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IMPACT OF FOLIAR SPRAYING OF SOME ORGANIC SUBSTANCES AND MICRONUTRIENTS ON WHEAT GROWN ON CLAYEY SOIL

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ABSTRACT

A field experiment was carried out at Sakha Agric. Exp. Res. Sta., Kafr El-Sheikh Governorate Egypt (31°05' N latitude and 30°56' E longitude), in successive winter seasons 2008/2009 and 2009/2010 on wheat (*Triticum aestivum L.* Sakha 93 variety). Effects of foliar spraying of organic substances and micronutrients on wheat productivity, nitrogen (N), phosphorus (P), protein contents and nitrogen use efficiency (NUE) were studied. Split plot design was used with four replicates; the main plots were assigned for three organic substances solutions (OS) treatments spraying:-: 1- without OS spraying (control). 2- humic acids spraying (HA_s). 3- compost tea (CT) spraying. And the sub plots were assigned for five treatments of micronutrients spraying :-1- without micronutrients spraying (C) 2- copper (Cu) foliar spraying 3- zinc (Zn) foliar spraying 4- iron (Fe) foliar spraying and 5- micronutrients, Cu +Zn +Fe (M) foliar spraying.

The obtained results showed that: Humic acids (HA_s) treatment had the highest mean values (5.61 and 5.88 Mg ha^{-1}) of wheat grain in the first and second seasons, respectively. Treatment in the main plots affected wheat grain yield in the order: HA ≥ CT> control. Nevertheless, the interaction between micronutrients foliar spraying with HA had the order: HA_s + M ≥ HA_s + Cu ≥ HA_s + Zn > HA_s. Spraying of HA, Zn and Fe led to elevate N % and P % in grain yield. Also, Cu treatment without or with (OS) led to increase their content in straw yield.

Organic substances spraying insignificantly affected wheat straw yield. However, the higher value was obtained with HA_s. HA Foliar spraying with Cu treatment had the highest mean value (9.73 Mg ha^{-1}), in the first season. While the highest mean value (9.12 Mg ha^{-1}) was recorded for HA_s and C spraying in the second season. The higher mean values of N and protein content in grain yield were observed with application HA_s. Nonetheless, HA_s +Zn treatment in the first season and HAs +M treatment in the second season exhibited the higher value. Spraying of HA treatment led to increase P content in grain yield. Spraying (OS) affected N, P and protein contents of straw in the order**:** HA_s > Control > CT, in both seasons. Copper spraying with or without HA led to increase N, P and protein content in straw yield in the both seasons.The lower mean values for N and protein contents were recorded for TC an /or TC+M. The higher mean values of NUE were obtained with HA spraying treatment and the interaction between HA_s + M in both seasons.

Keywords: Wheat, micronutrients, organic substances, humic acids, compost tea, foliar spraying

INTRODUCTION

Wheat (*Triticum aestivum L.*) has the first production rank; among all cultivated cereals in Egypt. Its cultivated area reached to about 1.2 million hectare in year 2008; produced about 7.9 million Mgs (FAO, 2008). However, such production does not meet the actual consumption. . Therefore tremendous amount of wheat are annually imported consequently there is a

dire need to augment wheat production. Applying balanced fertilizers, macro, micronutrients and organic materials are among the tools which could boost wheat productivity and its quality. Copper, Zinc and iron (Fe) are known to play a very important role in chemical processes in plants. Korzeniowska (2008) found that wheat plants after Cu application showed higher N concentration than control plants. Moreover, high correlation between Cu and N concentration in wheat shoots were obtained. Positive effect of copper foliar application studied on wheat growth parameters can be attributed to the important function of copper in metabolism and chloroplast development (Amberger, 1974). El-Magid *et al*. (2000) showed that, spraying Zn, Mn, B, Fe and Cu increased wheat plant P and K contents. Maralian (2009) demonstrated that foliar application of different micronutrients for wheat could be equal or more effective than soil applications and could be used effectively to overcome the problem of micronutrients deficiency in subsoil.

The stimulatory effects of humic substances have been directly correlated with enhanced uptake of macronutrients, such as nitrogen, phosphorus and micronutrients, that is, Fe, Zn, Cu and Mn (Jones *et al*. 2007 and Verlinden *et al*. (2009). Humic acids can be classified into three general categories like humic acid, fulvic acid and humin. (Solange and Rezende, 2008). Humic substances (HS) have significant impacts on the soil structure and plant growth, (Fong et. al 2007). Humic acids (HA) can indirectly and directly affects the physiological processes of plant growth. It could provide minerals, increase the micro-organism population, provide biochemical substances, and carry trace elements and growth regulators (Yang *et al*., 2004). Applications of (HA) may help in increasing organic food production, (HS) applications are generally recommended in organic agriculture (Reza Shahryari et. Al., 2009).. Yield of wheat was increased from 2.5 to 3.6 Mg/ha by using humic acid, (Reza Shahryari and Vahid Mollasadeghi 1995). Chen *et al*., (2001) and Shaaban et. al., (2009), concluded that humic acids foliar spray could enhance growth, nutrient uptake, yield and improves the quality of produce in some crops and might minimize pollution, costs and uptake of N, P, K Fe, Zn and Cu in wheat plants.

Ingham (1999) found that foliar application of the humic substances on wheat had statistically significant effect on Mg, Fe and Mn uptake. Humic acid raised the dry weight and N, P, K, Ca, Mg, Na, Fe, Cu, Zn and Mn uptake of plants.

Compost tea (CT) applied to plant foliage has immediate impacts upon the plants welfare. Good quality compost tea that provides beneficial organisms and plant nutrients are essential, and could avoid salt burn problems and risk of pathogens. Ingham (2005) suggested as a general guide an application of about 50 L/ha of compost tea for foliar application and 150 L/ha for soil application.

The purpose of this research work is to show up the effects of applying foliar spray of organic substances (HA or CT) and individual micronutrients: copper (Cu), zinc (Zn), iron (Fe) and all together (Cu + Zn + Fe) on wheat yield productivity, protein, nutrients content and nitrogen use efficiency (NUE) .

MATERIALS AND METHODS

A field experiments was conducted at Sakha Agric. Exp. Res. Station, Kafr El-Sheikh Governorate, Egypt, at Northern Delta region (31^{o}05' N latitude and 30^{o}56' E longitude), during successive winter seasons of 2008-2009 and 2009-2010 to study the effect of spraying micronutrients individually or in association with humic acid and /or compost tea on wheat (*Triticum aestivum* Sakha 93 variety) productivity ,100 grain weight, N, P content and nitrogen use efficiency (NUE). The experimental soil was prepared by suitable ploughing and land leveler. The recommended seed rate (143 kg ha^{-1}) of wheat was planted on 16th and 19th November in the first and second seasons, respectively. Split plot design was used with four replicates. The main plots were assigned for three treatments of foliar organic substances namely ; without spraying (Control) ; spraying with humic acids (HA_s) and Spraying with compost tea (CT). The subplots were randomly assigned by five micronutrients foliar spraying treatments, applied in the form of sulphate namely; 1- without spraying (C) 2- Copper (Cu) 3- Zinc (Zn) 4- Ferrous (Fe) and 5- Cu +Zn +Fe (M). Micronutrients and HA_s were prepared at Soil Fertility and Plant Nutrition Department, Sakha, Agric. Res. Stat., where their concentrations were 0.1% Cu, 0.5% Zn and 2.5% Fe in the stock solution. Compost tea was prepared by Soil Biology Department, Sakha, Agric. Res. Stat. It contained 227;23 and 16 mg kg^{-1} of total N, P and K ,respectively. Besides, 132 mg Fe, 15 mg Zn and 17 mg Cu kg^{-1}.

Single super phosphate fertilizer 15.5% P2O5 (6.77% P) was added at a rate of 238 kg ha^{-1} during the soil preparation. Potassium sulphate fertilizer 48% K_2O (19.92 % k) was added at a rate of 119 kg ha^{-1}in one dose with the first irrigation. Nitrogen fertilizer was added as urea (46% N) at two equal doses added just before the first and second irrigation. Micronutrients, HA and CT were foliar sprayed four weeks after emergence at the rate of 2.4 L ha^{-1} for HA and 50 L ha^{-1} for CT (spraying was executed using 500 L water ha^{-1}).This task was replicated three times every 21days. A composite soil sample was collected before planting from the experimental soil site to determine some soil properties; Black *et al*., (1965). Some physical and chemical characteristics are presented in Table 1.

Table1: Some physical and chemical properties of the experimental field.

Season	Particle size distribution %			Texture class	EC dSm^{-1}	pH (1:2.5)	Organic Matter (%)	Available nutrients (mg kg^{-1})		
	Sand	Silt	Clay					N	P	K
1st season	8.3	33.3	58.4	Clayey	2.46	7.81	1.89	22	7	236
2nd season	9.2	30.2	60.6	Clayey	2.32	7.93	1.74	19	6.9	216

At plant maturity, one meter square from each treatment was allocated to estimate the grain yield (Mg ha^{-1}), straw yield (Mg ha^{-1}); 100 grain weight (g), and the biological yield per ha (Mg ha^{-1}) . These plant samples were taken on 4th May 2009 and 8th of May 2010. Representative samples of straw and grain for each treatment were oven dried at 70°C. Plant samples were fine

ground and wet digested and kept for chemical analyses. Total contents of N and P. Total nitrogen and total phosphorus were determined in the digested samples according to Jackson (1967). Protein content was calculated by multiplying N% x 5.7 x Yield kg ha^{-1}

Extractable Fe,Zn and Cu from soil by using DTPA according to Lindsay and Norvell (1978) were in the average :4, 0.8 and 0.2 mg kg^{-1} ,respectively .

Nitrogen use efficiency (NUE) was calculated as grain yield Kg /one Kg of N added. The obtained results were statistically analyzed ($P \leq 0.05$) using MSTATC computer program.

RESULTS AND DISCUSSION

Grain yield, straw yield and 100 grain weight:

Data presented in Table 2 show that the treatment of foliar spraying organic substances led to significant increases of wheat grain yield in the two seasons. Humic acids (HA) treatment had the highest mean values (5.61 and 5.88 Mg ha^{-1}) in the first and second seasons, respectively. While the lowest mean values were observed with the control treatment (without foliar spraying of organic substances OS). The foliar spraying of (OS) affected wheat grain yield in the order: HA ≥ CT > 0 (control).

Table2: Effects of organic substances (HS) and micronutrients foliar spraying on wheat grain, straw yield (Mg ha^{-1}) and 100 grain weight (gm).

Treatments		Grain yield (Mg ha^{-1})		Straw yield (Mg ha^{-1})		100 grain weight (gm)	
OS	Micr.	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control	C	4.98 c	4.85 g	8.33 de	8.79 abc	5.18 ab	5.29 f
	Cu	5.32 abc	5.36 cde	9.33 ab	8.91 abc	5.17 ab	5.60 a
	Zn	5.05 bc	4.92 fg	9.00 bc	8.76 abc	5.22 a	5.31 bcd
	Fe	4.97 c	5.19 def	8.10 e	8.73 bcd	4.95a b	5.04 e
	M	5.08 abc	5.42 cde	9.07 b c	8.65 cde	5.20 a	5.38 abcd
Means		5.08 B	5.15 B	8.97 A	8.77 A	5.14 A	5.33 A
HA	C	5.37abc	5.97 ab	8.60 c de	9.12 a	5.23 a	5.48 ab
	Cu	5.83ab	6.07 a	9.73 a	9.03 ab	5.12 ab	5.18 cde
	Zn	5.50 abc	5.71 abc	9.47 ab	8.74 bcd	5.05 ab	5.17 cde
	Fe	5.50 abc	5.50 cde	9.47 ab	8.88 abc	5.07 ab	5.17 cde
	M	5.87 a	6.14 a	9.53 ab	8.95 abc	5.12 ab	5.18 cde
Means		5.61 A	5.88 A	9.36 A	8.94 A	5.12 A	5.24 A
CT	C	5.33 abc	5.39 cde	9.33 ab	8.55 de	5.07 ab	5.15 de
	Cu	5.47 abc	5.62 bcd	9.53 ab	8.85 abc	5.07 ab	5.18 cde
	Zn	5.18 abc	5.27 def	9.20 abc	8.47 e	4.82 b	5.07 e
	Fe	5.17 abc	5.07 efg	9.20 abc	8.67 bcd	5.08 ab	5.20 cde
	M	5.38 abc	5.35 cde	8.93 bcd	8.80 abc	5.15 ab	5.40 abc
Means		5.31 AB	5.34 AB	9.24 A	8.67 A	5.16 A	5.20 A

ha = 2.381 faddan C = without spray micronutrients (control). M = (Cu +Zn +Fe). HA = Humic acids. CT = Compost tea. Mg (megagram) = ton OS = Organic substances

With respect to the interaction between foliar spraying of (OS) and micronutrients, it led to a remarkable variations, the highest grain yield mean

values (5.87 and 6.14 Mg ha^{-1}) were recorded with the combination between HA and usage of the three micronutrients (M), in the first and second seasons, respectively. On the other hand the lowest values were observed with the treatment of the control having neither organic substances nor micronutrients (4.98 and 4.85 Mg ha^{-1}) in the first and second seasons, respectively. In general micronutrients foliar spraying and its combination with HA had best results in the order: HA + M ≥ HA + Cu ≥ HA + Zn > HA, in the two seasons. The obtained results may be attributed to the role of essential micronutrients added. And the positive effects of HA on plant growth (Dursun *et al*., 2002).

The obtained results are in agreement with those described by (Sarkar *et al*., 2007). The response of foliar application of humic acid was noticed by Ulukan (2007). He demonstrated that it stimulates growth, yield and the quality of wheat crop. Similar results were reported by El-Magid *et al*., (2000), Ziaeian and Malakouti (2001). Karamanos *et al*., (2003) showed that grain yield of wheat was increased due to foliar Cu application.

Data in Table 2 indicated that organic substances spraying insignificantly increased wheat straw yield. The highest mean values (9.36 and 8.94 Mg ha^{-1}) were recorded with HA treatment, in the first and second seasons, respectively. The interaction between foliar spraying of (OS) and micronutrients affected significantly the straw yield in the two seasons. Foliar spraying HA with Cu treatment had the highest mean value (9.73 Mg ha^{-1}) followed by mean values of (9.53 and 9.33 Mg ha^{-1}) with foliar spraying of CT with Cu and CT treatments, respectively. While the lowest mean value of straw yield (8.33 Mg ha^{-1}) was recorded for the control without organic substances and without micronutrients, in the first season.

The obtained data showed that foliar spraying (OS) had no significant effect on 100 grain weight. Nonetheless, the interaction between (OS) and micronutrients spraying had significant effects, in the two season's .The highest mean values (5.23 and 5.48 g) were observed with spraying HA without micronutrients treatments, in the first and second seasons, respectively. These results are in harmony with those described by Korzeniowska (2008), Reza Shahryari and Vahid Mollasadeghi(1995)and (Chen and Aviad, 1990) who reported that humic substances have positive effects on plant biomass.

N and P contents in grain and straw yields:

Data in Table 3 show that foliar spraying of (OS) treatments led to insignificant effect on N % in wheat grain in the both seasons. The highest mean values (1.96 and 2.02 N %) were recorded with HA_s treatment in the first and second seasons, respectively. However, the interaction between (OS) and micronutrients foliar spraying on N %in wheat grain showed some remarkable effect in both seasons. The highest mean values (2.22 and 2.15 N %) were observed due to HA_s + Zn treatments spraying and Fe treatment without (OS) spraying in the first and second seasons, respectively.

The obtained data revealed that increases of P in grain yield with (OS) foliar spraying in the both seasons were insignificant. The highest mean P values; 0.31 and 0.29 P % were recorded in grain yield with HA_s + C (without micronutrients spraying) treatment, in the first and second seasons, respectively. With respect to straw yield, foliar spraying of (OS) treatments had insignificant effect on N % in both seasons..In general higher mean values

for N content were observed Cu spraying treatments. With regard to P contents it showed the same trend of N .Similar results were reported by El-Magid *et al*., (2000).

Table3: Effect of organic substances (OS) and micronutrients foliar spraying on N % and P % in grain and straw yields of wheat

Treatment		Grain yield				Straw yield			
		N %		P %		N %		P %	
OS	Mic	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control	C	1.58 f	1.66hi	0.26 a	0.27 ab	0.62 a	0.58 a	0.025 a	0.025 b
	Cu	1.82 cde	1.87cdef	0.26 a	0.25 ab	0.66 a	0.61 a	0.051 a	0.032 b
	Zn	1.91 bcd	1.89cdef	0.27 a	0.28 ab	0.44 a	0.42 a	0.023 a	0.027 b
	Fe	2.16 ab	2.15 a	0.26 a	0.27 ab	0.58 a	0.47 a	0.021 a	0.024 b
	M	1.58 f	1.64 i	0.23 a	0.24 ab	0.61 a	0.58 a	0.021 a	0.025 b
Means		1.81 A	1.88 A	0.26 A	0.26 A	0.57 A	0.55 A	0.028A	0.027 A
HA	C	2.02 abc	2.04 abc	0.31 a	0.29 a	0.57 a	0.51 a	0.027 a	0.026 b
	Cu	1.85 cde	1.91 bcd	0.26 a	0.27 ab	0.61 a	0.49 a	0.038 a	0.033 b
	Zn	2.22 a	2.12 ab	0.22 a	0.24 ab	0.59 a	0.52 a	0.031 a	0.031 b
	Fe	1.77 cde	1.98 abc	0.27 a	0.28 ab	0.61 a	0.56 a	0.027 a	0.028 b
	M	1.93 bcd	2.07 abc	0.26 a	0.26 ab	0.54 a	0.51 a	0.024 a	0.023 b
Means		1.96 A	2.02 A	0.27 A	0.27 A	0.58 A	0.52 A	0.29 A	0.028 A
CT	C	1.75 cde	1.83 def	0.26 a	0.24 ab	0.42 a	0.47 a	0.023 a	0.021 b
	Cu	1.69 def	1.72 fgh	0.25 a	0.25 ab	0.51 a	0.51 a	0.027 a	0.027 b
	Zn	1.74 cde	1.76 efg	0.24 a	0.23 b	0.52 a	0.44 a	0.026 a	0.026 b
	Fe	1.65 ef	1.67 ghi	0.25 a	0.25 ab	0.54 a	0.47 a	0.023 a	0.023 b
	M	1.94 abc	1.87 cde	0.27 a	0.27 ab	0.47 a	0.35 a	0.025 a	0.057 a
Means		1.75 A	1.67A	0.25 A	0.25 A	0.49 A	0.45 A	0.025A	0.025A

ha = 2.381 faddan C = without spray micronutrients (control). M = (Cu +Zn +Fe). HA = Humic acids. CT = Compost tea. Mg (megagram) = ton OS = Organic substances

Total contents of N, protein, P and nitrogen use efficiency (NUE):-

Data in Table 4 indicate the effect of foliar spraying of (OS) and the interaction between (OS) and micronutrients treatments on the total contents of N, protein and P in grain yield.

Data revealed that foliar spraying of (OS) in particularly HA had a significant effect on the total N contents of the two seasons. 109.77 and 118.93 kg ha^{-1} were obtained with HA treatment in the first and second seasons, respectively. Also, the data showed significant differences between the interactions spraying of (HA) and micronutrient treatments in the first season. The highest mean values of N content (122.10 and 127.21 kg ha^{-1}) were recorded with spraying HA and Zn treatment and of HA with M treatment in the first and second seasons, respectively. The control treatment (without micronutrients treatment) had the lowest mean values (78.74 and 80.58 kg ha^{-1}) in the first and second seasons, respectively.

The data in Table 4, expectedly, showed that total protein content in for grain yield of the two seasons gave the same behavior exhibited by N content. It is worth mentioning that the highest values of total protein contents (633.52 and 677.88 kg ha-1) were assigned for the treatment of HA foliar spraying in the first and second seasons, respectively.

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Again the effects of interaction between (OS) and the micronutrients spraying on the total protein contents followed the same trend assigned for N . The highest mean values (695.97 and 725.10 kg ha^{-1}) were obtained with spraying HA +Zn and HA + M treatments in the first and second seasons, respectively. While the lowest mean values (448.80 and 429.29 kg ha^{-1}) were observed with the treatment of control treatment without OS and without micronutrients in the first and second seasons, respectively.

With regards to the total contents of P was high significantly increased in the first season and significantly increased with (OS) treatments in the second season. The highest mean values (15.07 and 15.69 Kg ha^{-1}) were recorded with HA treatment in the first and second seasons, respectively. On the other hand, the interaction between (OS) and the micronutrients treatments spraying were significantly in the two seasons. The highest mean values (16.53 and 17.51 Kg ha^{-1}) were obtained with HA without micronutrients spraying, in the first and second seasons, respectively. It interesting to note that either total N and P contents of the grains assigned for the interaction between treatments were higher with HA than CT in both seasons. This may be interpreted as HA together with the added micronutrients could enhance the roots growth and increase nutrients absorption in the one hand and improve nutritional assimilation in the plant cells in the other hand.

These results resemble those recorded by Ziaeian and Malakouti (2001) who reported that copper as well as the other micronutrient application led to significantly increase in their concentration and uptake in grain and flag leaf. And the work of, Yassen *et al*., (2011) revealed that fertilizing of wheat plants with Humic acid combined with Zinc is important to increase the yield production and nutrients uptake by wheat plants.

Data in Table 4 also disclosed that (OS) spraying treatment significantly affected N use efficiency in both seasons. The highest mean values (33.81 and 34.97 kg grain kg^{-1}N) were obtained with HA spraying treatment in the first and second season; respectively. There were noticeable variations of NUE with interaction between (OS) and micronutrients spraying treatments in both seasons. The highest mean values (34.92 and 36.53 kg grain kg^{-1}N) were observed with HA and M treatment in the first and second season, respectively. Followed by 34.72 and 36.11 kg grain kg^{-1} N recorded for HA and Cu spraying treatment in the first and second season, respectively. The lowest mean values; 29.66 and 28.87 kg grain kg^{-1}N were assigned for control treatment without micronutrients (C) spraying in the first and second season, respectively. As wheat is known to respond well to copper Cu, spraying such element may be accentuated the plant growth, N uptake and led to increase NUE. These results are in consonance with those reported by Jones *et al*. 2007, Verlinden *et al*. (2009), and (Reza Shahryari and Vahid Mollasadeghi, 1995).

N, Protein and P total contents in straw yield:

Data in Table 5 show the effect of (OS) and micronutrients spraying on N, protein and P total contents in wheat straw yield. N total content significantly increased with spraying of (HA) in both seasons. The highest mean values (54.54 and 46.29 kg ha^{-1}) were recorded with spraying HA in the first and second seasons, respectively. Also, the interaction between spraying of (OS) and the micronutrients significantly affected wheat straw N content. The higher

mean values (61.04 and 59.55 kg ha^{-1}) were obtained with Cu with and without spraying of (HA) , respectively. The mean values (39.85 and 36.76 kg ha^{-1}) were recorded with Zn without spraying of (OS) in the two seasons. However, the mean values were amounted to 55.56 and 45.77 kg ha^{-1} due to Zn + HA spraying treatment. It may be mentioned here that CT foliar gave the least values.

Data in Table 5 showed that (OS) foliar spraying affected straw protein content; in both seasons. The same trend of N, aforementioned, coincided with protein content. The highest mean values (310.91 and 293.85 kg protein ha^{-1}) were recoded with HA treatment, in the first and second seasons, respectively. The lowest mean values (258.33 and 227.71 kg ha^{-1}) were observed with the CT treatment in the first and second seasons, respectively. Spraying OF (OS) affected straw protein content in the order**:** HA > Control > CT, in both seasons. Also, data showed that the interaction between (OS) and micronutrients affected straw protein content, in both seasons. The highest mean value (339.42 kg ha^{-1}) was observed with the interaction between HA and Cu treatment, followed HA and Fe treatment, in the first season. Spraying of HA insignificantly affected straw P content in both seasons. The highest mean values (2.73 and 2.49 kg P ha^{-1}) were obtained with HA treatment, in the first and second seasons, respectively. The Cu treatment with or without (OS) led to increase straw P content, in both seasons. Spraying of (OS) affected straw phosphorus content in the order**:** HA > Control > CT, in both seasons.

Table 5: Effect of organic substances (OS) and micronutrients foliar spraying of on N, P and Protein total contents in straw yield (kg ha^{-1}) of wheat.

Treatments		N Content (kg ha^{-1})		Protein content (kg ha^{-1})		P content (kg ha^{-1})	
OS	Micr.	1st season	2ndseason	1st season	2ndseason	1st season	2ndseason
Control	C	51.67 bcd	51.16 ab	294.52 bcd	291.61 ab	2.06 def	2.17 fgh
	Cu	61.04 a	54.21 a	347.92 a	309.01 a	4.68 a	2.82 bc
	Zn	39.85 fg	36.76 fg	227.16 fg	209.53 fg	2.01 def	2.34 ef
	Fe	46.83 def	40.60 def	266.93 def	231.52 def	1.63 f	2.05 a
	M	55.07 abc	48.59 abc	313.88 abc	276.98 abc	1.86 ef	2.16 fgh
Means		50.89AB	46.26 A	290.08 AB	263.73 A	2.45 A	2.31 A
HA	C	49.37 cde	46.73 bc	281.43 cd	266.36 bc	2.30 cde	2.34 ef
	Cu	59.55 a	44.24 cde	339.42 a	252.17 cde	3.64 b	2.98 b
	Zn	55.56 abc	45.05 cde	316.54 abc	256.78 cde	2.93 c	2.65 cd
	Fe	57.28 ab	49.66 abc	326.95 ab	283.04 abc	2.50 cde	2.46 de
	M	50.91 bcd	45.77 bcd	290.20 bcd	260.89 bcd	2.28 cde	2.03 ghi
Means		54.54 A	46.29 A	310.91 A	263.85 A	2.73 A	2.49 A
CT	C	39.20 g	39.83 ef	223.44 g	227.05 ef	2.09 def	1.80 i
	Cu	48.81 cde	45.40 bcd	278.23 cde	258.78 bcd	2.58 cd	2.39 def
	Zn	47.32 de	37.54 f	269.72 de	213.46 f	2.39 cde	2.15 fgh
	Fe	49.28 cde	40.27 def	280.90 cd	229.54 def	2.09 def	1.97 hi
	M	42.00 efg	30.80 f	239.36 efg	209.74 f	2.21 def	2.30 efg
Means		45.32 B	38.77B	258.33 B	227.71 B	2.27 A	2.12 A

ha = 2.381 faddan C = without spray micronutrients (control). M = (Cu +Zn +Fe).
HA = Humic acids. CT = Compost tea. Mg (megagram) = ton
OS = Organic substances

The superiority of HA could ascribe to its ability to enhance the plant uptake of nitrogen, phosphorus and micronutrients. As for Cu it may be activated plant enzymes and the cell assimilation. The positive responses of wheat to Cu spray are in accord with those reported by Ali *et al*., (2009) who stated that dry weight of wheat and nitrogen uptake were elevated due to Cu spraying. Korzeniowska (2008) also found that there was a high correlation between Cu and N concentration in wheat shoots after Cu application.

Conclusion

Foliar spray of HA (Humic acid) and balanced micronutrients could augment the yield of wheat straw and grain yields as well as their total N, P and protein contents in addition to NUE (Nitrogen use efficiency) by wheat plants. Therefore, more researches are needed to ascertain such promising findings in order to boost wheat productivity and improve its quality under similar conditions.

REFERENCES

Ali Vahap Katkat, Hakan Çelik, Murat Ali Turan and Barýº Bülent t Aºýk (2009). Effects of soil and foliar applications of humic substances on dry weight and mineral nutrients uptake of wheat under calcareous soil conditions. Australian Journal of Basic and Applied Sciences, 3(2): 1266-1273.

Amberger, A. (1974). Micronutrients, Dynamics in the Soil and Function in Plant Metabolism. IV. Copper. Proc. Egypt Botany Society. Workshop

Black, C.A.; D. D. Evans; J.L.White, L.E. Ensuminger and F.F. Clark (1965). Methods of Soil Analysis. Am. Soc. Agron. Inc. Publ. Madison, wisconsin.

Chen, Y. and T. Aviad(1990). Effect of Humic Substances on Plant Growth. In Humic Substances in Soil and Crop Sciences: Selected Readings, Ed., P. Maccarthy, Am. Soc. of Agron. and Soil Sci. Soc. of Am., Madison, Wisconsin, pp: 161-186.

Chen, Y., H. Magen and C.E.Clapp, (2001). Plant growth stimulation by humic substances and their complexes with iron. Proceeding No.470, International fertilizer Society, York, UK, pp: 1-14.

Dursun, A., I. Guvenc and M. Turan (2002). Effects of different levels of humic acid on seedling growth and macro-and micro-nutrient contents of tomato and eggplant. ACTA Agrobotanica, 56: 81 – 88.

El-Magid, A. A. A.; R. E. Knany and H. G. A. El- Fotoh (2000). Effect of foliar application of some micronutrients on wheat yield and quality. Annals of Agricultural Science Cairo, 1(Special): 301-313.

FAO, (2008). Food and Agriculture Organization of the United Nation, Economic and Social Department.

Fong, S. S, L. Seng and H.B. Mat (2007). Reuse of Nitric Acid in the Oxidative Pretreatment Step for Preparation of Humic Acids from Low Rank Coal of Mukah, Sarawak. J. Braz. Chem. Soc., 18(1): 41-46.

Ingham, E. (1999). What is compost tea? Part1. BioCycle 40 No. 3 pp 74-75.

Ingham, E. (2005). The compost tea brewing manual. US Printings, Soil Food web Incorporated, Oregon.

Jackson, M. L.(1967).Soil chemical analysis printice-hall of India, New Delhi.

Jones, C.A., J.S. Jacobsen and A. Mugaas (2007).Effect of low-rate commercial humic acid on phosphorus availability, micro-nutrient uptake and spring wheat yield. Communications in Soil Science and Plant Analysis, 38: 921-933.

Karamanos R. E., Q. Pomarenski , T. B. Goh, and N. A Flore (2003). The effect of foliar copper application on grain yield and quality of wheat. Can. J. Plant Sci. 47:56

Korzeniowska, J. (2008). Winter wheat response to copper application under different cultivation technologies and nitrogen fertilization. Ecological Chemistry and Engineering, 15(1, 2):81-88.

Lindsay,W.L. and Norvell,W A. (1978) Development of DTPA micronutrient soil test.
Soil Science Society of American Journal 42:421-428.

Maralian, H. (2009). Effect of foliar application of Zn and Fe on wheat yield and quality. African J. Biotechnol., 8(24): 6795-6798.

Reza Shahryari and Vahid Mollasadeghi (1995) Increasing of wheat grain yield by use of a humic fertilizer Advances in Environmental Biology, 5(3): 516-518, 2011. ISSN 1995-0756

Reza Shahryari, Aladdin Gadimov, Elshad Gurbanov and Mustafa Valizade (2009).Applications of potassium humate to wheat for organic agriculture in Iran. As. J. Food Ag-Ind. 2009, Special Issue, S164-S168.

Sarker, D, B, Mandal and M. C. kundu (2007).Increasing use efficiency of boron fertilizers by rescheduling the time and methods of application for crops in India. Plant Soil 301 : 77 – 85.

Shaaban, S.H.A., F.M. Manal and M.H.M. Afifi (2009).Humic acid foliar to minimize soil applied fertilization on surface- irrigated wheat. World Journal of Agricultural Sciences 5 (2): 207-210.

Solange LM and Rezende MO, (2008).Capillary Electrophoresis (CE): A powerful tool to characterize humic acid (HA), J. Brazil Chemical Society, 19:24-28.

Ulukan, H.,(2007). Humic acid application into field crops cultivation. KS Uni. J. Sci. Eng., 11(2): 119-128.

Verlinden, G., B. Pycke, J. Mertens, F. Debersaques, K. Verheyen, G. Baert, J. Bries and G. Haesaert (2009). Application of humic substances results in consistent increases in crop yield and nutrient uptake. Journal of Plant Nutrition, 32: 1407-1426.

Yang, C.M., Wang, M.H., Lu, Y. F., Chang, I.F. and Chou, C.H. (2004).Humic substances affect the activity of chlorophyllase. J. Chem. Ecol., Vol. 30(5), pp. 1057-1065.

Yassen, A.A.,F.A. Hellal and Doaa M. Abo-Basha (2011).Influence of organic materials and foliar application of zinc on yield and nutrient uptake by wheat plants. Journal of Applied Sciences Research, 7(12): 2056-2062

Ziaeian, A. H. and M. J. Malakouti (2001).Effects of Fe, Mn, Zn and Cu fertilization on the yield and grain quality of wheat in the calcareous soils of Iran. Plant Nutrition - Food security and sustainability of agro-ecosystem, 92: 840-841.

تأثير الرش الورقى ببعض المواد العضوية والعناصر الصغرى على القمح النامى في أرض طينية

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أجريت تجربة حقلية بمزرعة محطة البحوث الزراعية بسخا- محافظة كفر الشيخ – مصر فى الموسمين الشتويين 2008/ 2009 و2009/ 2010 على القمح (صنف سخا 93) لدراسة تأثير الرش الورقى بعض المواد العضوية والعناصر الصغرى على انتاجية القمح ومحتواه من النيتروجين والفوسفور والبروتين وكفاءة استخدام النيتروجين.

استخدم تصميم القطع المنشقة فى أربعة مكررات حيث شغلت القطع الرئيسية ثلاث معاملات رش لمحاليل المواد العضوية :

1- بدون رش (كونترول) 2- رش بحامض الهيوميك 3- رش شاى الكمبوست

وشغل رش العناصر الصغرى القطع الشقية فى خمسة معاملات:

1- بدون رش عناصر صغرى 2- الرش الورقى بالنحاس 3- الرش الورقى بالزنك 4- الرش الورقى بالحديد 5- الرش الورقى بالعناصر الصغرى(النحاس والزنك والحديد)

أشارت النتائج أن حامض الهيوميك أعطى القيم (5.61 و5.88 طن للهكتار) من حبوب القمح فى الموسمين على التوالى و.كان تأثير رش المواد العضوية على حبوب القمح على النحو التالى: حامض الهيوميك ≤ شاى الكمبوست > الكونترول الا أن أعلى محصول حبوب سجل مع معاملة التفاعل بين حامض الهيوميك والعناصر الصغرى .

كان لرش العناصر الصغرى مع المواد العضوية أفضل النتائج وأعطت الترتيب: حامض الهيوميك + العناصر الصغرى (نحاس + زنك + حديد) ≤ حامض الهيوميك + النحاس > حامض الهيوميك + الزنك > حامض الهيوميك.

أدى رش حامض الهيوميك والزنك والحديد لزيادة النسبة المئوية للنيتروجين والفوسفور فى حبوب القمح، أيضا أدى رش النحاس بدون أو مع محاليل المواد العضوية لزيادتهما فى محصول قش القمح.

كان لرش المحاليل العضوية تأثير غير معنوى على محصول قش القمح الا أنه تم الحصول على أعلى القيم عند المعاملة بحامض الهيوميك وتلتها معاملة شاى الكمبوست .وأعطت معاملة تفاعل حامض الهيوميك +النحاس أعلى متوسط (9.73 طن/ هكتار) فى الموسم الأول. بينما فى الموسم الثانى سجلت (9.12 طن / هكتار) عند المعاملة حامض الهيوميك بدون رش عناصر صغرى.تبين ان استخدام حامض الهيوميك يزيد من متوسطات قيم محتوى النيتروجين والبروتين فى الحبوب الا انه قد لوحظ أن أعلى متوسط لقيم محتوى النيتروجين والبروتين فى حبوب القمح كان مع معاملة حامض الهيوميك والزنك فى الموسم الأول ومع معاملة حامض الهيوميك والعناصر الصغرى فى الموسم الثانى.

أدى رش معاملة حامض الهيوميك لزيادة محتوى الفوسفور فى الحبوب .وكان تأثير رش المحاليل العضوية على محتوى القش من النيتروجين و الفوسفور والبروتين على الترتيب: حامض الهيوميك > الكونترول > شاى الكمبوست فى الموسمين.

أدى رش النحاس مع أو بدون حامض الهيوميك لزيادة محتوى محصول القش من النيتروجين والفوسفور والبروتين فى الموسمين وقد لوحظت أقل قيم لمحتوى النيتروجين و البروتين مع معاملة شاى الكمبوست ومع معاملات شاى الكمبوست + العناصر الصغرى.

تم الحصول على أعلى قيم لكفاءة استخدام النيتروجين مع الرش بمعاملة حامض الهيوميك ومع معاملة التفاعل بين حامض الهيوميك + العناصر الصغرى فى الموسمين.

قام بتحكيم البحث

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Table 4: Effect of foliar spray of organic substances (OS) and micronutrients spraying on N, protein, P total contents and NUE in wheat grain (kg grain kg^{-1} N).

Treatment		N content (kg ha^{-1})		Protein content (kg ha^{-1})		P content (kg ha^{-1})		NUE	
OS	Micr	1stseason	2ndseason	1stseason	2ndseason	1stseason	2ndseason	1stseason	2ndseason
Control	C	78.74 g	80.58 g	448.80 g	429.29 g	12.87 c	13.06 ef	29.66 c	28.87 g
	Cu	96.64 de	100.43cde	550.87 de	572.47cde	13.84 bc	13.57 def	31.65 abc	31.88 cde
	Zn	96.52 de	92.91 efg	550.15 de	529.57efg	13.77 bc	13.67 def	30.06 bc	29.27 fg
	Fe	107.32bc	111.69 bc	611.71 bc	636.65 bc	12.66 efg	14.11 cde	29.56 c	30.87 def
	M	80.32 g	89.01 efg	457.81 g	507.34 g	11.55 g	12.98 ef	30.26 abc	32.26 cde
Means		91.91 B	94.92 B	523.87 B	541.06 B	12.94 B	13.48 B	30.23 B	30.63 B
HA	C	108.47 bc	121.76 ab	623.96 bc	694.05 ab	16.53 a	17.51 a	33.93 abc	35.52 ab
	Cu	107.63 bc	115.82 ab	613.51 bc	660.15 ab	15.87 ab	16.05 b	34.72 ab	36.11 a
	Zn	122.10 a	120.87 ab	695.97 a	688.94 ab	12.68 efg	13.51 def	32.74 abc	33.97 abc
	Fe	97.40 de	108.97 bc	588.51 de	621.13 bc	14.85 abc	15.20 bc	32.74 abc	32.74 cde
	M	113.27 ab	127.21 a	645.63 ab	725.10 a	15.41 abc	16.18 ab	34.92 a	36.53 a
Means		109.77A	118.93 A	633.52 A	677.88 A	15.07 A	15.69 A	33.81 A	34.97 A
CT	C	93.20 ef	98.35 cde	531.24 ef	560.61cde	13.61 cde	13.10 def	31.75 abc	32.10 cde
	Cu	92.54 ef	96.89 def	527.48 ef	552.27def	13.82 bc	13.88 cde	32.54 abc	33.47 bcd
	Zn	90.24 ef	92.53 efg	514.37 ef	527.41efg	12.17 fg	12.31 f	30.85 abc	31.39 def
	Fe	85.49 fg	84.40 fg	487.26 fg	481.06 fg	12.64 efg	12.83 ef	30.75 abc	30.16 efg
	M	104.2 cd	99.99 cde	594.19 cd	569.94cde	14.59 abc	14.43 cd	32.05 abc	31.85 cde
Means		93.14AB	94.43 B	530.91AB	538.26 B	13.37 B	13.31 B	31.59 AB	31.79 ab

ha = 2.381 faddan C = without spray micronutrients (control). M = (Cu +Zn +Fe). HA = Humic acids.
CT = Compost tea. Mg (megagram) = ton OS = Organic substances