[b]
7.2 kg HA/ha	5.41[b]	6.15[b]	9.55[a]	10.48[a]	14.90[a]	17.19[a]
14.4 kg HA/ha	6.37[a]	7.22[a]	8.79[b]	10.00[b]	15.12[a]	17.33[a]
B) Mineral-biofertilization						
100% NPK	4.83d	5.49d	8.24d	9.44c	13.11e	16.03b
75% NPK +Rhizobacterein	4.98d	5.43d	8.43c	9.71b	13.41de	16.43b
75% NPK +Phosphorein	5.44c	6.06c	8.43c	9.69b	13.87d	16.54b
75% NPK +Potasiumage	5.17dc	5.91dc	8.45c	10.07a	13.74d	15.67c
50% NPK +Rh. +Phosphorein	5.93c	6.51c	8.85b	9.70b	14.43c	15.58c
50% NPK +Rh. + Potasiumage	5.73c	6.58c	8.57c	9.43c	14.27c	16.21b
50% NPK + Phosph. + Potasiumage	6.16b	7.07b	8.86b	9.84b	15.13b	17.24a
50% NPK +Rh. + Phosph. + Potasiumage	6.74a	7.75a	9.18a	10.63a	15.63a	17.88a
Interactions						
A×B	*	*	*	*	*	*

- Means of each factor designated by the same letter are not significantly different at 5% using least significant difference (L.S.D.)
- * significant differences at 5%, levels of probability.

Table (5). The interaction effect between humic acid and mineral- biofertilization of grain yield, straw yield and biological yield for wheat c.v. Sids 12 in both seasons

Humic acids (kg/ha)	Mineral-biofertilization	Grain yield (t/ha)		straw yield (t/ha)		Biological yield (t/ha)	
		2015/2016	2016/2017	2015/2016	2016/2017	2015/2016	2016/2017
Untreated	100% NPK	4.55	5.23	7.04	8.47	11.59	13.70
	75% NPK +Rhizobacterein	4.62	5.31	7.16	8.23	11.78	13.54
	75% NPK +Phosphorein	4.93	5.45	7.00	8.05	11.93	13.50
	75% NPK +Potassmage	4.83	5.35	6.99	8.03	11.82	13.38
	50% NPK +Rh. +Phosph.	5.41	6.12	7.2	8.27	12.61	14.39
	50% NPK +Rh. + Potass.	5.33	6.1	6.89	7.94	12.22	14.04
	50% NPK + Phosph. + Potass.	5.55	6.38	8.45	9.72	14.00	16.10
	25% NPK+Rh. + Phosph. + Potass.	6.02	6.98	8.70	9.77	14.72	16.75
7.2	100% NPK	4.68	5.38	9.06	10.42	13.74	15.80
	75% NPK +Rhizobacterein	4.82	5.54	9.35	10.77	14.17	16.31
	75% NPK +Phosphorein	5.08	5.89	9.7	11.15	14.78	17.04
	75% NPK +Potassmage	4.91	5.65	9.56	11.00	14.47	16.65
	50% NPK +Rh. +Phosph.	5.58	6.41	9.6	11.13	15.18	17.54
	50% NPK +Rh. + Potass.	5.39	6.20	9.98	11.48	15.37	17.68
	50% NPK + Phosph. + Potass.	5.96	6.85	9.65	11.10	15.61	17.95
	25% NPK +Rh.+ Phosph. + Potass.	6.39	7.34	9.47	10.91	15.86	18.25
14.4	100% NPK	5.26	6.05	8.75	10.03	14.01	16.08
	75% NPK +Rhizobacterein	5.51	6.14	8.79	10.13	14.30	16.27
	75% NPK +Phosphorein	6.30	7.34	8.59	9.88	14.89	17.22
	75% NPK +Potassmage	5.78	6.64	8.79	10.17	14.57	16.81
	50% NPK +Rh. +Phosph.	6.8	7.8	8.74	9.79	15.54	17.59
	50% NPK +Rh. + Potass.	6.47	7.44	8.83	10.07	15.30	17.51
	50% NPK + Phosph. + Potass.	6.98	8.02	8.49	10.15	15.47	18.17
	25% NPK +Rh.+ Phosph. + Potass.	7.82	9	9.35	9.76	17.17	18.76
LSD at 0.05		2.50	0.60	0.60	0.50	0.50	0.55

B- Grain characters:

Results in Table (6) illustrated the effect of two studied factors on grain crude protein %, P %, and K% in the two seasons.

Generally, humic acid rates up to 6 kg/ha produced significantly, high protein content (13.63 and 14.06 %), phosphorus percent (0.650 and 0.750 %) and potassium percent (2.21 and 2.54%), in the first and second seasons, respectively, while the lowest values of grain characters were recorded by untreated control. Humic acid application may increase in the availability of macro-micronutrients and improvement of physical and chemical soil properties (Mackowiak *et al*. (2001), Ibrahim *et al*. (2004), Karakurt *et al*. (2009) and Abdel-Lattief (2012).

Results in Table (6) indicated that percentage of crude protein, phosphorus and potassium significantly increased by inoculation of wheat grain with biofertilizer. The maximum increases were generally obtained with the treatment of (25 % NPK + rhizobacterin+ phosphorein + potasiumage). The increment percentage increases were (14.46 and 15.93 %) for crude protein (0.740 and 0.850%) for P% and (2.22 and 2.55%) for K in the two seasons, respectively, compared with 100% NPK treatment. This may be due to the role of dissolving phosphate and nitrogen fixation bacteria on increasing the endogenous phytohormones (IAA, GAs and CKs) which play an important role in formation a big active root system, increasing the nutrients uptake and photosynthesis rate and translocation as well as accumulation within different parts (El- Khawas, 1990). These results agreed with those obtained by Shaban and Helmy (2006), Hosam El-Din (2007) and Mohammed *et al*. (2012).

The interaction between humic acid rate and biofertilization was significant for some grain characters in the first season, only (Table 4). The presented date in Table (5) revealed that humic acid application at rate (6 kg/ha) gave the highest mean values of these traits with mixed biofertilizer inoculation (25 % NPK + rhizobacterin + phosphorein + potassmage), while the lowest ones recorded by untreated treatment with 100% NPK treatment in the first season.

Table (4). Grain Crude protein (%) P %, and K % of wheat c.v. Sids 12 as affected by humic acids and mineral-biofertilization in both seasons

Treatments	Crude protein (%)		Grain P (%)		Grain K (%)	
	Seasons					
	2015/2016	2016/2017	2015/2016	2016/2017	2015/2016	2016/2017
A) Humic acids (kg/ha)						
Untreated	11.26c	11.14c	0.544c	0.620c	1.83	2.09c
7.2	12.42b	12.23b	0.600b	0.680b	2.01	2.30b
14.4	13.63a	14.06a	0.650a	0.750a	2.21	2.54a
B) Mineral-biofertilization						
100% NPK	11.08c	12.18c	0.515a	0.590a	1.88c	2.16b
75% NPK +Rhizobacterein	11.36c	12.43c	0.530a	0.610a	1.93b	2.22b
75% NPK +Phosphorein	12.05b	13.25b	0.580a	0.670a	1.98b	2.27b
75% NPK +Potasiumage	11.51c	12.69c	0.570a	0.660a	1.94b	2.23b
50% NPK +Rh. +Phosphorein	13.11b	14.43a	0.620a	0.710a	2.06a	2.37a
50% NPK +Rh. + Potasiumage	12.49b	13.75b	0.600a	0.690a	2.01a	2.31a
50% NPK + Phosph. + Potasiumage	13.47a	14.81a	0.630a	0.720a	2.10a	2.39a
50% NPK +Rh. + Phosph. + Potasiumage	14.46a	15.93a	0.740a	0.850a	2.22a	2.55a
Interactions						
A×B	*	ns	*	ns	*	ns

- Means of each factor designated by the same letter are not significantly different at 5% using least significant difference (LSD).
- * significant differences at 5%, levels of probability.

Table (5). Interactions between humic acids and mineral-biofertilization on crude protein (%) and chemical compositions in 2015/2016 season

Humic acids (kg/ha)	Treatments Mineral-biofertilization	2015/2016 Protein (%)	P (%)	K (%)
untreated	100% NPK.	10.04	0.466	1.72
	75% NPK +Rhizobacterein	10.29	0.480	1.75
	75% NPK +Phosphorein	10.93	0.532	1.79
	75% NPK +Potassmage	10.30	0.522	1.76
	50% NPK +Rh. +Phosph.	11.87	0.559	1.87
	50% NPK +Rh. + Potass.	11.33	0.543	1.82
	50% NPK + Phosph. + Potass.	12.23	0.569	1.90
	25% NPK +Rh. + Phosph. + Potass.	13.10	0.678	2.02
7.2	100% NPK.	11.05	0.512	1.88
	75% NPK +Rhizobacterein	11.36	0.525	1.91
	75% NPK +Phosphorein	12.02	0.585	1.97
	75% NPK +Potassmage	11.54	0.575	1.94
	50% NPK +Rh. +Phosph.	13.06	0.613	2.03
	50% NPK +Rh. + Potass.	12.46	0.579	2.00
	50% NPK + Phosph. + Potass.	13.41	0.626	2.09
	25% NPK +Rh. + Phosph. + Potass.	14.42	0.738	2.21
14.4	100% NPK.	12.15	0.563	2.04
	75% NPK +Rhizobacterein	12.42	0.581	2.14
	75% NPK +Phosphorein	13.21	0.643	2.18
	75% NPK +Potassmage	12.69	0.632	2.13
	50% NPK +Rh. +Phosph.	14.40	0.677	2.26
	50% NPK +Rh. + Potass.	13.69	0.656	2.21
	50% NPK + Phosph. + Potass.	14.77	0.688	2.30
	25% NPK +Rh. + Phosph. + Potass.	15.85	0.812	2.43
	LSD at 0.05	0.50	0.115	0.09

CONCLUSION

From the above-mentioned results under the conditions of this research it could be concluded that the economic fertilization treatment for best growth attributes and the maximum grain, straw and biological yields of wheat plants and a good quality resulted with humic application at 14.4 kg /ha and 25% NPK + Rhizobacterin + Phosphorein + Potassmage under Alexandria conditions.

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الملخص العربي

إنتاجية وجودة القمح تحت مستويات مختلفة من حامض الهيوميك، والتسميد المعدني والحيوي

محمود عبد العزيز جمعه ، فتحي ابراهيم رضوان ، عصام إسماعيل قنديل ، أسماء رابح سعيد أدم
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أجريت تجربتان حقليتان بمزرعة كلية الزراعة (سابا باشا) – الإسكندرية – مصر أثناء موسمي النمو ٢٠١٥/٢٠١٦، ٢٠١٦/٢٠١٧ وكان الهدف منها دراسة تأثير إضافة حمض الهيوميك والتسميد المعدني و الحيوي على المحصول ومكوناته والمكونات الكيميائية في صنف قمح سدس ١٢ لتحسين إنتاجية القمح.

ويمكن تلخيص أهم النتائج فيما يلي:

- أدى إضافة حمض الهيوميك بمعدل ٦ كجم/فدان الى زيادة معنوية في طول السنبلة، عدد السنابل/م٢ ، عدد السنبيلات/سنبلة، وزن ألف حبة، محصول الحبوب، والقش والمحصول البيولوجي (طن/فدان) مقارنة بالكنترول في كلا الموسمين.
- إضافة حمض الهيوميك بمعدل ٦ كجم/فدان أدى فدان الى زيادة معنوية في محتوى البروتين كنسبة مئوية، والنسبة المئوية للنتروجين والفوسفور والبوتاسيوم مقارنة بالكنترول في كلا الموسمين.
- تفوقت المعاملة (٢٥% ن فو بو+ ريزوباكتيرين+ فوسفورين + بوتاسيوماج) معنوياً مقارنة بالمعاملة ١٠٠% ن فو بو (كنترول) وباقي المعاملات في المحصول ومكوناته والمكونات الكيميائية في كلا الموسمين.
- أدى التداخل بين إضافة حمض الهيوميك بمعدل ٦ كجم/فدان مع خليط (٢٥% ن فو بو+ ريزوباكتيرين+ فوسفورين + بوتاسيوماج) ادى الى زيادة معنوية في المحصول ومكوناته ومحتوي الحبوب من البروتين والفوسفور والبوتاسيوم للقمح صنف سدس 12.

التوصية

- توصي الدراسة بزراعة صنف القمح سدس ١٢ مع الأضافة الأرضية ٢٥% من الجرعة الموصى بها من السماد المعدني النتروجيني والفوسفوري والبوتاسي + حمض الهيوميك بمعدل ٦ كجم/فدان + تلقيح الحبوب بكل من الريزوبكتيرين والفوسفورين والبوتاسيوماج حيث أن هذه التوليفة ذات تأثير معنوي على المحصول ومكوناته ومحتوي الحبوب من البروتين والفوسفور والبوتاسيوم تحت ظروف الأسكندرية.