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Response of wheat yield to soil application of humic acid and foliar application of sodium silicate.

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ABSTRACT

A field experiments was carried out during the winter seasons of 2014/2015 and 2015/2016 at the experimental farm of The City of Scientific Research and Technological Applications (SRTA-City), Borg El-Arab City, Alexandria, Egypt, to study the effect of humic acid as soil application at the rates of (0, 1, and 2 kg/feddan) and sodium silicate as foliar application at the rates of (0, 100 ppm, 200 ppm) on wheat grain yield and grain yield components under calcareous soil conditions. The results showed that increasing the levels of humic acid did not significantly affect spike length (cm), number of grain /spike, and harvest index (%). Also, plant height (cm), number of spikes/m^2, weight of grain/spike (g), grain yield (tons/feddan), straw yield (tons/feddan), and biological yield (tons/feddan) had no specific trend and were not significantly affected by humic acid. The application of sodium silicate at 200 ppm resulted in a remarkable increase in all the studied parameters as compared with control except for spike length (cm) and harvest index (%) which were not significantly affected by the foliar application of sodium silicate. Number of spikes/m^2, straw yield (tons/feddan), and biological yield (tons/feddan) were significantly increased by increasing the levels of sodium silicate. The interaction was not significant for all the studied parameters revealing that both humic acid and sodium silicate acted independently from each other.
Keywords: Humic acid, Sodium silicate, wheat, calcareous soils.

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INTRODUCTION

Food production in third world countries should be 70% more than the current production to be able to meet population growth and their needs [1]. Egypt, as one of the developing countries, suffers from shortage in food due to the increase in population and the loss of agricultural lands. Wheat (*Triticum aestivum*, L.) is considered one of the most important cereal crops not only in Egypt but also in the world where it is used in both human food and animal feed. Wheat supplies about 37 % of the total calories and about 40 % of the protein in the Egyptian diet. Recently, an increasing attention of several investigators has been focused on enhancing the productivity of wheat in order to minimize the gap between the production and consumption by increasing wheat production per unit land area and reclamation of new lands. Increasing wheat grain yield per unit area may be reached by using traditional and modern breeding to produce high yielding varieties as well as applying the optimum management or practices such as the addition of organic fertilizers which improve soil fertility via their effect on the physical, chemical and biological properties of the soil, but when it is used alone it is not sufficient to meet the crop requirements of nutrients. The grain yield of wheat is a function of many factors where cultivars and fertilization are the most important. Silicon (Si) is the second abundant element in soil after oxygen and comprises about 31% of its weight, 3-17% in soil solution [2]. It is commonly found in soils in many different forms such as Silicic Acid [Si $(OH)_4$], its absorption happens mainly from this form [3], its quantity is 0.1 to 0.6 mmol.dm^{-3}. However, silicon is not considered an essential element for the growth of the plants, in addition, its role in plant biology is not completely understood. By losing water from shoots, Silicic Acid concentrated, and then converts to silica gel ($SiO_2.nH_2O$) and consequently increases plant's resistance to stress [2]. Researches have proved that enough uptake of silicon (Si) can increase crop tolerance to both abiotic and biotic stress such as in Rice. Effects of silicon on crop yield is correlated to the its deposition under leaf epidermis which provides a physical mechanism of defense and consequently reduces lodging, increases photosynthesis capacity and decreases water losses via transpiration [4]. Application of organic and mineral fertilizers in agricultural production has greatly increased in recent years [5]. Humic acid is one of the used organic-mineral fertilizers and constitutes a major component of humic substances. Humic matter is formed through the chemical and biological humification of plant and animal matter and via the biological activities of microorganisms [6]. Under water stress, foliar fertilization with humic acid increased leaf water retention, photosynthesis, and the metabolism of antioxidant [7]. Humic acids have both hydrophilic and hydrophobic groups. The hydrophilic group’s hydration caused increasing of water retention capacity in soils. Humic acids (HAs) are the main fractions of humic substances (HS) and the most active components in soil and organic matter. HAs stimulate crop growth and consequently crop yield by involving in mechanisms such as photosynthesis, water and nutrients uptake, cell respiration, protein synthesis, and enzyme activities [8-9-10]. The action of humic acids has been shown to be dependent on dose and especially effective in low concentrations [9].

MATERIALS AND METHODS

A field experiments was carried out during winter season of 2014/2015 and 2015/2016 at the experimental farm of City of Scientific Research and Technological Applications, Borg El-Arab City, Alexandria, Egypt to study the effect of the addition of humic acid (0, 1, and 2 kg/feddan) and the foliar application of sodium silicate (0, 100, and 200 ppm) on yield and yield components of wheat variety (Giza 168) grown under calcareous soil conditions. Chemical properties of the soil (Table 1) were analyzed according to [11]. The experimental design was split plot with three replicates was used, the main plots were occupied by humic acid rates whereas sodium silicate levels were allocated in the subplots. The sub plot area was 10.5 m^2 (1/400 feddan, one feddan = 4200 m^2) it includes 15 rows, 20 cm apart and each of 3.5 m in length. Sowing dates of experiments were on late November in both seasons and harvested early May. The humic acid was applied at 30 and 45 days after sowing. N fertilizer was added in the form of ammonium nitrate (33.5% N). Super phosphate fertilizer (15.5 % P_2O_5) was applied before sowing at the rate of 150kg/feddan Potassium fertilizer was applied before sowing (during seedbed preparation) at the rate of 50 kg/feddan in the form of potassium sulphate (48% K_2O). At harvest one square meter of each plots were harvested for determining the following: Plant height (cm), number of spikes/m^2, spike length (cm), number of grain/spike, weight of grain/spike (g), grain yield (tons/feddan), straw yield (tons/feddan), biological yield (tons/feddan) and harvest index. Data obtained were subjected to procedures of split plot design outlined by [12] by using analysis of variance Technique.

Table 1: Mechanical and chemical analyses of experimental soil before sowing.

Sand%	Silt %	Clay %	Soil Texture	pH	O.M. %	$CaCo_3$ %	E.C. dS/m	Available nutrients, ppm		
								N	P	K
63.05	14.22	20.64	Sandy clay loam	8.24	0.69	30.64	2.2	119	5.1	420

RESULTS AND DISCUSSIONS

Effect of Humic acid as soil application

Data in Tables (2 & 3) indicated that humic acid levels had no significant effect on all the studied parameters, no specific trend was observed in plant height (cm), weight of grain/spike (g), number of spikes/m^2, grain yield (tons/feddan), and biological yield (tons/feddan). However, a slight increase was observed in spike length (cm), number of grain/spike, and harvest index whereas a slight decrease was observed in straw yield (tons/feddan). In general, the level of 2 kg/feddan of humic acid gave an increase of 1.89 % in plant height (cm), 4.34 % in spike length (cm), 14.22 % in number of grain/spike, 9.19 % in weight of grain/spike, 11.29 % in number of spikes/m^2, 8.3 % in grain yield (tons/feddan), 7.41 % in harvest index as compared to the control treatment. The improving effect of humic acid may be due to the indirect effects of humic acid such as enrichment of soil nutrients, increase in microbial population, higher cation exchange capacity, and improvement of soil structures [13-10]. The results are in general agreement with those obtained by [14] who stated that humic acid insignificantly increased grain yield of wheat grown under calcareous conditions.

Effect of sodium silicate as foliar application

Data presented in Tables (2 & 3) indicated that foliar application of sodium silicate had significant effect on plant height (cm), number of spikes/m^2, straw yield (tons/feddan), and biological yield (tons/feddan) where applying 200 ppm of sodium silicate resulted in a significant increase of 8.22 %, 23.82 %, 12.67 %, and 12.06 % respectively. However, a non significant increase was observed in number of grain/spike, weight of grain/spike (g), and grain yield (tons/feddan) where application of 200 ppm of sodium silicate resulted in an increase of 9 %, 14.52 %, and 10.55 % respectively. In addition, no specific trend was observed in spike length (cm) and weight of grain/spike (g). The higher silicon content was associated with the higher rate of silicon application (200ppm). This might be due to increase in root growth and enhanced soil silicon availability with silicon application. This finding is in agreement with the reports of [15].

Table 2: Effect of humic acid and sodium silicate on yield components of wheat
(combined analysis of the two seasons).

Treatments	Plant height (cm)	Spike length (cm)	Number of grain/ spike	Weight of grain/ Spike (g)	Number of spikes/m^2
	Humic acid				
0Kg/feddan	82.33 a	15.44 a	37.55 a	1.85 a	322.67 a
1Kg/feddan	82.00 a	15.89 a	38.44 a	1.73 a	364.00 a
2Kg/feddan	83.89 a	16.11 a	42.89 a	2.02 a	359.11 a
	Sodium silicate				
0 ppm	81.11 b	16.22 a	38.33 a	1.79 a	311.56 b
100 ppm	79.33 b	15.22 a	38.78 a	1.76 a	348.44 ab
200 ppm	87.78 a	16.00 a	41.78 a	2.05 a	385.78 a

Table 3: Effect of humic acid and sodium silicate on wheat yield
(combined analysis of the two seasons).

Treatments	Grain yield (tons/feddan)	Straw yield (tons/feddan)	Biological yield (tons/feddan)	H.I.
	Humic acid			
0Kg/feddan	2.41 a	6.41 a	8.83 a	0.27 a
1Kg/feddan	2.38 a	6.25 a	8.63 a	0.28 a
2Kg/feddan	2.61 a	6.18 a	8.79 a	0.29 a
	Sodium silicate			
0 ppm	2.37 a	5.92 b	8.30 b	0.29 a
100 ppm	2.40 a	6.25 ab	8.66 ab	0.28 a
200 ppm	2.62 a	6.67 a	9.30 a	0.28 a

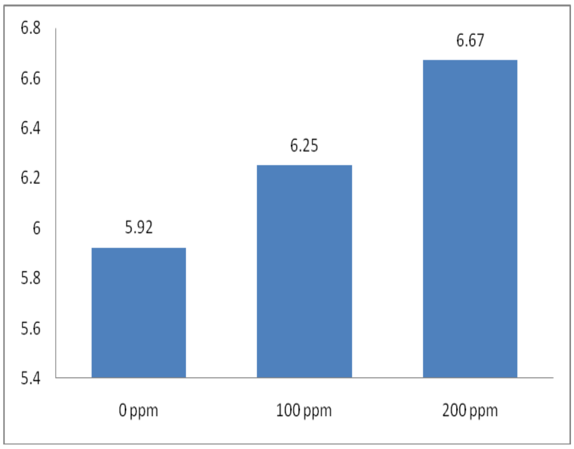

Figure 1: Effect of sodium silicate on wheat straw yield

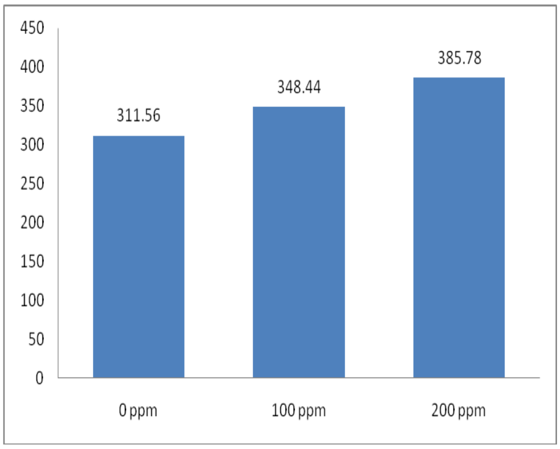

Figure 2: Effect of sodium silicate on number of spikes/m^2

CONCLUSION

It can be concluded from the current study that humic acid did not significantly affected wheat yield at the studied levels which reveal that more investigation is needed at higher rates of applications while application of sodium silicate at 200 ppm significantly increased number of spikes/m^2 and consequently straw yield and biological yield.

REFERENCES

[1] Asgharid D. Potatoes History. Prootion Management and Public Participation of Agricultural Organization, 2011.Khorasan.
[2] Epstien E. Silicon. *Annual Review of Plant Physiology and Plant Molecular Biology*. 1999; 50: 641-664.
[3] Chen W, Yao X, Cai K, Chen J. *Biological Trace* Element Research. 2010; 142:67–76.
[4] Korndörfer GH, Snyder GH, Ulloa M, Powell G, and Datnoff LE. Journal of Plant Nutrition. 2001; 24:7, 1071 – 1084.
[5] Doran I, Akinci C and Yildirim M. Effects of delta humate applied with different doses and methods on yield and yield components of Diyarbakir-81 wheat cultivar. 5th Field Crops Congress, Diyarbakir, Turkey. 2003; (2): 530-534 (in Turkish with English abstracts).
[6] Anonymous. Humic and fulvic acids: The black gold of agriculture? http://www.humintech.com/pdf/humicfulvicacids.pdf (Access date: 10.08.2010)
[7] Fu Jiu C, Dao Qi Y and Quing Sheng W. Yingyong Shengtai Xuebao.1995; 6, 363–367.

[8] Albuzio A, Ferrari G and Nardi S. Can J Soil Sci 1986; 66, 731-736.
[9] Chen Y and Aviad T. Effects of humic substances on plant growth. In: Humic substances in soil and crop sciences: selected readings (MacCarthy P., Clapp C., Malcolm R.L., Bloom P.R., eds). Am Soc Agron, Madison, WI, USA. 1990; pp. 161-186.
[10] Chen Y, De Nobili M and Aviad T. Stimulatory effects of humic substances on plant growth. In: Soil organic matter in sustainable agriculture (Magdoff F., Weil R.R., eds). CRC Press, NY, USA. 2004; pp. 103-129.
[11] Page AL, Miller RH and Keeney DR. Methods of Soil Analysis: Part 2 Chemical and Microbiological Properties. ASA Inc., SSSA, Inc., 1982; Medisio Wiscansin
[12] Gomez KA and Gomez AA. Statistical procedures for agricultural research 2nd. 1984; pp 680, John Willy and Sons. NewYourk.
[13] Varanini Z and Pinton R. Direct versus indirect effects of soil humic substances on plant growth and nutrition. In: The rhizosphere: biochemistry and organic substances at the soil-plant interface (Pinton R., Varanini Z., Nannipieri P., eds). Marcel Dekker Inc, NY, USA. 2001; pp. 141-157.
[14] Asal MW, Elham AB, Ibrahim OM**,** Ghalab EG. Can humic acid replace part of the applied mineral fertilizers? A study on two wheat cultivars grown under calcareous soil conditions. 2015; 8(9): 20-26.
[15] Kalyan Singh, Ragavendra Singh, Singh JP, Yogeshwar Singh, and Singh KK. Indian J Agric Sci 2006; 76(7): 410 – 413.