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Comparative Studies on Organic and Inorganic N, P, K, and Zn- Fertilization for Wheat Crop in Northern Delta Soils.

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Abstract

Two factorial experiments on wheat *Triticum aestivum, L. (var. Msr$_1$)* were conducted at Sakha Agric. Res. Station on a clay soil for two successive seasons of (2015/2016; 2016/2017). Factors1 comprised 3 organic manuring (0, 24 and 48 m^3 ha^{-1}) and 5 mineral fertilizations (none, N, NP, NPK and NPK Zn). Mineral rates (kg ha^{-1}) :240 kg N (as urea),32 kg P (as Ca-superphosphate), 48 kg K (as K-sulphate) and 12 kg Zn (as Zn-sulphate). Application of organic manure (as compost) increased wheat grain and straw yields as well as grains protein content. Also all the values of the previously mentioned studied parameters increased by applying mineral fertilizers. The highest positive effect was by applying the high compost + NPKZn giving increases of 106 to 114 % in grain yield and increases occurred also in contents of protein as well as N, P, K and Zn contents.

Keywords: Organic manure, Mineral fertilization, Compost, NPKZn fertilizers, Wheat (*var. Msr1*).

Introduction

Wheat is the most important food crop in Egypt. More than 1050 thousand hectares are cultivated with wheat, with average productivity of 6.5 Mg ha^{-1} with application of various fertilizers (Genaidy and Hegazy, 2001). Organic manuring has safer effects on soil properties. Mineral fertilization for wheat in optimum recommended rates may maximize yields (Genaidy, 2010). Nitrogen fertilization of maize increases plant growth and yield (Bleken *et al*. 2009, Pavlík *et al*. 2010). Liu Dandan and Yan Shi (2013), observed that the number of kernels per spike and grain yield increased with nitrogen application. The positive effect of phosphorus and potassium aggregate of the functions played by nutrients in mitigating negative effects of biotic and abiotic stresses. Plants provided with sufficient amounts of phosphorus and potassium are can improve water efficiency (Ma *et al*. 2006).Potassium is an indispensable component during the main stages of protein biosynthesis. Its deficiency leads to a decrease in protein content in plant (RICE 2007). Arshad *et al*. (2016) reported that 10 kg Zn ha^{-1} increased wheat spike length, 1000 grain weight and grain yield. The objective of this investigation was to assess the effects of organic manuring with or without mineral fertilization of N P K Zn nutrients.

Materials And Methods

Two field experiments on wheat crop (*Triticum aestivum, L.*) var. Msr (1) were carried out at Sakha Agricultural Research Station during 2015/2016 and 2016/2017 seasons in two different experimental sites. The design was a randomized complete block, factorial (2 factors). Factor 1 was organic fertilization using 3 rates: 0, 24 and 48 m^3 ha^{-1}. Factor 2 was mineral fertilization using 5 treatments of none, N, NP, NPK and NPKZn. Rates (kg element ha^{-1}) being 240 N ; 32 P ; 48 K ; 12 Zn. Treatments were in 4 replicates. Soils of both experiments were clay, slight alkaline and non-saline. Table 1 shows the main properties of the soils. Analyses of plant and soil were done according to Chapman and Pratt (1961) and Black (1965). The plot area was 6 m^2. Organic manure as compost, P and K were added during soil preparation. P form was Ca-superphosphate (68 g P kg^{-1}); N form was urea (460 g N kg^{-1}); K form was K-sulphate (400 g K kg^{-1}); Zn form was $ZnSO_4.7H_2O$ (227 g Zn kg^{-1}). Main properties of the compost are given in Table 2. Wheat (Triticum aestivum, L.) var. Msr_1 was seeded on 17/11/2015 in season 1 and 20/11/2016 in season 2. Nitrogen was applied in two equal doses; the first was before the first irrigation (30 days after seeding); and the second was before the second irrigation (30 days after the first).
All the agronomic practices were applied according to the recommended methods. Harvesting was conducted on 13/5/2016 and on 11/5/2017; for the two seasons, respectively.

Results And Discussion

The data obtained from the two experiments are presented in Tables 3 and 4.

a- Main effects:

1- Organic manuring :

As shown in Table 3; increasing organic manure rate (M_1"24 m^3 ha^{-1}" and M_2 "48 m^3 ha^{-1}") led to increases in wheat grain and straw yields as well as grain / straw ratios. Average increases of grain yield were 18.7 and 36.0 % due to M_1 and M_2 respectively in season 1, comparable increases in season 2 were 7.9 and 26.1 % respectively. Increases in straw yield followed a pattern similar to that of the grain yield.

Grains / straw ratio increased only upon applied the high rate of manure. With regard to wheat grains-protein content, it increased with the increase in organic manuring. Increases due to the low and high rates were 21.7 and 25.5 % respectively in season 1and 8.9 and 13.9% respectively in season 2. Abou El-Enein *et al.*(2008), hammad *et al.*(2008) and Zeidan *et al*. (2009) reported that organic manuring increases crop yields and protein content.

2- N, P, K and Zn-mineral fertilization Effects:

Table 3 reveals that wheat grains and straw yields as well as grains / straw ratio increased by applying mineral fertilizers of N, NP, NPK and N P K Zn. The highest response was that upon application of NPKZn. Grain yield increase by mineral fertilization averaged 14.2, 23.3, 26.7and 35.1 % for the 4 treatment respectively in season 1. Comparable increases in season 2 averaged 16.4, 32.0, 38.7and 45.7 % respectively. With respect to contents of N P K and Zn in grains results indicate pattern rather similar to that of grain yield. These results are in agreement with those obtained by Genaidy *et al* (2007), Abbas *et al*.(2009), and Atia (2012).

As for wheat grains- protein content, data presented in Table 3 show that application of mineral fertilizers significantly increased the values of this parameter in the same trend taken by the other studied characters. Zeidan *et al*. (2009), reported increased contents of protein in wheat grains upon application of N and organic manure

b- Effect of different combination treatments:

Table 4 indicates increased positive response due to applying any ore more of the organic or mineral fertilizer. The lowest grain yield increase of 42.2 and 29.9% in season 1 and 2 respectively occurred with applying N while the highest of 113.7 and 105.6% in season 1 and 2 respectively occurred with the high organic manure + N P K Zn. As for contents of N P K and Zn in wheat grains results show increases due to application of manure and mineral fertilizer singly or combined. Lowest increase in N content was with N application (3.8% increase) in season 1and by N P application (7.8%) in season 2. Highest increase in N contents occurred with high manure + N P K Zn which caused increases of 54.1 % in season 1 and 31.8% in season 2.

Table 1. Some physical and chemical characteristics of the two experimental sites before wheat planting during the two growth seasons.

Soil fertility characteristic	$Site_1$ (1st season)	$Site_2$ (2nd season)
Mechanical analysis (%)	24.20 sand, 24.10 silt, 51.70 clay	23.30 sand, 24.60 silt, 52.10 clay
Soil texture class	Clay	Clay
Saturation percentage (SP) %	70	72
EC (Soil paste extract) dSm^{-1}	3.86	3.90
Soluble cations (mmole L^{-1})	Ca^{2+} = 6.15; Mg^{2+} = 5.75 Na^{+} = 13.00; K^{+} = 1.70	Ca^{2+} = 6.25; Mg^{2+} = 6 Na^{+} = 13.20; K^{+} = 1.80
Soluble anions (mmole L^{-1})	CO_3^{2-} = 0.00; HCO_3^{-} = 13.00 SO_4^{2-} = 9.90; Cl^{-} = 5.70	CO_3^{2-} = 0.00; HCO_3^{-} = 16.00 SO_4^{2-} = 8.35; Cl^{-} = 6.70
Soil – pH (1:2.5)	7.86	7.91
$CaCO_3$ (g kg^{-1})	18.9	20.0
O.M (g kg^{-1})	16.5	16.0
Soil-CEC ($cmol_c$ kg^{-1})	32.0	30.0
Available N, P, K, Zn (mg kg^{-1})		
N	31.0	28.2
P	21.0	18.0
K	312.0	363.0
Zn	0.77	0.68

Notes: 1- The two experiments were conducted in two different experimental sites for the two growth seasons.
2- Soil analyses were done using representative composite samples.
3- Extraction solution for available N (KCl), P (Na-bicarbonate), K (NH_4-acetate), Zn (DTPA).

Table 2. Main properties of the tested organic manure at the two growth seasons.

organic manure characteristics	$Site_1$ (1st season)	$Site_2$ (2nd season)
Moisture content (%)	29.0	30.0
Bulk density (Mg m^{-3})	0.423	0.415
Organic matter %	37.93	41.43
Organic carbon %	22.0	23.91
Total nitrogen g kg^{-1}	11.2	13.7
C/N ratio	19.6	18.0
pH (1 : 10 extract, w/v)	7.83	7.92
EC (1 : 10 extract)	1.72	1.37
Total –P g kg^{-1}	4.78	6.81
Total –K g kg^{-1}	18.4	25.3
Total –Zn ($mgkg^{-1}$)	0.96	1.47

Table 3. Main effects of organic and mineral fertilization on wheat yield, -N P K Zn and protein contents in grain for the two growth seasons.

	Treatment		Grain yield *Mg ha^{-1}		Straw yield Mg ha^{-1}		Grain / Straw ratio		N gkg^{-1}		P gkg^{-1}		K gkg^{-1}		Zn mg kg^{-1}		Protein gkg^{-1}	
			Growth Season															
			1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Means of mineral and manure applications	manuring	0 m^{3}ha^{-1}	5.04	4.89	11.96	11.31	0.42	0.43	16.90	16.10	2.90	2.70	5.30	4.80	12.56	12.13	98.50	94.0
		24 m^{3}ha^{-1}	5.98	5.28	14.18	12.01	0.42	0.44	20.00	17.60	3.20	3.00	5.30	4.90	18.24	16.95	116.6	102.4
		48 m^{3}ha^{-1}	6.85	6.17	15.34	13.29	0.45	0.46	21.30	17.70	3.90	3.10	5.70	5.10	27.49	25.96	124.4	103.1
	LSD(0.05)		**0.25**	**0.18**	**0.50**	**0.35**	**0.01**	**0.01**	**0.10**	**0.10**	**0.20**	**0.10**	**0.20**	**0.10**	**7.39**	**8.24**	**5.0**	**6.3**
	mineral fertilization	0	4.97	4.30	12.47	10.29	0.4	0.42	17.30	15.70	2.70	2.40	4.80	4.30	16.42	15.06	101.0	91.5
		N	5.67	5.06	13.32	11.22	0.43	0.46	18.10	15.97	3.00	2.50	5.30	4.70	17.12	16.4	105.4	92.9
		NP	6.13	5.68	13.94	12.58	0.44	0.45	19.70	17.00	3.40	3.10	5.60	4.70	18.34	17.42	114.7	99.1
		NPK	6.3	5.96	14.35	13.02	0.44	0.46	20.70	18.20	3.70	3.30	5.60	5.40	20.83	19.39	120.7	105.7
		N P K Zn	6.72	6.27	15.05	13.84	0.45	0.45	21.30	18.90	3.90	3.30	5.80	5.60	24.43	23.45	124.2	109.8
	LSD(0.05)		**0.18**	**0.18**	**0.27**	**0.39**	**0.01**	**Ns**	**0.30**	**0.50**	**0.30**	**0.30**	**0.10**	**0.20**	**6.37**	**5.43**	**3.3**	**4.0**

Notes: 1- Protein % = N % x 5.83 according to Ronald *et al*. (2005).

2- Mineral rates (kg ha^{-1}) N: 240; P:32;K:48; Zn:12.

3- Megagram (Mg) = 10^6g

Table 4. Results of the 25 treatment combinations regarding effects of manure and mineral fertilizers

Treatment		Grain yield Mg ha^{-1}		Straw yield Mg ha^{-1}		N gkg^{-1}		P gkg^{-1}		K gkg^{-1}		Zn mg kg^{-1}		Protein gkg^{-1}	
		Growth Season													
Organic fert. m^3 ha^{-1}	Mineral fert. kg ha^{-1}	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
0	**0**	3.54	3.31	9.42	9.46	15.70	14.80	2.40	2.30	4.40	4.00	10.93	10.50	91.5	86.3
0	**N**	5.04	4.30	11.12	11.14	16.30	14.10	2.60	2.20	5.30	4.40	11.73	11.2	95.0	82.2
0	**NP**	5.25	5.44	11.96	11.31	16.70	15.90	2.90	3.00	5.60	4.90	11.8	11.76	97.4	92.7
0	**NPK**	5.46	5.43	12.95	11.71	17.80	17.70	3.20	3.00	5.60	5.30	12.35	12.00	103.8	103.2
0	**N P K Zn**	5.88	5.99	14.33	12.90	18.00	18.10	3.40	3.10	5.70	5.50	16.00	15.17	104.9	105.5
24	**0**	5.04	4.25	13.46	9.89	18.00	16.20	2.50	2.40	4.80	4.70	12.67	11.00	104.9	94.4
24	**N**	5.54	4.82	13.89	10.50	18.80	17.00	2.70	2.50	5.30	4.90	13.50	12.83	109.6	99.1
24	**NP**	6.27	5.34	14.16	12.87	20.60	17.30	3.30	3.30	5.50	4.30	16.17	14.80	120.1	100.9
24	**NPK**	6.35	5.95	14.55	12.99	20.90	18.40	3.60	3.50	5.40	5.20	21.73	20.14	121.8	107.3
24	**N P K Zn**	6.70	6.01	14.83	13.79	21.70	18.90	4.00	3.10	5.30	5.50	27.12	26.00	126.6	110.2
48	**0**	6.33	5.36	14.52	11.54	18.30	16.10	3.20	2.50	5.20	4.30	25.66	23.67	106.7	93.9
48	**N**	6.45	5.89	14.93	12.05	19.10	16.70	3.60	2.90	5.40	4.70	26.14	25.18	111.4	97.4
48	**NP**	6.85	6.27	15.72	13.59	21.70	17.80	3.90	3.10	5.60	5.00	27.06	25.70	126.5	103.8
48	**NPK**	7.09	6.50	15.56	14.38	23.40	18.30	4.20	3.40	5.80	5.6	28.41	26.05	136.4	106.7
48	**N P K Zn**	7.58	6.80	15.99	14.85	24.20	19.50	4.40	3.60	6.30	5.80	30.17	29.18	141.1	113.7
LSD(0.05)		**0.50**	**0.45**	**0.79**	**0.35**	**0.70**	**0.60**	**0.20**	**0.10**	**0.20**	**0.3**	**0.67**	**0.70**	**3.7**	**3.6**

Notes: 1- Protein % = N % x 5.83 according to Ronald *et al*. (2005).
2- Mineral rates (kg ha-1) N: 240; P:32;K:48; Zn:12.
3- Megagram (Mg) = 10^6g

Conclusions:

According to the previous results; it could be concluded that:

1- For such alluvial soils; they have to be manured with composts at 24 to 48 $m^3.ha^{-1}$ singly or combined with the recommended mineral N-, P-, K- and Zn fertilizers for realizing the highest contents of protein and N P K Zn in grains as well as wheat grain yield .

2- The beneficial effects of the organic manure would be:

a- Improving soil physical; bio-chemical; subsequent soil fertility and nutritional properties.

b- The slow release and continuous supplying of most nutrients in available forms for grown plants.

c- Increasing the absorption efficiencies of N, P, K, and Zn nutrients for growth plants.

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دراسات مقارنة التسميد العضوي و المعدني لعناصر النيتروجين و الفوسفور و البوتاسيوم و الزنك علي محصول القمح في أراضي شمال الدلتا.

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أجريت تجربتان حقليتان علي محصول القمح (صنف مصر 1) في تربة طينية بمحطة البحوث الزراعية بسخا – محافظة كفر الشيخ خلال موسمي 2015/ 2016 و 2017/2016. تضمنت العوامل: معاملة للتسميد العضوي في صورة كومبوست بثلاث معدلات (صفر – 24 – 48 م^3 هكتار$^{-1}$) وخمسة معاملات للتسميد المعدني [بدون – (ن) – (ن + فو) – (ن + فو + بو) – (ن + فو+ بو+ ز)]. كانت معدلات التسميد المعدني بالكيلو جرام لكل هكتارعلي النحو التالي : 240 كجم ن (يوريا) , 32 كجم فو (كالسيوم سوبر فوسفات) , 48 كجم بو (كبريتات بوتاسيوم) , 12 كجم ز (كبريتات زنك). أدي استخدام التسميد العضوي علي صورة كومبوست إلي زيادة محصول القمح من الحبوب و القش وكذلك محتوي الحبوب من البروتين. أيضا زادت قيم الصفات المدروسة المشار إليها سابقا مع استخدام الأسمدة المعدنية . كان أعلى تأثير إيجابي ناتج عن استخدام المعدلات المرتفعة من الكومبوست + (ن + فو+ بو+ ز) حيث أعطت زيادات في محصول الحبوب مقدارها 106 و 114 % و حدوث زيادة أيضا في محتوي الحبوب من البروتين و الفوسفور و البوتاسيوم والزنك .

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