J.Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 4 (10): 1101 - 1116, 2013

EFFECT OF MINERAL, BIO AND ORGANIC NITROGEN FERTILIZATION ON WHEAT YIELD AND NITROGEN UTILIZATION EFFICIENCY AND UPTAKE AT NORTHERN DELTA OF EGYPT.

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ABSTRACT

Effect of organic fertilizer as compost (20 m^3 fed^{-1}), N-biofertilization (cyanobacteria *Azospirillum*, *Azotobacter* inoculations and mix of previous inoculations) and mineral nitrogen fertilization application rates (0, 30, 60 and 90 kg N fed^{-1}) on wheat grain and straw yields, N-uptake and nitrogen utilization efficiency (NU_tE) were studied for wheat crop (*Triticum aestivum, L.*), variety Sakha 93. Two field trials at El-Serw Agricultural Research Station, Dammietta governorate through winter season 2011/2012 and 2012/2013 were conducted. The results showed that wheat grain and straw yields and N-uptake in grain and straw increased with use of mineral fertilizer rates up to 90 kg N fed^{-1}, but N utilization efficiency for wheat crop was decreased. As well as these results showed that a mixture of bio-fertilizers, cyanobacteria, *Azotobacer* and *Azospirillum* inoculations, respectively gave the highest values of the previous parameters except the NU_tE, where the order of values was upward with the order of the previous inoculations. Also, the results showed that the use of organic fertilizer as a compost gave the highest values of wheat grain and straw yields and N-uptake in grain and straw and the lowest values of NU_tE. Organic fertilizer + a mixture of bio-fertilizers + 90 kg N fed^{-1} gave the highest wheat grain and straw yields and N-uptake and gave the lowest N utilization efficiency. In addition, applying organic fertilizer + mix or BGA or *Azotobacer* inoculation could produce economic wheat grain and straw yields when it combined with 30 kg N fed^{-1} and in the same time, this treatment gave high N utilization efficiency and thus saves in mineral fertilization, which may lose when applying the full recommended dose and conserves environment by reducing pollution hazards.

Keywords: Wheat, cyanobacteria, *Azospirillum*, *Azotobacter*, compost, organic fertilizer, nitrogen utilization efficiency, N-uptake, mineral nitrogen fertilization.

INTRODUCTION

Wheat (*Triticm aestivum, L.*) is considered one of the most important cereals crop in Egypt. The amount needed from it is greater than that locally produced. Therefore, increasing its productivity as well as cultivated area is highly recommended.

Plants show dramatic response to nitrogen additions, since nitrogen is a major building block of amino acids and proteins (Wilkinson, 2000). Fertilization of wheat is an important limiting factor affecting wheat production. Results of many researchers that achieved in Egypt revealed that nitrogen fertilizer levels significantly affected most of plant growth traits, yield and its components. The optimum nitrogen fertilizer levels for wheat vary widely in amounts, it was ranged between 70 and 120 kg N fed^{-1} according to environmental conditions (Tammam and Tawfils, 2004; Salem, 2005 and Mansour and Bassiouny, 2009). Application of very high nitrogen rate can reduce grain yield by increasing lodging and disease incidence.

Bio-fertilizers assume special significance particularly because they are eco-friendly and because of their alternative chemical fertilizers are expensive (Kannaiyan, 2003 and Choudhury and Kennedy, 2004). Cyanobacteria may increase yields by providing the crop with N, possibly by producing growth-promoting substances and improving P availability and soil properties (Roger, *et al.,* 1980; Abd El-Fattah *et al.,* 1999 and Mosaad, 2005). Also, Azospirilla are free-living rhizobacteria that are able to promote plant growth and increase yields of many crops of agronomic importance (Bloemberg and Lugtenberg, 2001 and Dobbelaere *et al.,* 2001). Inoculation of wheat plants with *Azospirillum spp.* resulted in significant increases in grain yield and total nitrogen yield (Tarrand *et al.,* 1978; Baldani *et al.,* 1983, 1987 and Kapulnik *et al.,* 1983).

Organic manures have long been used in agriculture as they provide plant nutrients and improve biological and thus the physical properties of soils (Poincelo, 1975 and Vaughan and Ord, 1985). The use of organic manures has declined recently, in favour of highly plant available inorganic fertilizers. There has been a renewal of interest in the use of organic manures as a source of plant nutrients (Parsons, 1985), due to dwindling non-renewable resources and increasing energy costs involved in the manufacture of inorganic fertilizers (Chen and Avenimelech, 1986). Furthermore, adverse effects on environmental quality due to the excessive use of fertilizers are increasingly being recognized. In present, low N and P contents are hampering the widespread use of organic manures such as compost although these are relatively rich in micronutrients (Stevenson and Ardakani, 1972) and may improve the physical properties of the soil (Simpson, 1983). Zein *et al.,* (2000), Shoman *et al.,* (2006) and El-Sirafy *et al.,* (2012) observed that wheat yields were significantly affected by adding organic fertilizer. Also, Tuttobene, *et al.,* (2009) showed that organic fertilization gave similar wheat yields to the compared mineral fertilization, averaging at 3.63 t/ha.

El-Hamdi *et al.,* (2012) showed that adding 40 kg N fed^{-1} of nitrogen fertilizer mixed with Azotobacter + Asospirillum in presence of humic acid (50 L fed^{-1}) gave the highest value of grain and straw yields, N, P and K uptake. El-Sirafy *et al.,* (2012) showed that wheat yield components have been increased by applying organic manure, bio-treated compost along with N, P, K and Zn mineral fertilization.

The aim of this investigation is to study the combined effect of using organic fertilizer as compost, mineral nitrogen and biological nitrogen fixation (BNF) on wheat grain and straw yields and N-uptake and utilization efficiency.

MATERIALS AND METHDOS

Two field trials were performed at El-Serw Agricultural Research Station, Damietta Governorate during the two winter seasons of 2011/2012 and 2012/2013. Split Split Plot design with four replications was conducted to study the effect of using organic fertilizer as compost treatments (the main plots) i.e. O_0, without organic fertilizer and O_1, with organic fertilizer at a level of 20m^3 fed^{-1} of mature compost rice straw and farmyard manure, the various N_2-biofertilizers (I_0, control without inoculation, I_1, cyanobacteria, I_2, *Azotobacter*, I_3, *Azospirillum* inoculations and I_4, Mix from previous inoculations) were added in the sub plots and mineral nitrogen fertilizer levels were added in the sub subplots, e.g. N_0, 0, N_{30}, 30, N_{60}, 60 and N_{90}, 90 kg N fed^{-1}, on wheat growth and nutrients uptake.

Wheat seeds, CV. Sakha 93, were sowed on 20th November 2011 in 1st season and on 25th November 2012 in 2nd season. Wheat harvesting was done on 25th April 2012 and 1 May 2013 in both seasons, respectively.

Soil samples were taken from the experimental field before conducting from soil layer (0-30cm depth), then air-dried and ground to pass through 2 mm sieve. Soil physical and chemical properties were carried out according to Piper (1950) and Jackson (1967) as shown in Table 1. EC, cations and anions were estimated in 1:5 soil water extract, where PH was measured in soil water suspensions (1:2.5).

Table 1: Some physical and chemical properties of soil before wheat cultivation in seasons 2011/2012 and 2012/2013.

Growing season	Particle size distribution%					OM %	$CaCO_3$ %	C.E.C (meq /100g soil soil)	PH	EC, dSm^{-1}
	Coarse sand	Fine sand	Silt	Clay	Texture class					
1st	1.44	10.35	22.26	65.95	Clayey	0.86	1.34	42.3	8.0	2.41
2nd	1.09	11.23	21.67	66.01	Clayey	0.75	1.41	44.1	8.0	2.32

Growing season	Cations and anions in the soil water extract (1:5), meq/100 g soil								NPK available (ppm)		
	Cations				Anions				N	P	K
	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	Cl^{-}	SO_4^{--}			
1st	3.11	2.69	11.40	0.28	---	1.70	12.21	3.68	33	7.94	479
2nd	2.95	2.81	11.21	0.27	---	1.59	12.02	3.63	31	8.01	483

Mature compost (rice straw and farmyard manure) (20m^3 fed^{-1}) were added to the soil and mixed with the upper layer before planting.

Table (2): Analysis of compost in 2011/2012 and 2012/2013 seasons.

Season	pH	EC, dS/m at 25 ^oC	O.C. %	Total N %	Total P %	C/N
2011/2012	7.55	2.90	29.91	1.59	0.25	19.07
2012/2013	7.53	2.87	29.81	1.57	0.28	19.15

Nitrogen fertilizer was added in the form of urea (46% N) at two equal doses. The first dose was added before the first irrigation and the last dose was added before the second irrigation. Calcium superphosphate fertilizer (15% P2O5) was added at the rate of 100 Kg/fed as basal of each plot before ploughing.

The blue-green alga (Cyanobacteria) was provided from soil Microbiology Department at Soil, Water and Environmental Institute, ARC, Giza. N_2-fixing bacteria (*Azospirillum spp*, *Azotobacter sp.* and Mix inoculation) were provided from the Soil, Water and Environmental Institute, ARC, Giza. Bacterial inoculation was performed using seed coating technique by ARC recommendations as follows, the seeds were classified into 5 groups for biofertilization and seed coat procedures before that, it washed to avoid anti-fungus effects then air dried and mixed with a microbial adhesive and then mixed by the biofertilization inoculants separately in a (30 min) shadow place.

After wheat harvest, grain and straw yields and N-uptake (N-uptake kg fed^{-1} = (N% * the yield kg. fed^{-1}) / 100) in grains and straw were recorded. Also the Nitrogen utilization efficiency for wheat crop was calculated.

N utilization efficiency NU_tE (Sowers *et al.,* 1994, Fiez *et al.,* 1995 and Bellido, *et al.,* 2005) for wheat grain production is equal to grain yield per unit of total N uptake. N utilization efficiency was calculated as follows:

NU_tE kg grain yield per kg N-uptake= Grain Yield (kg fed^{-1})/ Total aboveground plant (grain + straw) N uptake (kg fed^{-1}).

The statistical analysis was carried out according to Steel and Torrie (1980) to compare the treatments values.

RESULTS AND DISCUSSION

Wheat grain and straw yields (ton fed^{-1}).

Table 3 and Figs. 1, 2, 3 and 4 pointed out that adding nitrogen fertilizer significantly affected on wheat grain and straw yields (ton fed^{-1}) by increasing nitrogen rate up to 90 kg N fed^{-1}. Also, data showed that yields significantly were affected by biofertilization inoculation treatments and, the order of nitrogen biofertilization inoculations for their influence on wheat grain and straw yields was as follows: Mix from (BGA + *Azospirillum sp.* and *Azotobacter sp.* Inoculations) > blue green algae (cyanobacteria) > *Azotobacter sp.* Inoculation > *Azospirillum sp.* inoculation. In addition, there was significant increase in wheat grain and straw yields by using organic fertilizer treatments in both seasons 2011/2012 – 2012/2013 and the data showed that the highest result of wheat grain and straw yields was obtained with organic fertilizer treatment. Kapulnik *et al.,* (1983), Vaughan and Ord, (1985), Tammam and Tawfils, (2004), Mosaad, (2005) and Salem, (2005) reported similar results.

The effect of interactions among organic fertilizer as compost, N-biofertilization Inoculations and nitrogen application rates were showed in Table 3. These interactions (I*O, N*I and N*I*O) in both seasons and (N*O) in 2^{nd} season significantly affected on wheat grain and straw yields, but the interaction (N*O) in 1^{st} season was no significant on previous variance.

Data in Table 3 and Figs. 1, 2, 3 and 4 show the interaction effect between nitrogen application rates, N-biofertilization Inoculations and organic fertilizer treatments. This interaction effect on wheat grain and straw yields was significantly in both 1^{st} and 2^{nd} seasons. Table 3 and Fig 1 and 2 showed that the highest values for grain yield (ton fed^{-1}) in 1^{st} and 2^{nd} seasons were obtained with $O_1I_4N_{90}$ (3.813 and 4.179), $O_1I_1N_{90}$ (3.688 and 3.994), $O_1I_2N_{90}$ (3.513 and 3.778), $O_1I_4N_{60}$ (3.440 and 3.773), $O_0I_4N_{90}$ (3.436 and 3.610), $O_1I_3N_{90}$ (3.338 and 3.514), $O_0I_1N_{90}$ (3.300 and 3.475), respectively. At the same time, grain yield was obtained by $O_1I_4N_{30}$ and $O_0I_1N_{60}$ in both seasons and $O_1I_2N_{60}$ at 2nd season, more than that obtained from $O_0I_0N_{90}$. So that, when applying organic fertilizer as compost (20 m^3 fed^{-1}) + cyanobacteria inoculation or *Azotobacter sp.* Inoculation + 60 kg N fed^{-1} can be given an economic yield, but with using organic fertilizer as compost (20 m^3 fed-1) + Mixture inoculation (cyanobacteria + *Azotobacter sp.* + *Azospirillum sp.*) + 30 kg N fed^{-1} can two-thirds of mineral nitrogen fertilization is enough, whereas the recommended rate of nitrogen fertilization under the same condition is 90 kg N fed^{-1}. It is very important from the economical point of view.

Table3:Effect of interactions among nitrogen rates, N-biofertilization and organic fertilizer on wheat grain and straw yields (ton fed^{-1}).

Treatment		Grain yield (ton fed^{-1})				Straw yield (ton fed^{-1})			
		2011/2012		2012/2013		2011/2012		2012/2013	
		O_0	O_1	O_0	O_1	O_0	O_1	O_0	O_1
I_0	Cont.	1.460	1.898	1.497	2.000	1.912	2.513	1.968	2.740
	N_{30}	1.898	2.208	1.948	2.343	2.513	2.880	2.604	3.276
	N_{60}	2.420	2.488	2.496	2.645	3.277	3.462	3.419	3.744
	N_{90}	2.940	2.995	3.038	3.155	4.060	4.171	4.178	4.375
I_1	Cont.	2.080	2.458	2.171	2.641	2.720	3.255	2.854	3.617
	N_{30}	2.565	2.890	2.687	3.114	3.399	3.907	3.591	4.353
	N_{60}	2.815	3.108	2.959	3.361	3.811	4.329	4.053	4.758
	N_{90}	3.300	3.688	3.475	3.994	4.556	5.195	4.779	5.538
I_2	Cont.	1.908	2.135	1.976	2.275	2.500	2.831	2.600	3.116
	N_{30}	2.238	2.535	2.323	2.710	2.966	3.434	3.104	3.790
	N_{60}	2.703	2.930	2.813	3.148	3.658	4.082	3.853	4.455
	N_{90}	3.130	3.513	3.265	3.778	4.321	4.947	4.490	5.239
I_3	Cont.	1.803	2.075	1.831	2.172	2.362	2.754	2.408	2.975
	N_{30}	2.155	2.448	2.150	2.565	2.800	3.312	2.873	3.586
	N_{60}	2.600	2.765	2.652	2.905	3.517	3.849	3.633	4.111
	N_{90}	2.965	3.338	3.036	3.514	4.098	4.702	4.175	4.872
I_4	Cont.	2.175	2.685	2.292	2.931	2.849	3.561	3.013	4.014
	N_{30}	2.738	3.005	2.890	3.286	3.628	4.050	3.862	4.594
	N_{60}	3.003	3.440	3.176	3.773	4.060	4.791	4.351	5.340
	N_{90}	3.436	3.813	3.610	4.179	4.745	5.372	4.964	5.794
F. test		**		**		**		**	
LSD 5%		0.073		0.095		0.104		0.134	
LSD 1%		0.096		0.126		0.138		0.177	
F. test	N	**		**		**		**	
	I	**		**		**		**	
	O	**		**		**		**	
	I*O	**		**		**		**	
	N*O	**		**		ns		*	
	N*I	**		**		**		**	

Significant at 5% level.** * Significant at 1% level.**
O_0= without compost. **O_1 = with compost.**
I_0 =without inoculations. **I_1 = Cyanobacteria.** **I_2 = *Azotobacter*.**
I_3 = *Azospirillum*. **I_4= Mixture from $I_1+I_2+I_3$**

In addition, the use of mix with some N-biofertilizations and organic fertilizer conserves the environment by reducing pollution hazards caused by leaching nitrate in the drainage water and through volatilization of NH_3 gas from $(NH_4)_2SO_4$ and $CO(NH_2)_2$ fertilizers and also, nitrogen oxides envolved during denitrification processes. As soon as, results showed that applying compost (20m^3 fed^{-1}) + mixture inoculation or Cyanobacteria inoculation or *Azotobacter* inoculation + 90 kg N fed^{-1} recorded the highest value for straw yield in both seasons. Similar results were obtained by Hammad *et al.,* (2011), El-Hamdi *et al.,* (2012), El-Sirafy *et al.,* (2012).

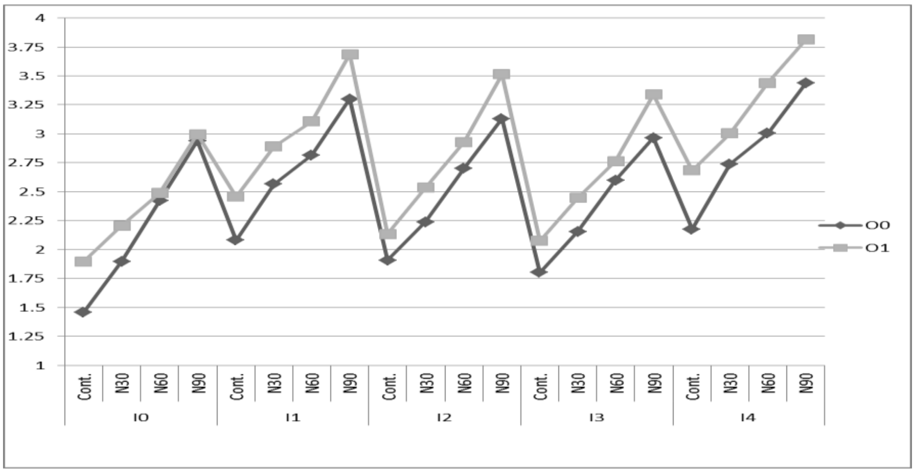

Fig. 1: Effect of interactions among nitrogen rates, N-biofertilization and organic fertilizer on wheat grain yield (ton fed^{-1}) in 2011/2012 season.

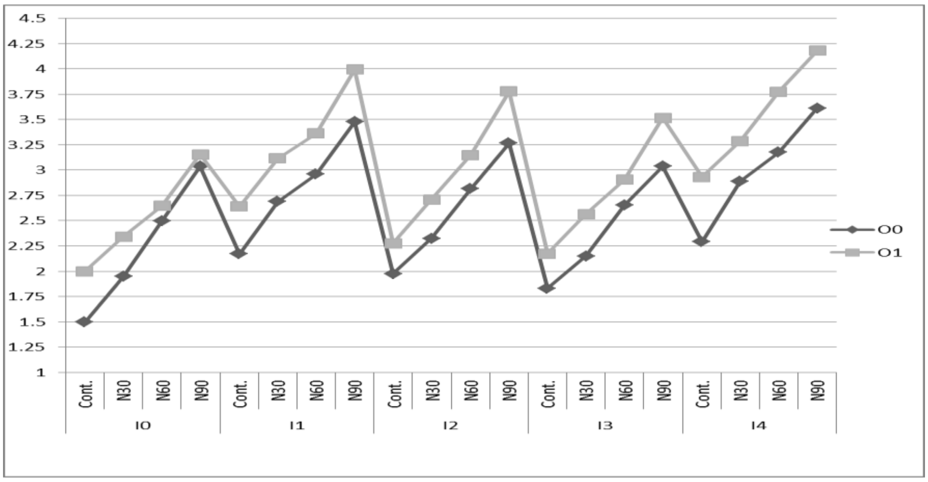

Fig. 2: Effect of interactions among nitrogen rates, N-biofertilization and organic fertilizer on wheat grain yield (ton fed^{-1}) in 2012/2013 season.

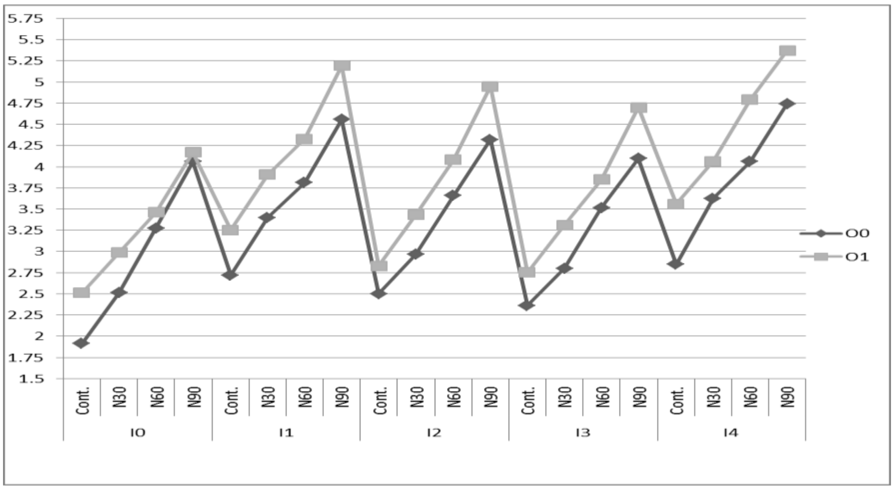

Fig. 3: Effect of interactions among nitrogen rates, N-biofertilization and organic fertilizer on wheat straw yield (ton fed^{-1}) in 2011/2012 season.

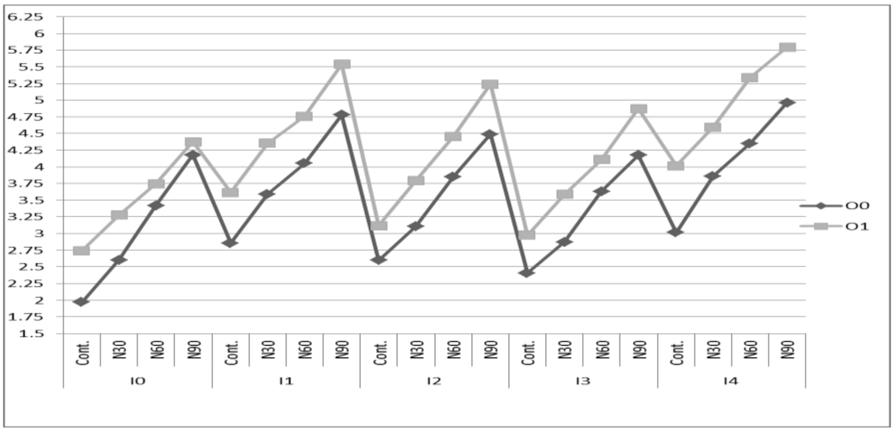

Fig. 4: Effect of interactions among nitrogen rates, N-biofertilization and organic fertilizer on wheat grain yield (ton fed^{-1}) in 2012/2013 season.

Nitrogen uptake of wheat grain and straw (kg-N fed^{-1}).

Data in Table 4 and Figs. 5, 6, 7 and 8 showed that there was significant increment in nitrogen uptake in both wheat grain and straw (total nitrogen removed by the crop from the soil in grain and straw) in both 2011/2012 and 2012/2013 seasons by increasing nitrogen fertilizer rates up to 90 kg N fed^{-1}. Also, there was significant increment in N-uptake in wheat grain and straw in both 2011/2012 and 2012/2013 seasons, by using the inoculations, the highest mean values of N-uptake in grains and straw in 2011/2012 and 2012/2013 seasons were recorded when mixture of inoculation was applied followed by cyanobacteria inoculation then *Azotobacer* and lately *Azospirillum*. In addition, there was significant increment in N-uptake in wheat grains and straw by applying organic fertilizer as compost in both seasons 2011/2012 and 2012/2013. These results are confirmed with those obtained by Ali *et al.,* (2008), Hammad *et al.,* (2011) and El-Sirafy *et al.,* (2012).

The effects of interactions among organic fertilizer as compost, N-biofertilization Inoculations and nitrogen application rates were showed in Table4. These interactions (I*O, N*I and N*O) significantly affected N-uptake in grains and straw in 2011/2012 and 2012/2013 seasons, as well as (N*I*O) on N-Uptake in grains in 2nd season, but the interaction effect (N*I*O) on N-uptake in grains in 1st season was no significant.

Table 4: Effect of interactions among nitrogen rates, N-biofertilization and organic fertilizer on N-Uptake (kg N fed^{-1}) of wheat grain and straw yields.

Treatment		N-Uptake (kg-N fed^{-1}) of wheat grain				N-Uptake (kg-N fed^{-1}) of wheat straw			
		2011/2012		2012/2013		2011/2012		2012/2013	
		O_0	O_1	O_0	O_1	O_0	O_1	O_0	O_1
I_0	Cont.	7.152	10.840	7.874	11.634	1.925	4.196	1.959	4.522
	N_{30}	10.968	14.860	12.080	16.059	4.215	5.541	4.413	6.138
	N_{60}	19.429	22.051	21.866	25.612	5.900	6.891	6.125	7.414
	N_{90}	29.005	31.544	29.692	34.094	7.488	8.504	7.778	9.005
I_1	Cont.	15.198	19.808	17.191	21.673	3.248	6.446	3.459	7.268
	N_{30}	23.793	28.400	27.409	32.915	6.447	8.193	6.843	9.170
	N_{60}	29.818	36.103	33.759	39.739	7.563	9.499	8.008	10.391
	N_{90}	37.019	48.444	44.299	52.765	9.402	11.852	9.610	12.311
I_2	Cont.	11.755	16.419	14.946	18.209	2.854	5.359	2.982	5.929
	N_{30}	17.272	20.873	20.366	23.643	5.367	6.755	5.643	7.500
	N_{60}	26.434	31.280	29.467	34.894	6.906	8.520	7.309	9.342
	N_{90}	33.892	40.854	36.378	44.556	8.387	10.615	8.753	11.289
I_3	Cont.	9.542	12.063	10.243	13.136	2.545	4.920	2.608	5.343
	N_{30}	13.067	16.920	15.191	19.605	4.819	6.302	4.970	6.859
	N_{60}	23.825	27.402	25.049	29.664	6.455	7.810	6.668	8.342
	N_{90}	31.562	37.662	32.021	40.080	7.809	9.906	7.993	10.311
I_4	Cont.	17.198	23.343	19.574	25.676	3.587	7.433	3.810	8.417
	N_{30}	26.969	32.638	32.514	37.925	7.263	8.997	7.765	10.212
	N_{60}	32.498	44.259	40.339	49.147	8.235	10.744	8.862	12.026
	N_{90}	38.889	52.235	48.916	58.080	10.042	12.568	10.243	13.216
F. test		**		ns		**		**	
LSD 5%		1.553		1.887		0.327		0.370	
LSD 1%		2.057		2.500		0.433		0.490	
F. test	N	**		**		**		**	
	I	**		**		**		**	
	O	**		**		**		**	
	I*O	**		**		**		**	
	N.O	**		**		**		**	
	N*I	**		**		**		**	

***Significant at 5% level. ** Significant at 1% level.**
O_0= without compost. O_1 = with compost.
I_0 =without inoculations. I_1 = Cyanobacteria. I_2 = *Azotobacter*.
I_3 = *Azospirillum*.

Data in Table 4 and Figs. 5, 6, 7 and 8 showed that interaction effect between Nitrogen application, N-biofertlizaton inoculations and organic fertilizer treatments were significant on N-Uptake in wheat grain in 2011/2012 season and wheat straw in both 2011/2012 and 2012/2013 seasons, but it was insignificantly for wheat grain in 2012/2013 season. The highest values of N-uptake for wheat grains and straw in both 2011/2012 and 2012/2013 seasons, were obtained with $O_1I_4N_{90}$, $O_1I_1N_{90}$ and $O_1I_4N_{60}$, respectively. This effect of organic fertilizer and N-biofertilizer inoculations on nitrogen uptake could be attributed to release of nitrogen element from organic fertilizer through and after decomposing and to the high efficiency of these inoculations on fixing atmospheric nitrogen and/or to produce some biological active substances, e.g., gibberellins and cytokine, Keeling *et al.,* (1994); El-Hamdi *et al.,* (2012); El-Sirafy *et al.,* (2012) and Hammad *et al.,* (2011).

Nitrogen Utilization Efficiency (NU_tE) (kg grain kg N-uptake^{-1}) of wheat crop:

Data in Table 5 and Figs. 9 and 10 showed that there was significant decrease in NU_tE in both 2011/2012 and 2012/2013 seasons by increasing nitrogen fertilizer rates up to 90 kg-N fed-1. Also, there was significant increment in NU_tE by applying N-biofertilizer inoculations in both seasons 2011/2012 and 2012/2013. The highest value of NU_tE was obtained with control treatment followed by *Azospirillum* inoculation, then *Azotobacter* inoculation, then cyanobacteria inoculation and then Mix inoculation. In addition, there was significant increment in NU_tE by applying organic fertilizer as compost in both seasons 2011/2012 and 2012/2013, the highest value of NU_tE was obtained without of organic fertilizer treatment then organic fertilizer treatment.

Data in Table 5 showed the effect of the interactions among nitrogen application, N-biofertlizaton inoculations and organic fertilizer treatments on nitrogen utilization efficiency for wheat crop in 2011/2012 and 2012/2013 seasons. These interactions (I*O, N*O, N*I and N*I*O) were significantly decreased in NU_tE for wheat crop in both seasons.

Data in Table 5 and Figs. 9 and 10 showed that interaction effect among nitrogen application, N-biofertlizaton inoculations and organic fertilizer treatments was significant on NU_tE in both 2011/2012 and 2012/2013 seasons and the lowest values of NU_tE were obtained with $N_{90}I_4O_1$ followed by $N_{90}I_1O_1$, $N_{60}I_4O_1$ and $N_{60}I_1O_1$.

Reduced overhead costs and the development of management practices were more responsive to a crop's physiological needs are both two of modern agriculture's primary objectives. Growing attention in this connection has been devoted to the nitrogen utilization efficiency of plants. Although it is the determinant factor in cereal crop yield, nitrogen involves high energy-production costs and because of its mobility in the soil–plant–atmosphere system, easily dissipated in the environment if not properly applied (Giardini, 1989 and Mahler *et al.,* 1994).

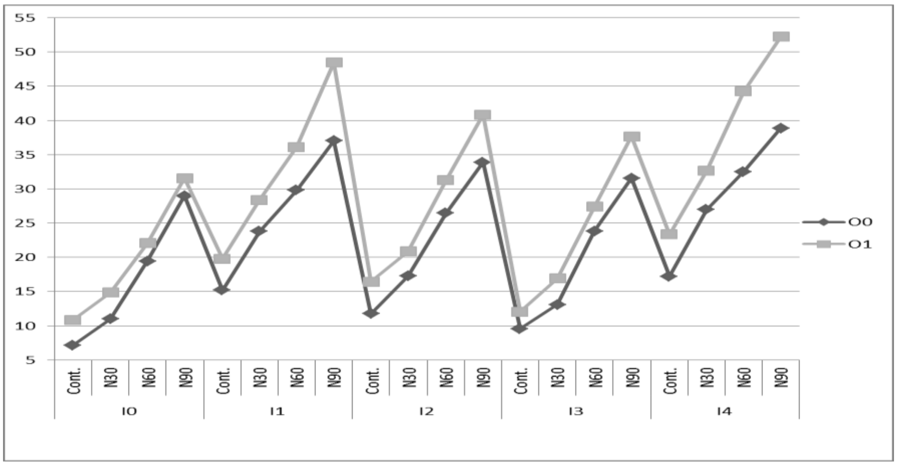

Fig. 5: Effect of interactions among nitrogen rates, N-biofertilization and organic fertilizer on N-Uptake (kg N fed^{-1}) of wheat grain yield in 2011/2012 season.

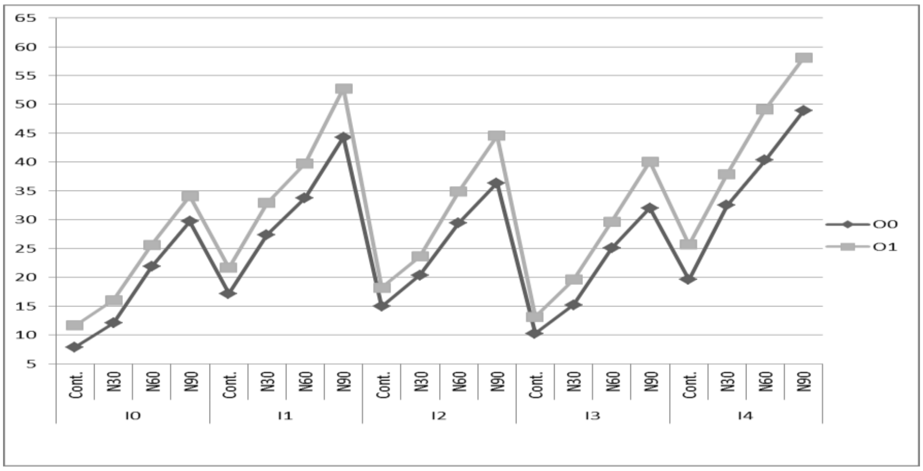

Fig. 6: Effect of interactions among nitrogen rates, N-biofertilization and organic fertilizer on N-Uptake (kg N fed^{-1}) of wheat grain yield in 2012/2013 season.

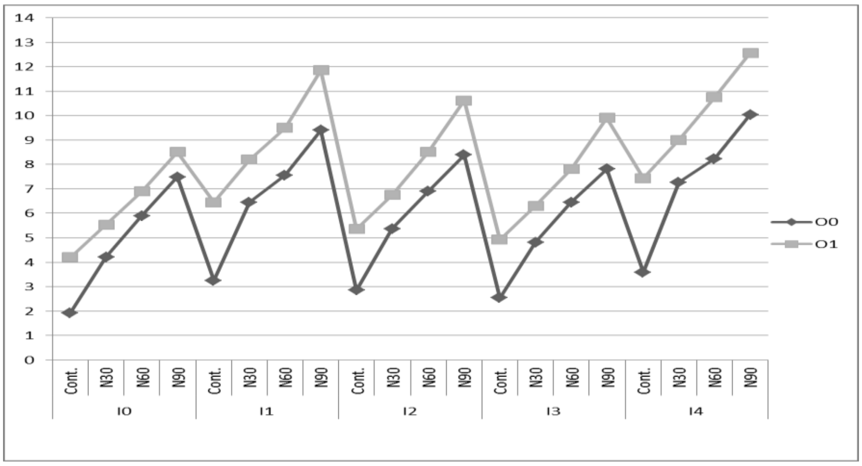

Fig. 7: Effect of interactions among nitrogen rates, N-biofertilization and organic fertilizer on N-Uptake (kg N fed^{-1}) by wheat straw yield in 2011/2012 season.

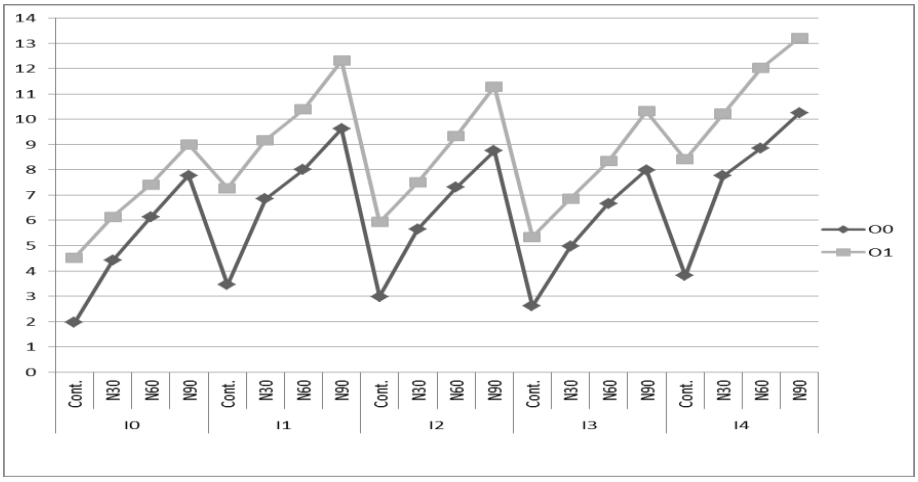

Fig. 8: Effect of interactions among nitrogen rates, N-biofertilization and organic fertilizer on N-Uptake (kg N fed^{-1}) by wheat straw yield in 2012/2013 season.

Table 5: Effect of interactions among Nitrogen rates, N-biofertilization and organic fertilizer on N Utilization Efficiency (kg grain kg N-uptake^{-1})

Treatment		Nitrogen utilization efficiency (kg-grain kg N-uptake^{-1})			
		2011/2012		2012/2013	
		O_0	O_1	O_0	O_1
I_0	Cont.	161.01	126.22	152.38	123.97
	N_{30}	124.97	108.39	118.25	105.68
	N_{60}	95.720	86.020	89.260	80.180
	N_{90}	80.650	73.980	81.150	73.300
I_1	Cont.	112.69	93.630	105.22	91.340
	N_{30}	84.870	79.010	78.520	74.060
	N_{60}	75.420	68.260	70.910	67.120
	N_{90}	71.140	61.190	64.520	61.440
I_2	Cont.	130.81	98.170	110.35	94.350
	N_{30}	98.950	93.160	89.380	88.580
	N_{60}	81.170	73.750	76.570	71.230
	N_{90}	74.080	68.270	72.400	67.720
I_3	Cont.	149.41	122.49	142.65	117.67
	N_{30}	118.21	105.53	106.73	97.050
	N_{60}	85.930	78.600	83.710	76.510
	N_{90}	75.450	70.210	75.940	69.810
I_4	Cont.	104.79	87.390	98.090	68.060
	N_{30}	80.020	72.240	71.800	68.330
	N_{60}	73.730	62.620	64.610	61.730
	N_{90}	70.290	58.870	61.070	58.670
F. test		**		**	
LSD 5%		2.414		2.660	
LSD 1%		3.197		3.523	
F. test	N	**		**	
	I	**		**	
	O	**		**	
	I*O	**		**	
	N.O	**		**	
	N*I	**		**	

***Significant at 5% level. ** Significant at 1% level.**
O_0= without compost. O_1 = with compost.
I_0 =without inoculations. I_1 = Cyanobacteria. I_2 = *Azotobacter*. I_3 = *Azospirillum*.

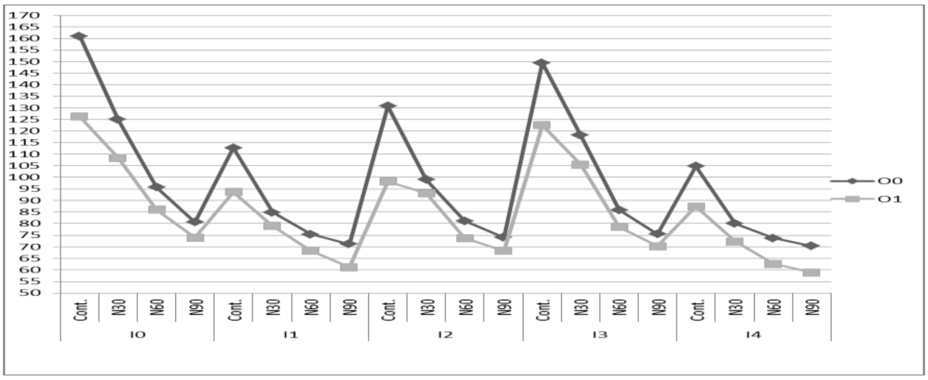

Fig. 9: Effect of interactions among Nitrogen rates, N-biofertilization and organic fertilizer on NU_tE (kg grain kg N-uptake^{-1}) of wheat grain yield in 2011/2012 season.

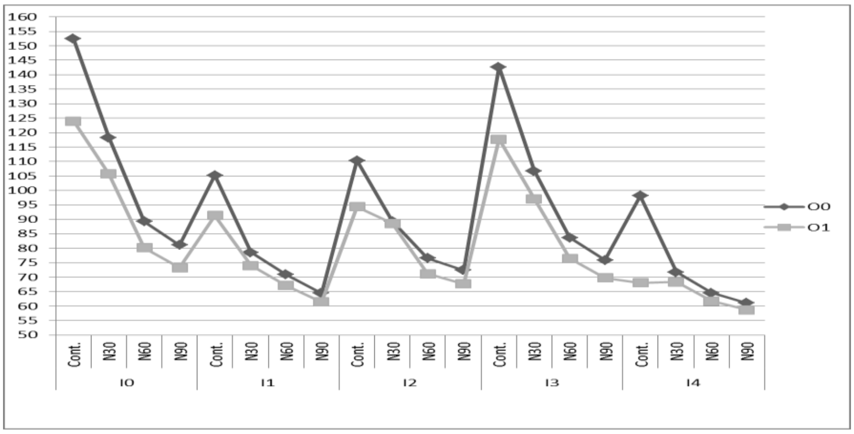

Fig. 10: Effect of interactions among Nitrogen rates, N-biofertilization and organic fertilizer on NU_tE (kg grain kg N-uptake^{-1}) of wheat grain yield in 2012/2013 season.

CONCLUSION

It could be concluded that applying N-biofertilizers and organic fertilizer produced high wheat grain yield when it combined with (30 kg-N fed^{1}). Also applying biofertilization and organic fertilizer with 30 or 60 kg-N fed^{-1} conserves the environment by reducing pollution hazards caused by leaching nitrate in the drainage water and through volatilization of NH_3 gas from $(NH_4)_2SO_4$ and $CO(NH_2)_2$ fertilizers.

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تأثير التسميد النيتروجينى المعدنى , الحيوى والعضوى على انتاجية القمح وكفاءة الاستفادة من النيتروجين وامتصاصه فى شمال دلتا مصر.

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أجريت تجربتان حقليتان فى محطة البحوث الزراعية بالسرو بمحافظة دمياط خلال الموسمين الشتويين لعامي٢٠١٢/٢٠١١ – ٢٠١٣/٢٠١٢ لدارسة تأثير كل من التسميد العضوي فى صورة كمبوست بمعدل ٢٠ م٣/الفدان , التسميد الحيوي النيتروجينى (طحالب خضراء مزرقة, لقاح الأزوتوباكتر, لقاح الأزوسبيريلم ومخلوط من اللقاحات السابقة) أربع معدلات من التسميد النيتروجينى (صفر, ٣٠ ، ٦٠ و٩٠كجم نتروجين /فدان) على محصول القمح من الحبوب والقش, امتصاص النيتروجين فى الحبوب والقش وكفاءة الاستفادة من النيتروجين لمحصول القمح صنف سخا ٩٣. أوضحت النتائج أن قيم كل من محصول القمح من الحبوب والقش وإمتصاص النيتروجين فى الحبوب والقش تزيد مع استخدام معدلات التسميد النيتروجينى حتى ٩٠ كجم نيتروجين /فدان بينما تنقص قيم كفاءة الاستفادة من النيتروجين. كذلك أوضحت النتائج أن مخلوط الأسمدة الحيوية ثم الطحالب الخضراء المزرقة ثم لقاح الأزوتوباكتر ثم الأزوسبيريلم على التوالى أعطت أعلى القيم من المدلولات السابقة ماعدا كفاءة الاستفادة من النيتروجين لمحصول القمح. أيضا أوضحت النتائج أن استخدام التسميد العضوى فى صورة كومبوست أعطى أعلى القيم من محصول القمح من الحبوب والقش وإمتصاص النيتروجين فى الحبوب والقش وأقل قيم كفاءة الاستفادة من النيتروجين لمحصول القمح. كما أوضحت النتائج أنه باستخدام التسميد العضوي مع مخلوط الأسمدة الحيوية مع ٩٠ كجم نيتروجين/فدان أعطت أعلى القيم لمحصول الحبوب والقش وكذلك امتصاص النيتروجين للحبوب والقش بينما أعطت أقل قيم كفاءة الاستفادة من النيتروجين. أوضحت النتائج أيضا أنه باستخدام التسميد العضوي مع التسميد الحيوي بمخلوط اللقاحات أو الطحالب الخضراء المزرقة أو الأزوتوباكتر مع ثلث معدل التسميد النيتروجينى المعدني الموصى به (٣٠ كجم نيتروجين /فدان) أعطت محصول إقتصادى من حبوب وقش القمح واستفادة للنيتروجين عالية وبالتالي توفيرا في التسميد النيتروجينى المعدني الذي قد يفقد عند استخدام المعدلات الموصى بها كاملة وبالتالي المحافظة على البيئة عن طريق الحد من مخاطر التلوث.

قام بتحكيم البحث

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