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INFLUENCE OF ORGANIC AND INORGANIC FERTILIZERS ON SOIL NUTRIENTS AVAILABILITY AND WHEAT PRODUCTIVITY.

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ABSTRACT

Soils degraded physically and nutritionally due to continuous use of chemical fertilizers under intensive agricultural. Management of N is the key for sustainable and profitable wheat production in a low N-soil availability. So a field experiment was conducted on a clay soil using wheat (Triticum aestivum) Giza 168 variety during 2008 / 2009 season at Agricultural Experimental Station of Fac. Agric, Mansoura Univ., to study the influence of combined use of mineral fertilizers (urea) and organic fertilizers in the form of farmyard manure (FYM), composted rice straw (CRS) and their combinations on wheat productivity, nutrients availability and monitoring soil organic matter (SOM) status in soil at certain times 45, 88 and 155 days from wheat planting. The randomize complete blocks design with three replications was used. The mineral fertilizer (urea) was applied at the rate of N_1=60 and N_2=120 kg urea fed^{-1}.The amounts of various organic fertilizers used were (10 and 20 m^3 fed^{-1}), for both FYM and CRS. Organic fertilizers added either alone or in combinations with urea to the soil. Results indicated that the maximum increase in grain yield (54.66 and 56.55 % over untreated control) and straw yield (1660.50 and 1710.99 g.m^2) were recorded with N_2FYM_2 and N_2CRS_2 respectively. All combination of organic (FYM or CRS) and inorganic fertilizers gave the optimum availability of NH_4^+, NO_3^-, P, K concentration in soil beside the enhancement of soil organic matter percentage (SOM) as compared to the other treatments.

INTRODUCTION

Wheat (Triticum aestivum) is one of the major cereal crops in Egypt. Local production of wheat is not sufficient to face the domestic consumption. The Egyptian soil has been suffering the lack of nutrients as a result of many reasons such as intensive cropping, cultivars of high yielding crop variety and alkaline conditions of soil which decreased nutrients availability and the low of soil organic matter content. Mineral fertilizer plays an important role in crop production, but unbalanced application of nutrients leads to productivity loss arising from soil exhaustion of macro and micro-nutrients Bhandari *et al*., (2002) and Yadvinder-Singh *et al*., (2004). Continuous use of chemical fertilizers even in balanced proportion will not be able to sustain crop productivity due to deterioration in soil fertility Zia *et al*. (2000). Addition of organic fertilizers one of the most promising means for increasing wheat yield and maintaining soil health. Integrated management of organic manure and chemical fertilizer is useful practice to increase crop yields and maintain soil fertility Yadav *et al* (2000). Organic matter makes its greatest contribution to soil productivity. Soil organic matter encourages granulation, increases cation exchange capacity (CEC) and is responsible for adsorbing power of the soils up to 90 %. Cations such as Ca, Mg and K are produced during decomposition (Brady, 1990). Organic and inorganic fertilizer is used primarily to increase nutrient availability to plants; however, they can also affect the population, composition, and function of soil micro- organisms (Marschner *et al*. 2003). The balanced fertilization with major elements (nitrogen, phosphorus, and potassium) for plant nutrient supply could be beneficial for the growth of above- and below-ground plant parts. But in fact, farmers are often forced to make decisions about their fertilizer strategy that reflects economic rather than agronomic pressure; as a result, unbalanced fertilization is still widespread (Chu *et al*. 2007). This study aimed to:

1) Assess effects of integrated inorganic and organic fertilizers on wheat yield.
2) Investigate the effect of integrated use of organic and inorganic fertilizers on availability of nutrients (N, P and K) in soil at certain times (45, 88 and 155 days) during wheat planting.
3) Monitor decomposition of soil organic matter (SOM %) at different times of wheat growth.

MATERIALS AND METHODS

A field experiment was conducted using wheat plant (Triticum aestivum) Giza 168 variety during 2008 / 2009 season at the Agricultural Experiment Station of Fac. Agric., Mansoura Univ., to study the influence of combined use of organic and inorganic (urea) fertilizers on productivity of wheat, availability of nutrients and monitoring the status of soil organic matter (SOM) in soil through different stages of wheat growth (after 45, 80 and 155 days from planting). Randomize complete blocks design with three replications was used. The area of field plot was 1x1 m^2. The mineral fertilizer (urea) added to the soil at rates of N_1=60 and N_2=120 kg urea fed^{-1}. Organic fertilizers were applied to the soil in two forms, Farmyard manure (FYM) and composted rice straw (CRS) at the rates of (10, and 20 m^3 fed^{-1}). Organic fertilizers added alone and in the combined with urea to the soil. Recommended super phosphate was added to all plots at the rate of (100 kg super phosphate fed^{-1}).

Data in Table 1 show the physical and chemical properties of the experimental soil before planting. Soil samples were sieved and routine analysis in the beginning of the experiment was done according to Hesse (1971). Mechanical analysis was determined according to the international pipette method as described by Piper (1950). Samples of straw and grains were taken at harvest, then dried at 70 ^{o}C till constant weight then grained to a fine powder and then 0.2 g was taken to wet digestion using a mixture of sulfuric and perchloric acids according to Jackson, (1967) to determine the percentage of total nitrogen which determined by Kjeldahl method as described by Hesse, (1971). Nitrate and nitrite were determined according to the method described by Singh (1988). Organic materials were analyzed before cultivation to be added before planting by two weeks. Data in Table 2 show the chemical properties of FYM and Rice straw (organic materials).

Organic materials analysis:

Electrical conductivity (EC) was determined in (1:10) organic material extract and pH value was determined in (1:5) extract according to Jackson, (1967). Total carbon (C %) content was determined according to Walkly & Black method as described by Hesse, (1971). Total nitrogen was determined using the conventional method of Jackson, (1967). Total phosphorus was determined calorimetrically at wavelength of 700 n by Hesse (1971). Total potassium was estimated by using flame photometer according to Jackson (1967).

Table 1: Some physical and chemical properties of the experiment soil before planting.

pH	E.c $ds.m^{-1}$	Sp %	Ions meq/100 g soil							
			Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	CO_3^{-2}	HCO_3^{-}	Cl^{-}	SO_4^{-2}
7.81	2.66	61	0.79	0.41	0.99	0.07	0.00	0.63	0.84	0.79
Mechanical analysis %				O.M %	CaCO3 %	Available (ppm)				
sand		Silt	Clay	Texture			N	P	K	
21.12		27.69	51.19	clayey	1.31	1.73	36	5.2	290	

Table 2: Some chemical properties of farmyard manure (FYM) and composted rice straw (CRS).

Organic materials	Total N %	Total P, ppm	Total K, ppm	O.C %	C:N	O.M %	pH	EC, dSm^{-1}
Farmyard manure (FYM)	0.88	700.50	665.00	14.95	17.00	25.77	7.66	3.25
Rice Straw compost (CRS)	1.41	680.50	788.01	22.83	16.19	39.27	6.93	2.86

Soil analysis:

Data in Table 1 show the physical and chemical properties of the experimental soil before planting. Soil samples were sieved and prepared for analysis according to Hesse (1971). Soil reaction pH in 1:2.5 soil-water suspensions was determined using Bechman pH meter and electrical conductivity (Ec), $dS.m^{-1}$, at 24 C° in soil paste extracted(page *et al*, 1982). Total phosphorus was determined calorimetrically at wavelength of 660 n Hesse (1971). Mechanical analysis was determined according to the international pipette method as described by Piper (1950). Total potassium was estimated by using flame photometer according to Jackson, (1967).

RESULTS AND DISCUSSION

Data in Table 3 show the grain and straw yield of wheat as affected by the application of different rates of organic (FYM or CRS) and inorganic fertilizers (N) and their integrations. Grains and straw yield increase with increasing levels of fertilizers when were added in the form of organic or inorganic fertilizers as compared to the untreated control. There is a significant increase in grain yield under integrated use of organic and inorganic fertilizers (FYM or CRS) at all levels over the control. The increase in grain yield with the combined use of both these sources is advantageous and substantial amount of inorganic N (urea) can be saved.

Table 3: Effect of organic, inorganic fertilizers and their combinations on wheat yield (g. m^{-2}) during 2008 / 2009 seasons.

Treatments	Straw	Grain	% increase Or decrease
Control	757.15 h	420.55 d	-
N1	893.98 g	480.33 cd	14.21
N2	1090.88 e	530.66 bc	26.18
Mean	992.43	505.50	20.20
FYM1	935.89 fg	460.77 cd	9.56
N1 FYM1	1330.50 d	596.90 ab	41.90
N2 FYM1	1500.13 bc	616.67 ab	46.63
FYM2	1011.15 ef	471.30 cd	12.06
N1 FYM2	1350.88 d	633.89 a	50.72
N2 FYM2	1660.50 a	650.45 a	54.66
Mean	1298.10	569.81	35.92
CRS1	987.66 f	465.77 cd	10.75
N1 CRS1	1434.80 c	611.98 ab	45.51
N2 CRS1	1688.60 a	630.76 a	49.98
CRS2	1080.99 e	592.20 ab	40.81
N1 CRS2	1567.70 b	640.10 a	52.20
N2 CRS2	1710.99 a	660.10 a	56.55
Mean	1411.80	611.06	42.64

N_1= 60 kg urea fed^{-1} . N_2= 120 kg urea fed^{-1} .
FYM_1= 10 m^3 fed^{-1} . & FYM_2= 20 $m^3 fed^{-1}$.
CRS_1= 10 m^3 fed^{-1} . & CRS_2= 20 m^3 fed^{-1} .

These mainly could be attributed to that combined use of FYM or CRS with urea increase nutrients availability for plant through their different growth stages which make balance in nutrients uptake. The maximum increase in grain yield (54.66 and 56.55 % over the untreated control) was recorded by the application of integrated organic and inorganic fertilizers at N_2FYM_2 and N_2CRS_2 treatments respectively. Maximum values of straw yield (1660.50 and 1710.99 g.m^2) were found at the same treatments which gave higher grain yield.

This is might attributed to the integrated use of inorganic fertilizers with organic manures sustains higher crop yields, maintain soil health and improving N use efficiency and reducing environment pollution. Generally integrations of urea with organic fertilizers (FYM or CRS) gave higher grains and straw yield than that observed with urea alone. These results are confirmed with those obtained by Hammad *et al*., (2006a) and Naeem (2006).

The straw yield followed the same trend as that of wheat grains. Data also show that utilization of CRS gave higher grains and straw yields whether, added separately or combined with urea to the soil than FYM utilization at the same level. This is might be attributed to the enrichment composted rice straw by nutrients and the high content of organic matter and the low both of C/N ratio and EC than farmyard manure (FYM) as shown in Table 2. The mean values of gains and straw yields descended as follow: CRS > FYM > urea.

Table 4: NH_4^+ availability (ppm) in soil as affected by the studied treatments at certain times after planting during 2008 / 2009 season.

Treatments	Days after planting		
	45	80	155
Control	23.30	16.13	17.07
N1	33.10	23.10	25.80
N2	43.50	31.50	34.80
Mean	38.30	27.30	30.30
FYM1	47.33	39.62	41.70
N1 FYM1	53.90	39.72	42.36
N2 FYM1	60.66	47.12	50.98
FYM2	51.84	43.22	49.70
N1 FYM2	70.60	54.90	60.04
N2 FYM2	76.88	60.91	63.12
Mean	60.20	47.58	51.36
CRS1	48.20	38.12	43.30
N1 CRS1	56.88	43.55	46.45
N2 CRS1	65.33	46.66	55.59
CRS2	56.85	54.33	61.78
N1 CRS2	75.61	60.77	67.90
N2 CRS2	80.54	68.90	70.11
Mean	63.90	52.05	57.52

1- Nitrogen (N) availability in soil (ppm):

1.1- Ammonium (NH_4^+) availability in soil (ppm):

Data in Table 4 show the available NH_4^+ concentrations (ppm) as affected by the applications of organic, inorganic fertilizers and their integrations. NH_4^+ concentration (ppm) enhanced with increasing levels of organic (FYM or CRS) and inorganic fertilizers whether applied alone or in combinations at all addition levels. All combinations of organic (FYM or CRS) and urea treatments gave higher NH_4^+ concentration in soil than the other treatments. The increment of soil NH_4^+ -N was also, noticeable during the periods of wheat growth. These results are in harmony with obtained by Gupta *et al* (2000) who reported that, combined application of urea and farmyard manure significantly increased available N status over similar N addition through urea alone. This might be due to the integration of urea and FYM or CRS enhance microorganism's activities which increase the mineralization beside application of FYM or CRS to the soil increase of biological N-fixing activity (IRRI, 1984). Regarding to NH_4^+ concentrations at certain times 45, 88 and 155days from planting, Maximum NH_4^+ concentrations was detected at 45 days from planting and then decreased over time. This decrement may be due to 1) NH4+ absorption by plant, 2) NH_4^+ fixations by clay minerals and 3) conversion of NH_4^+ to NO_3^-. It is noted from the results slight increase in available NH_4^+ concentrations at 155 as compared to 45 and 88 days from planting. This may be attributed to at 155 days (at harvest) soil exposed to aerobic conditions led to that enhance activity of microorganisms which accelerate organic matter decomposition that increase available NH_4^+. Data also, showed that NH_4^+ availability in soil with CRS was higher than FYM treatments with the same addition levels of fertilizers. This might be due to the composted rice straw contents easily decomposable C and has a relatively narrow C/N ratio as compared with the farmyard manure.

1.2- Nitrate (NO_3^-) availability in soil (ppm:

NO_3^- availability (ppm) in soil at different times 45, 88 and 155 days from planting as affected by applications of organic and inorganic fertilizers presented in Table 5. Data represent that the available NO_3^- concentrations increased with increasing levels of organic (FYM or CRS) and inorganic fertilizers as compared to the untreated control. Regarding to NO_3^- availability at certain times from planting, data illustrate that the available NO_3^- concentration increased with time till 45 days from planting and then decreased at 88 and 155 days. This might be due to: 1) NO_3^- absorption by plant, 2) NO_3^- losses by leaching and 3) NO_3^- assimilation by microorganisms.

Table 5:NO_3^- availability (ppm) in soil as affected by the studied treatments at certain times after planting during 2008 / 2009 season.

Treatments	Days after planting		
	45	80	155
Control	13.33	9.88	10.98
N1	20.98	15.57	17.20
N2	26.88	19.65	21.99
Mean	23.93	17.61	19.59
FYM1	25.66	18.77	19.63
N1 FYM1	32.85	20.98	22.98
N2 FYM1	39.00	26.88	31.20
FYM2	30.11	22.66	25.90
N1 FYM2	35.11	24.90	28.90
N2 FYM2	40.11	32.98	34.33
Mean	33.80	24.52	27.15
CRS1	28.90	16.90	22.89
N1 CRS1	34.50	27.68	30.76
N2 CRS1	38.90	26.89	29.11
CRS2	32.11	23.88	25.66
N1 CRS2	37.90	30.11	35.77
N2 CRS2	43.12	31.90	36.10
Mean	35.90	26.22	30.04

2- Phosphors (P) availability in soil (ppm):

Data in Table 6 show the available P concentrations (ppm) in soils at certain times (45, 88 and 155 days) from planting as affected by the applications of organic and inorganic fertilizers and their integrations. Results indicated that the available P concentration increased with all treatments. But the availability of P with application of FYM or CRS whether added alone or combined with urea was higher than separated urea or the control. This might be due to the increase of the negative charges on the surface of organic matter that enhance selective adsorption of organic molecules containing a greater concentration of anionic group. These organic molecules not only compete for sorption sites with orthophosphate ions but also increase negative charges, which results in a higher orthophosphate concentration in solution, Moshi *et al*., (1974) and Perrott (1978). These results are confirmed by the findings of Alam *et al*., (2005) who found that P availability increased in soil with integrated use of organic waste and chemical fertilizer than organic waste or urea alone, also, illustrate that the available P concentration was higher with FYM than CRS treatments. This might be attributed to P content in FYM as shown in Table 2 was 700.50 ppm while the content of P in CRS was 680.50 ppm. Concerning to the changes of the available P concentration at different times (45, 88 and 155 days) from planting, it is clear from the data, that the available P concentration increased with time till 45 days from planting then tended to decrease at 88 and 155 days. This decrease might be attributed to: 1) Meet the high demand of P by wheat plant at earlier stage, 2) P precipitation by carbonates.

Based on the results, it could be concluded that the application of organic manures with and without fertilizer N resulted in a greater increase in available P concentration in the soil. These results are in harmony with those obtained by Singh *et al*., (2007).

Table 6: P availability (ppm) in soil as affected by the studied treatments at certain times after planting during 2008 / 2009 seasons.

Treatments	Days after planting		
	45	**80**	**155**
Control	10.51	7.12	4.45
N1	11.54	7.67	4.33
N2	12.66	6.86	5.59
Mean	12.10	7.26	4.96
FYM1	22.53	15.69	10.27
N1 FYM1	25.38	17.88	12.16
N2 FYM1	28.11	17.96	12.92
FYM2	31.50	19.18	15.11
N1 FYM2	34.99	21.75	17.45
N2 FYM2	36.57	27.40	16.98
Mean	29.84	19.80	14.1426
CRS1	19.34	13.86	8.96
N1 CRS1	22.98	15.10	10.50
N2 CRS1	24.64	14.30	9.88
CRS2	28.90	19.8	11.80
N1 CRS2	30.60	18.77	13.98
N2 CRS2	33.70	25.11	14.10
Mean	26.69	17.82	11.55

3- Potassium (K) availability in soil:

Data in Table 7 illustrate that the available K concentration (ppm) in soil as affected by the application of organic and inorganic fertilizers. Data show that the availability of K increased with increasing levels of organic fertilizers whether, added to the soil individual or combined with urea. Data also, indicate that the available K concentration was higher with CRS than FYM treatments. This could be attributed to the higher K- content of rice straw. Available K concentration starts to decrease after 45 days after planting. This might be due to 1) K absorption by plant, 2) K adsorbed by clay mineral and 3) K losses by leaching. This results are in harmony with those obtained by Doberman and Fairhrust ., (2000) and Naeem (2006). Concerning to available K concentration at certain times after planting, data indicate that the available K concentration (ppm) decrease with passage time where, the highest value of available K concentration was found after 45 days from sowing then decrease over time. It is clear from the data in the mean values of available K concentration are descended as follow: CRS > FYM > urea.

Table 7: K availability (ppm) in soil as affected by the studied treatments at certain times after planting during 2008 / 2009 season.

Treatments	Days after planting		
	45	80	155
Control	250.45	169.89	145.66
N1	300.34	230.77	195.15
N2	322.45	275.66	198.69
Mean	311.39	253.15	196.92
FYM1	750.60	684.11	522.65
N1 FYM1	770.33	632.90	488.33
N2 FYM1	738.45	589.25	423.46
FYM2	800.43	640.45	529.26
N1 FYM2	795.90	612.22	480.98
N2 FYM2	788.35	520.55	419.49
Mean	774.01	613.24	477.36
CRS1	820.33	670.34	556.90
N1 CRS1	803.54	647.76	580.76
N2 CRS1	790.35	620.34	517.66
CRS2	880.66	690.77	540.45
N1 CRS2	866.57	687.90	491.23
N2 CRS2	820.66	630.11	467.29
Mean	830.35	657.87	525.71

4- Soil organic matter (SOM) %:

Soil organic matter percentage (SOM) % as affected by the application of organic and inorganic fertilizers and their combinations at different certain times (45, 88 and 155 days) from planting of wheat is presented in Table 8. Data show that the percentage of soil organic matter increased with increasing amount of FYM or CRS either applied alone or in combinations with different levels of urea as compared with the control. The highest values of SOM % were found with integrated use of organic (FYM or CRS) and inorganic fertilizers N_2FYM_2 and N_2CRS_2 at 45, 88 and 155 days from planting. Charkrabarti *et al*, (2003) found similar results with integrated applications of organic and inorganic fertilizers. Inorganic fertilizers may meet the demand of mineral nutrition by microbes but cannot provide carbon, which is a major constituent of microbial cells. Integrated applications of organic and inorganic materials provide balanced mineral nutrition as well as carbon. It is clear from the data the reduction of soil organic matter percentage with the control or urea may be due to the decomposition of the initial organic matter in the soil. These results are in agreement with those obtained by Hammad *et al*, (2006b), Naeem (2006) and Howida (2009). Concerning to the decomposition organic matter through certain times from planting, data indicate that the decomposition of soil organic matter increased with increment the levels of FYM or CRS whether, alone or integrated with urea at all times. These results agree with the finding of Chen and Avnimelech (2002) who revealed that the added organic materials to the soil in various forms i.e. 1) Crop residues, 2) Organic wastes such as animal manure and 3) Dead microbial cell biomass, with large addition caused increase in the microbial activity in soil thus, accelerating the rate of organic matter decomposition .It is clear from the data with increasing levels of addition organic fertilizers up to the second level of FYM or CRS whether alone or integrations with urea led to elevated SOM % in soil.

Table 8: Soil organic matter (%) as affected by the studied treatments at different times of wheat growth during 2008/2009 season.

Treatments	Days after planting		
	45	80	155
Control	1.40	1.22	1.13
N1	1.46	1.35	1.21
N2	1.42	1.33	1.17
Mean	1.44	1.34	1.19
FYM1	1.70	1.53	1.38
N1 FYM1	1.85	1.65	1.45
N2 FYM1	1.90	1.71	1.56
FYM2	2.11	1.89	1.67
N1 FYM2	2.31	2.05	1.88
N2 FYM2	2.45	2.17	1.91
Mean	2.05	1.83	1.64
CRS1	1.80	1.63	1.39
N1 CRS1	1.86	1.61	1.50
N2 CRS1	1.96	1.82	1.59
CRS2	2.25	1.93	1.73
N1 CRS2	2.29	2.15	1.93
N2 CRS2	2.46	2.24	2.00
Mean	2.01	1.89	1.36

Conclusion:

It could be concluded that, the integration of organic and inorganic fertilizers was better than inorganic fertilizer only. Also, using high amount of organic fertilizers with urea gave the highest grain yield and keeps the soil rich in soil organic matter (SOM).

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تأثير الأسمدة العضوية والمعدنية علي صلاحية عناصر التربة وإنتاجية القمح

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لقد أدي الأستخدام المستمر للأسمدة الكيميائية إلي تدهور الخواص الطبيعية للتربة ومحتواها من العناصر الغذائية تحت ظروف الزراعة المستديمه . وإن الإدارة المثلي للنيتروجين هو مفتاح الزيادة المستمرة في إنتاج القمح في الأراضي الفقيرة في عنصر النيتروجين . لذا فإنه تم إجراء التجربة الحقلية في تربة طينية وكان صنف القمح المنزرع (جيزة 168) خلال موسم (2008-2009) في محطة التجارب بكلية الزراعة – جامعة المنصورة. وذلك لدراسة التاثير المشترك لكل من الاسمدة المعدنية مع الأسمدة العضوية في صورة (سماد بلدي – كمبوست قش أرز) وتأثيرهم المشترك علي إنتاجية القمح وتيسر العناصر الغذائية ومحتوي المادة العضوية في التربة لفترات (45- 88 -155) يوم من زراعة القمح . ولقد إستخدم تصميم القطاعات كاملة العشوائية مع 3 مكررات . تم إضافة السماد المعدني (يوريا) بمعدل 60-120 كجم/فدان يوريا . ومعدلات السماد العضوي [(10-20م^3 /فدان) سماد بلدي - (10-20م^3 /فدان) كمبوست] . تضاف الأسمدة العضوية إما منفردة أو مع اليوريا في التربة . توضح النتائج أن أعلي زيادة في محصول الحبوب (54.66- 56.55 %) اعلي من الكنترول . ومحصول القش (1660.50 – 1710.99 جم/م^2) وسجلت مع المعدل الثاني من النيتروجين و المعدل الثاني من السماد البلدي وسجلت مع المعدل الثاني من النيتروجين و المعدل الثاني من الكمبوست .

و لذلك ينصح بإضافة التاثير المشترك للسماد البلدي والكمبوست والمعدني للحصول علي التركيزات المثلي من NH_4^+, NO_3^-, P, K في التربة إلي جانب زيادة النسبة المئوية لمادة الأرض العضوية بالمقارنة بباقي المعاملات.

قام بتحكيم البحث

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