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Evaluation of the effect of chemical fertilizer and humic Acid on yield and yield components of wheat plants (*Triticum aestivum*) grown under newly reclaimed sandy soil

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Abstract : Two field experiments were carried out at the experimental Station Farm of National Research Centre, Al-Nubaria District, Al Behaira Governorate, Egypt during the two successive winter seasons of 2012/2013 and 2013/2014, to study the effect of NPK fertilization and foliar application with humic acid at the rate of 1,2 and 4 litre/ faddan on yield, yield attributes and grain quality characters of wheat plants grown under sandy soil condition. Highest values of spike length, number of grains/spike, grains weight/spike and thousand grains weight as well as grain yield were obtained by foliar spraying with 2 litres of humic acid/ faddan over both seasons as compared with other treatments. Higher content of carbohydrate and protein recorded with the same rate of humic acid treatment.
Keywords: *Triticum aestivum,* chemical fertilizer and humic Acid, wheat plants, sandy soil.

Introduction:

Wheat is considered as the major cereal crop in the world in respect of the cultivate area and total production. It provides an almost 20 % of food calories for people in the world as well as in Egypt. Wheat (*Triticum aestivum* L.) is the most important food crop in Egypt. High production of wheat is the ultimate goal need to meet the increasing population and growing demand for food. Wheat is among the crops whose yield are limited by low nutrients availability in sand soils[1]. Thus excessive chemical fertilizers are used to supply wheat plants with the major nutrients which in turn induce environment pollution.

Sandy soils are deficient in organic matter which is less than 5% and it can be replenished by the application of organic matters and composts to the soil[2]. Higher soil organic matter concentrations have been proved to enhance the yield and yield components of cereals[2]. Humic acid is the active constituents of organic fertilizers[3], and its application may represent an alternative to conventional soil fertilization. The value of humic acid substances cannot be overstated, they are absolutely critical elements, without which health in plant cannot be achieved. Humic substances can both directly and indirectly affect the physiological processes of plant growth[4]. Humic substances can be useful for living creatures in developing, as carrier of nutrition, as catalysts of biochemmical reactions, and in antioxidant activity[5].

The ecological benefits of humic substances, particularly humic acids, are diverse and represent profitable and effective solutions for environmental problems and preservation of the environment.

The objective of this work was to evaluate the effect of chemical fertilizers and humic acid on yield and yield components of wheat under sandy soil conditions.

Material and Methods

Two field experiments were conducted during two successive winter seasons of 2012/2013 and 2013/2014 in Research and Production Station, National Research Centre, Al-Nubaria District, Al Behaira Governorate. Egypt. Experiments were carried out to compare between the effect of chemical fertilizers and different levels of humic acid on the yield and yield components of wheat plants under sandy soil conditions. The mechanical and chemical analysis of the soil was conducted according to the method described by [6]and is presented in Table (1).

Table (1): Mechanical and chemical analysis of experimental soil

Sand %	Silt %	Clay %	pH	Organic matter,%	CaCO3 %	E.C. ds/m	Soluble N, ppm	Available P, ppm	Exchangeable K, ppm
98.1	3.6	4.9	7.3	0.4	1.4	0.3	8.8	3.3	21

Each experiment include five treatments in three replicates which were : control (without fertilizers), NPK fertilizer with the recommended dose, foliar spraying with (Actosol) which is a commercial product of humic acid containing 2.9% humic acid and NPK (10,10,10 %) . Foliar application with humic acid was done at 30 days after sowing with a rate of (1,2 and 4 litre/ feddan).

The experimental design was complete block design with three replicates The plot size was 10.5 m^2 = 1/400 fed. Grains of wheat (*Triticum aestivum* c,v. Sakha-93) were sown in 15 November in both winter seasons. The normal agriculture practices of growing wheat were practiced till harvest as recommended.

At harvest time representative samples from each plot for the three replicates were taken to determine plant height cm, number of spikes/m^2, dry weight of spikes g/m^2, spike length cm, number of grains/ spike, weight of 1000 grains (g). In addition, grain, straw and biological yields ton/fed were determined. NPK in grains were determined according to the method described by[7] and the grain protein content was calculated by multiplying total nitrogen concentration by 5.75. Statistical analysis was performed according to[8]. Treatments mean were compared by L.S.D. test.

Results and Disscusion:

a-Plant height:

The data obtained in Table (2) showed that either chemical or humic acid fertilization significantly increased plant height of wheat plants The same table also show that foliar application of humic acid significantly affected plant height and the highest parameter was achieved by foliar application of humic acid at the level of 2 Litre/ feddan and the lowest plant height was obtained under control conditions. Also, means comparison showed that plant height under 1litre foliar application of humic acid and 4 litre foliar application of humic acid were in a similar statistical group. The results further revealed that the application of humic acid resulted in significantly taller plants as compared to control. In this respect [9] reported that humic acid enhanced the growth of both roots and shoots. Similar results obtained by [10, 11] who reported that application of humic acid increased plant growth in terms of shoot length (18%).

Spikes characters:

Regarding spikes length the results presented in Table (2) showed that, the effect of chemical fertlizers and foliar spraying of humic acid was significant as compared with control plants.The comparison of the mean values of spike length showed that application of humic acid at 2 litre/ faddan has the highest record (11.87 cm.) and control treatment had the lowest spike length (84 cm).

Concerning spike weight similar trend was also observed i.e both chemical and humic acid fertilization has significant promoting effect on spike weight as compared with the control. The highest weight recorded by wheat plants sprayed with 2 litre / faddan. However, the difference between chemical fertilizer and humic acid treatment with rate of 2 litre/ faddan was not significant.

The effect of either chemical fertilizer or humic acid on number of grains per spike was significant at all levels of humic acid application as compared with unfertilized plants. The comparison of the mean values for grain weight per spike for wheat showed that application of humic acid application at the rate (2 litre / faddan) had the highest record (2.73 gm) and the control treatment had the lowest grains weight per spike (2.27 gm) .

Such effect of humic acid on spikes characters confirmed by the finding obtained by [12] and [10]. In this respect, [13] reported that number of spiklets/ spike as well as weight of grains per spike positively affected by humic acid fertilization..

c-Grain yield :

The grain yield is the final interaction of all yield contributing factors of wheat which resulted in the form of final yield, The final grain yield of cereal crops mainly depend upon the seed development and 1000 grain weight .

The data presented in Table (2) show that grain yield increased with different levels of humic acid but to less effect of chemical fertilizer as compared with unfertilized plants. The highest grain yield (2987.64 Kg/ fad.) obtained by wheat plants foliar sprayed with 2 litre humic acid/ faddan. However, such effect of chemical fertilizer on grain yield may be attributed to lowering the number of fertile spikelets per spike[14] .The positive effect of humic acid confirmed with the finding of [15,12,10,13,16]. Recently,[17,11] also added that maximum grain yield obtained by high level of humic acid.

Table 2: Effect of chemical fertilizer and foliar application of humic acid on yield of wheat plants

Treatment	plant length (cm)	spike length (cm)	wt. of spike (gm/spike)	wt.grains (gm/spike)	grain yield (kg/fad	bio. Yield (kg/fad)	straw yield (kg/fad)	Harvest index	wt.of 1000 grains (gm)
control	84.00	9.50	2.94	2.27	2317.23	7021.2	4704.0	33.5	47.7
NPK	108.33	10.63	3.49	2.56	2503.96	7880.0	5376.0	31.9	47.7
1 Litre/Fad	110.00	10.50	3.30	2.52	2656.08	9029.4	6373.3	29.4	46.3
2 Litre/Fad	112.33	11.87	3.63	2.73	2987.64	10392.6	7728.0	28.8	47.2
4 Litre/Fad	115.33	11.00	3.07	2.35	2664.56	9203.6	6216.0	28.9	51.2
LSD 5%	3.97	0.62	0.42	0.24	157.72	1429.73	1697.61	6.28	3.0

d-Straw Yield :

Data regarding to straw yield (Table 2) revealed that high straw yield was observed with all levels of humic acid than those plots receiving the only recommended rate of chemical fertilizers. The obtained results also claimed that the highest weight of straw per faddan (7728.0 Kg) was obtained by wheat plants foliar sprayed with 2 litre humic acid / faddan . Such promoting effect on straw yield may be resulted from the ability of humic acid to sustain photosynthetic tissues which in turn increase the total dry weight[18]. The results obtained in this section are ascertained by the findings of [19,13,20,11].

e-Biological Yield:

Results from mean comparison of data (Table 2) of studied treatments indicate that high application of humic fertilizer (2 litre/faddan) produced the highest biological yield, whereas no application of fertilizer produced the lowest biological yield. Biological results show the produced dry mater accumulation during its life cycle that indicate the response of growth and yield of wheat to humic acid. The data regarding to this parameter (Table 2) also revealed significant differences among all humic acid levels on the biological yield of the wheat crop as compared with unfertilized plants. Such pronounced effect of humic acid on the biological yield may be attributed to the promoting effect of humic acid on growth and yield and height and in turn biological yield. In this respect,[21] on wheat and [22] on maize reported that application of humic acid in nutritional

solution led to increased content of nitrogen within aerial parts and growth of shoots and root. Similar results obtained by [13,16,17,11].

f-1000 grain weight:

A part from all other yield contributing factors, the ultimate final grain yield of cereal crops mainly depend upon the seed development and 1000- grain weight of that crop which were nourished under the available nutrients in the prevailing field conditions.The data shown in Table (2) indicated that there is no significant effect was recorded between chemical fertilizers and different levels of humic acid treatment on 1000- grain weight except the rate of humic acid (2 litre / faddan). The data indicated that the maximum 1000-weight obtained by wheat plants foliar sprayed with 2 litre humic acid / faddan (51.2 gm). These results are strongly supported by[23,13,11] .

Harvest index:

The data presented in Table (2) show that such criterion slightly decreased in wheat plants sprayed with humic acid at any level as compared with unfertilized plants or supplied with chemical fertilizer These results supported by findings obtained by[24] .

Effects of chemical fertilizer and foliar application of humic acid on the nutrients content of the straw:

a-Effect on NPK uptake:

The data presented in Table (3a) show that either chemical fertilization or humic acid application increased nitrogen percentage of wheat straw as compared with untreated plants. However, the highest percentage recorded by rate of (2 litre humic/ faddan) .These results were in full with [25, 26] who reported that application of humic acid led to increased nitrogen content of nut grass plant.

The same table (3a) also show that both chemical fertilization and foliar spraying with humic acid in most levels increased phosphorus uptake of wheat leaves. But it is worthy to note that high rate of humic acid application (4 litre humic acid/ faddan) resulted in low level of phosphorus. These findings ascertained by the results obtained by [26,27,28,13]. The increased P content in different wheat parts with humic acid application may be due to the fact that humic acid increased phosphorus availability and uptake [29].

Table 3 (a):chemical constituents of straw as affected by chemical fertilizer and foliar application of humic acid

Treatment	N %	P %	K %	Carbohydrate %	Protein %	C/N ratio
control	1.33	0.11	1.73	9.80	8.77	1.12
NPK	2.06	0.16	2.43	15.40	11.70	1.32
1 Litre/Fad	2.87	0.17	2.23	16.77	12.10	1.39
2 Litre/Fad	3.20	0.17	2.90	18.67	12.50	1.49
4 Litre/Fad	2.77	0.14	2.00	13.47	10.63	1.27
LSD 5%	0.35	0.02	0.26	3.78	0.88	0.30

Data recorded in Table (3a) also indicated that when compared with the control,either chemical fertilization or foliar application of humic acid raised K uptake of wheat leaves and the amounts (2.90) were found high at the rate of humic acid (2 litre humic acid/ faddan) . [30,28,13]came to the same conclusion. Such increase in wheat K-uptake recorded in this study may be resulted from the reduced potassium fixation with the addition of humic acid.[13].

Such enhancing effect of humic acid on nutrient uptake with foliar application of humic acid reported by various researchers [25,31,27,13,1]. The stimulation of ion uptake by treatments with humic acid material may be attributed to the effect of humic acid on the membrane permeability and the better- developed root system [32]. [11] added that the wide variation in nutrient contents and uptake was associated with humic acid rates. In general, concentration and uptake of nutrients increased with increasing humic acid level.

.b- Effect on carbohydrate and protein percentage:

As regards the effect of chemical and humic acid treatment on carbohydrate percentage of wheat grains the data clearly indicate that either chemical fertilizer or humic acid treatment increased carbohydrate percentage of the straw (Table 3a). The data also show that foliar application with 2 litre / faddan surpassed all treatment and gained 18.67% .These results are in full agreement with those obtained by [33,11,34]..

As for protein content of the straw the data presented in Table (3a) show similar trend of chemical fertilizer and humic acid application on protein percentage of the straw and the highest protein content obtained by wheat straw foliar sprayed with 2 litre/faddan humic acid. In this concern, [33] reported that application of humic acid gave considerable improvement in total carbohydrates and crude protein of wheat plants when compared with unfertilized plants. Similar results obtained by [35,36].

Concerning C/N ratio the data presented in Table 3 (a) show that generally, there is no significant effect of chemical or humic acid application on this criterion.

Effects of chemical fertilizer and foliar application of humic acid on the nutrients contents of the grains:

a-Effect on NPK uptake:

Table 3 (b) clearly indicate that either chemical fertilizers or foliar application of humic acid at all rates significantly increased nitrogen percentage as compared with unfertilized plants. It is obviously indicated that chemical fertilizer treatment surpassed all the treatment. Similar results obtained by [13] in wheat and [31] in maize.

Concerning phosphorus percentage the previous Table 3(b) also show that phosphorus affected slightly by either chemical fertilizer or humic acid application. But it is worthy to note that grain wheat supplied by 2 litre humic acid per faddan gain the highest phosphorus percentage. These results confirmed by those obtained by[33,27].

Table 3 (b): chemical constituents of grains as affected by chemical fertilizer and foliar application of humic acid

Treatment	N	P	K	Carbohydrate	Protein	C/N ratio
	%	%	%	%	%	
control	1.40	0.24	0.25	20.57	7.93	2.61
NPK	2.00	0.25	0.28	55.67	17.00	3.29
1 Litre/Fad	1.93	0.24	0.28	57.13	17.90	3.23
2 Litre/Fad	1.87	0.32	0.29	62.30	20.00	3.12
4 Litre/Fad	1.70	0.27	0.27	51.07	17.30	2.95
LSD 5%	0.14	0.04	0.02	3.52	2.06	0.47

Concerning potassium uptake as affected by chemical fertilizer and humic acid application the data presented in Table 3(b) show that both NPK fertilizer and humic acid spraying slightly increased potassium concentration of the grains as compared by control plants. Such effect was in agreement with those obtained by [28,13] who reported that humic acid significantly improved wheat potassium content under calcareous soil.

In general, it is obvious from Table 3(b) that application of humic acid gave considerable improvement in nutrients uptake of wheat grains when compared with un fertilized treatment. In this respect, [37,38] documented that enhance uptake of macronutrients(NPK) was due to the stimulatory effect of humic substances. Recently, [11]added that application of humic acid showed promising effects on nutrient contents in different components of wheat (shoot and grains).

b- Effect on carbohydrate and protein percentage:

Regarding total carbohydrate and crude protein in the grain, the same positive trend on straw was observed with application of humic acid and chemical fertilizer as compared with unfertilized plants. However, such effect was obvious by humic acid application The maximum carbohydrate and protein percentage was

(62% and 20%) respectively obtained by foliar application of humic acid with the rate of 2 litre/ faddan (Table 3b). These results were in full agreement with those obtained by [33, 39,11]. In this respect [34] reported that that foliar spraying with humic acid resulted the highest values of yield attributes and increased grain and straw yields ,protein and carbohydrates contents in grains as compared with the control treatment.

Regarding C/N ratio the data recorded in Table 3 (b) indicate that this criterion increased by either chemical and humic acid application as compared with control plants. However, there are no significant effect between chemical and humic acid treatments.

Conclusion :

From the obtained results it can be concluded that application of humic acid has promoting effect on most yield components. Humic acid application can lessen the need for chemical fertilizers and subsequently reduce environmental pollution. Finally, it can be said that application of humic fertilizer not only increases the yield of wheat, but also wheat quality reflexed by high content of carbohydrate and protein content of grain wheat . It can play a significant role in achieving the goals of sustainable agriculture in new reclaimed sandy soils.

Overall, this study indicate that the application doses are important for deriving benefit from humic substances under sand soils. These results indicate that the highest yield and yield components revealed by foliar application of 2 litre humic acid/ faddan.

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