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INTEGRATED NITROGEN MANAGEMENT TO WHEAT THROUGH MINERAL AND BIOFERTILIZATION ALONG WITH ORGANIC MUNICIPAL-WASTES IN SOME NEWLY-RECLAIMED SOILS OF EGYPT

1- VEGETATIVE GROWTH, GRAIN YIELD AND ITS QUALITY

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ABSTRACT: A green-house pot-experiment was carried out with wheat (*Triticum aestivum L.*) cultivar Giza 163, grown in two soils i.e. sandy loam non-calcareous and sand clay loam calcareous soils. The study aimed to investigate the integral effect of mineral N-fertilization at three levels of the field recommended rate (i.e., 1/3, 2/3 & full N-dose, equivalent to 40, 80 & 120 kg N fed^{-1}, respectively) and bio-N fertilization through inoculating seeds with a mixture of active non-symbiotic N_2-fixing bacteria (*Azotobacter, Azopirillum & Bacillus*) along with organic manures of municipal-wastes, i.e. sewage-sludge compost (SSC) or matured town-refuse (MTR) at rate of 20 m^3 fed^{-1}; on the growth (at tillering & flowering stages) and at maturity (harvesting), through dry matter accumulation and grain potential per plant as well as crude protein percent of grains and its yield per plant. Results of this work could be summarized as follows:

A) The individual treatments: Raising the levels of added N-fertilizer up to 120 kg fed^{-1} (full N-dose) highly significantly increased dry weight at growth & maturity stages, yield potential, protein content and its yield; with significant differences between the applied rates, irrespective of other treatments, in both studied soils. Bio-fertilization resulted in high significant increments in all above parameters as compared to the unbiofertilized ones (control treatment) in both soil types. Organic manuring highly significantly improved all measured plant traits as compared to the control treatment. Manure of SSC recorded the highest averages, on both soils, with significant differences than MTR, for the most cases.

B) The interaction effects: Combination of studied treatments were found to be more effective than their applied separately, for all plant parameters tested on both studied soil types. Two third dose of recommended N-fertilizer (80

kg N fed^{-1}) plus biofertilizer, irrespective of organic applications, appeared to be the most efficient combined treatment due to, it gave a higher percentage increase of all wheat characters in both soils than full N-dose fertilization either with or without bio-N fertilizer. Wheat plants grown on soils fertilized with 2/3 N-dose and manured by SSC were more or less similar to those received full N-dose either amended or not with SSC or MTR. In both types of soil, seed inoculation plus SSC- addition gave the maximum values, with significant differences than inoculation coupled with MTR for straw & grains yields as well as protein content and its yield. However, the latter treatment (inoculation plus MTR) differed from the treatment of SSC applied alone, significantly on sandy loam non-calcareous soil and non significantly on sandy clay loam calcareous one, for most plant parameters. Conjunction of 2/3 recommended dose of N-fertilizer, seed inoculation and SSC-manure was the compatible treatment in both studied soils for all studied wheat attributes, it did not significant different than combination of full N-dose, biofertilizer and adding either SSC or MTR, in most cases.

C)The soil effects: Under the different treatments applied either alone or in combinations, sandy clay loam calcareous soil of Maryout manifested relatively lower mean values of all tested wheat traits than sandy loam non-calcareous one of Ismaillia.

It could be concluded that the moderate level of mineral N-fertilizer (80 kg N fed^{-1}) and appropriate bio-N-fertilization along with application of suitable composted organic manures are satisfied the demands of well crop production without much affecting the optimum crop yield and grain quality in the newly-reclaimed soils, avoided excessive additions of chemical N-fertilizers and subsequently reducing the environment at pollutions.

Key words: **Sandy and calcareous soils, mineral N-fertilizer, bio N-fertilizer, sewage sludge compost, matured town refuse, wheat yield and its quality.**

INTRODUCTION

In Egypt, there is a great need to bridge the wide gap between the consumption and production of cereal crops, particularly wheat which is one of the most important grain crops allover the world. The cultivated area in the Nile Valley is limited, thus it must be looking for desert lands through growing high yielding well adapted cultivars accompanied by improving the favourable agronomic practices.

Whether, nitrogen is a key element in the nutrition of most crops, especially cereals. In the newly reclaimed desert soils, the positive response of wheat to increased rates of mineral N-fertilization has recorded up to 160 kg N fed^{-1} (Fayed, 1992; El-Hawary et al., 1998; Eman & Abo-Warda, 1998; Mahfouz & Ghabour, 1998 and Omran et al., 1999).

It was found that, inoculation of wheat seeds with non symbiotic N_2-fixing bacteria (such as Azotobacter, Azospirillum, ...etc) is of great value for growth parameters, yield components and grain quality. Consequently, it could be saving huge amounts of inorganic N-fertilizers used, on one hand and, minimizing the induced environmental pollution resulted from N-losses (as volatilized ammonia and /or leaching nitrate to the ground water on the other hand (Attallah & El-Karamity, 1997; El-Hawary et al., 1998; El-Kholi, 1998; Kotb, 1998 and Sharief et al., 1998).

Recycling the various of municipal wastes has been recently received much attention for reducing the environmental pollution and producing more efficient organic manures, where the organic manuring of the soil comes next to water in Egypt. In this respect, refuses of city and sewage sludge have examined (Gommaa, 1991; Abou- Bakr & Omar, 1996; Zaghloul et al., 1996 and Rabie et al., 1997).

Keeping in view the scarcity of information on the role of mineral and bio-N-fertilization along with soil organic amendments on wheat crop, especially under newly reclaimed land conditions. This knowledge would be extremely useful for developing the suitable management practices for their efficient use. therefore, we under took the present study to evaluate the response of wheat plants grown on sandy and calcareous soils to the integral effect of inorganic and bio N-fertilization conjunctive with organic ameliorants.

MATERIALS AND METHODS

Two surface soil samples (0-30 cm depth), having different characteristics, were collected from two locations of newly reclaimed desert soils. The first sample was taken from Ismaillia Governorate and the second one from Maryout region (Northern part of Tahrir Province). They were air-dried, ground and sieved to pass 2 mm sieve and analyzed. The revelant data are presented in Table (1).

Two types of municipal organic wastes were tested, namely; matured town refuse (MTR) brought from El-Mokattam (Cairo Governorate) and sewage-sludge compost (SSC) from Abou-Rawash (Giza Governorate). The chemical composition and nutritional status of each is given in Table (2).

Analyses of the used soils and added organic materials were carried out by the methods described by Jackson (1973) and Page et al. (1982).

Under green-house conditions , the experiment was conducted in earthenware pots, 20 cm in both diameter and depth, filled with 5 kg of sandy or calcareous soils, which was previously mixed well with MTR or SSC-manure at rate equivalent to 20 m^3 fed^{-1}. Control treatment (without organic material added) taken into consideration. Twenty seeds of wheat (*Triticum aestivum L.*) cultivar Giza 163, were sown in each pot. Inoculation of wheat seeds was run by immersing in appropriate bacterial suspension for 3 hr, then they were dried at room-temperature, before using in plantation. This cell suspension containing a mixture of non-symbiotic N_2-fixing bacteria of the genera *Azotobacter*, *Azospirillum*, and *Bacillus*, which used as a bio-N-fertilizer. It was supplied by soils, Water & Environ Res. Inst., Giza, Egypt. Mineral N-fertilizer, in the form of ammonium sulphate (20.5 % N), was added as soil application at levels of one-third dose, two third dose and full dose from the field dose recommended (120 kg N fed^{-1}) in newly-reclaimed soils (i.e. 40, 80 & 120 kg N fed^{-1}, denoted as N_1, N_2 and N_3 respectively) in two equal portions after 15 & 30 days from planting. The experimental layout was split split plots in randomized complete blocks design, with nine replicates of each treatment. The main plots were allocated to the two organic manures, the sub-plots occupied with three N-fertilizer levels and, the sub-subplots devoted to the biofertilization treatments. All pots were received basis fertilizer dressing ordinary superphosphate(15.5% P_2O_5) added before sowing at the rate of 30 kg P_2O_6 fed^{-1}. Potassium sulphate (48 % K_2O)

Table (1): Some physical, chemical and fertility status characteristics of the studied soil samples.

Particle size distribution (%)				(1) Text. class	CaCO$_3$ (%)	(2) E..C.	(3) CEC	(4) ESP	(5) pH	Ionic content (meq L^{-1}) (2)								OM (%)	Total N %	Macro-and micro-nutrients						
																				Avail. (µg g^{-1})			DTPA-ext. (ppm)			
C.S	F.S	Silt	Clay							Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Cl^{-}	CO_3^{--}	HCO_3^{--}	SO_4^{--}			N	P	K	Fe	Mn	Zn	Cu
Sandy loam non-calcareous soil																										
6.30	66.35	17.60	9.75	S.L.	1.60	0.25	5.40	3.35	7.61	0.87	1.14	0.35	0.13	0.64	0.00	1.40	0.45	0.65	0.02	25	5.51	251	5.91	3.81	0.90	0.23
Sandy clay loam calcareous soil																										
13.00	49.40	15.11	29.50	S.C.L.	30.00	4.19	17.00	9.70	7.87	10.75	9.70	20.45	0.97	16.52	0.00	5.55	19.80	0.85	0.01	21	4.12	255	5.31	5.40	1.01	0.50

(1): S.L. - Sandy loam. S.C.L. = Sandy clay loam. (2): Determined in the saturation extract of the soil paste, (dSm^{-1}). (3): Cation-exchangeable capacity, (meq 100g soil^{-1}).
(4): Exchangeable sodium percentage. (5): Measured in 1:2.5 soil-water suspension (W/V).

Table (2): Some chemical characteristics and nutrients status of the applied organic wastes.

Organic carbon (%)	organic matter (%)	C/N ratio	pH (1:10)	EC (dS/m)	Macro-and micro-nutrients									
					N		P		K		DTPA-extractable (ppm)			
					Total (%)	Avail. (ppm)	Total (%)	Avail. (ppm)	Total (%)	Avail. (ppm)	Fe	Mn	Zn	Cu
Matured town-refuse (MTR)														
20.53	35.39	18.33	7.42	3.10	1.12	68.40	0.69	85	0.41	55	40.7	11.20	10.90	6.70
Sewage-sludge compost (SSC)														
30.03	51.77	11.33	6.70	2.10	2.65	88.00	1.08	110	0.76	77	35.20	6.70	15.90	9.00

at 50 kg K_2O fed^{-1} rate, divided into two equal doses applied at the same times of adding N-fertilizer. Fresh Nile water (EC = 0.35 dSm^{-1}) was used to maintain soil moisture content close to about field capacity during the experimental period. Other cultural operations were followed as usually done with wheat crop.

Plant samples representing the different growth stages were performed: at tillering, 45-days from sowing; at flowering, 90-days and, at harvesting. Three replicates of each treatment were removed, respectively. The samples were oven dried at 70 °C and the dry weights per plant were recorded. Dried grains were wet digested and total-N content determined, then grain crude protein percentage and its yield per plant were calculated (Chapman and Pratt, 1961).

All obtained data were statistically analyzed (Snedecor & Cochran, 1989) and LSD at 5% probability level was applied to verify the differences among the treatment means.

RESULTS AND DISCUSSION

All studied parameters of wheat plants grown on both soil types; concerning the vegetative growth (as expressed by dry-matter accumulation at the two stages of tillering and flowering), yield traits (i.e. straw, grains and biological yield per plant) and some criteria of grain quality (through determination of crude protein content, %) and its yield per plant, in the present part of study, were positively responded to the different treatments added, either alone or together, with varying the magnitude of response according to the applied treatment as well as the soil used.

I-Effect of mineral N-fertilizer levels:

Increasing the added rate at N-fertilizer up to the full dose (120 kg N fed-1) was accompanied by gradually and highly significant increase in each value of plant characters measured in both tested soils (Table 3, A & B). The highest percentage increases brought by adding 120 kg N fed-1 was 49.5, 40.3, 28.9, 34.7, 30.6, 26.2, and 69.6 % for dry matter weights at tillering & flowering stages, straw, grains and biological yield as well as content and yield of straw, grain protein, respectively on sandy loam non-calcareous, while the

Table (3): Dry-matter production (g/plant) at different growth stages up to maturity and grain quality of wheat plants grown on newly-reclaimed sandy and calcareous soils as affected by the studied treatments.

(A)- Sandy loam non-calcareous soil

Treatments Organic manure	(1) N-rate	At tillering stage (45-day)			At flowering stage (90-days)			Straw yield (g/plant)			Grain yield (g/plant)			Biological yield (4) (g/plant)			Grain protein Content (%)			Grain protein yield (g/plant)		
		(2) Unino.	(3) Inoc.	Mean	Unino.	Inoc.	Mean	Unino.	Inoc.	Mean	Unino.	Inoc.	Mean	Unino.	Inoc.	Mean	Unino.	Inoc.	Mean	Unino.	Inoc.	Mean
None	N1	0.54	0.60	0.57	1.13	130	1.22	1.42	1.70	1.56	0.55	0.71	0.63	1.97	2.41	2.19	7.97	8.22	8.10	4.38	5.84	5.11
	N2	0.61	0.65	0.63	1.50	1.68	1.59	1.98	2.16	2.07	0.70	0.85	0.78	2.68	3.01	2.85	8.75	10.12	9.44	6.13	8.60	7.36
	N3	0.64	0.67	0.66	1.63	1.70	1.67	2.03	2.20	2.12	0.77	0.90	0.84	2.80	3.10	2.96	10.05	10.32	10.19	7.74	9.29	8.51
	Mean	0.60	0.64	0.62	1.42	1.56	1.49	1.81	2.02	1.92	0.67	0.82	0.75	2.48	2.84	2.67	8.92	9.55	9.24	6.08	7.91	7.00
MTR	N1	0.63	0.85	0.74	1.70	2.20	1.95	2.20	2.45	2.33	0.85	1.12	0.99	3.05	3.57	3.32	8.33	9.02	8.68	7.08	10.10	8.59
	N2	1.01	1.22	1.12	2.38	2.98	2.68	2.81	3.21	3.01	1.10	1.42	1.24	3.91	4.63	4.25	9.79	11.20	10.50	10.77	15.90	13.34
	N3	1.15	1.27	1.21	2.76	3.04	2.90	2.82	3.25	3.04	1.17	1.45	1.34	3.99	4.70	4.38	10.85	11.92	11.10	12.70	16.46	14.58
	Mean	0.93	1.11	1.02	2.28	2.74	2.51	2.61	2.97	2.79	1.04	1.33	1.19	3.65	4.30	3.98	9.66	10.52	10.09	10.18	14.16	12.17
SSC	N1	0.67	0.95	0.81	1.95	2.45	2.20	2.35	2.70	2.53	0.90	1.18	1.04	3.25	3.88	3.57	9.10	10.33	9.473	8.21	12.19	10.20
	N2	1.11	1.30	1.21	2.72	3.10	2.91	2.87	3.34	3.11	1.12	1.05	1.39	3.99	4.99	4.50	10.70	12.21	11.46	11.98	20.14	16.07
	N3	1.26	1.35	1.31	2.83	3.09	2.96	2.88	3.35	3.12	1.19	1.67	1.43	4.07	5.02	4.55	11.90	12.40	12.15	14.16	20.71	17.44
	Mean	1.01	1.20	1.11	2.50	2.88	2.69	2.70	3.13	2.92	1.07	1.50	1.29	3.77	4.63	4.21	10.57	11.65	11.11	11.45	17.68	14.57
Average		0.85	0.98	0.92	2.07	2.39	2.23	2.38	2.71	2.55	0.93	1.22	1.07	3.31	3.93	3.62	9.72	10.57	10.15	9.24	13.25	11.25
		F-test	$LSD_{(0.05)}$		F-test	$LSD_{(0.05)}$		F-test	$LSD_{(0.05)}$		F-test	$LSD_{(0.05)}$		F-test	$LSD_{(0.05)}$		F-test	$LSD_{(0.05)}$		F-test	LSD(0.05)	
N (A) =		**	0.091		**	0.127		**	0.091		**	0.081		**	0.296		**	0.264		**	0.488	
INOC (B) =		**	0.075		**	0.104		**	0.074		**	0.066		**	0.242		**	0.215		**	0.398	
OM (C) =		**	0.091		**	0.127		**	0.091		**	0.081		**	0.296		**	0.264		**	0.488	
AxB =		*	0.129		NS	0.180		*	0.129		*	0.114		*	0.418		**	0.373		**	0.689	
AxC =		**	0.158		*	0.220		*	0.141		NS	0.139		NS	0.513		NS	0.457		**	0.844	
BxC =		NS	0.158		*	0.179		NS	0.124		**	0.114		NS	0.448		NS	0.373		**	0.689	
AxBxC =		NS	0.224		NS	0.312		*	0.184		*	0.173		NS	0.725		*	0.510		NS	1.194	

(1) N1, N2, and N3 represent 1/3, 2/3 and full dose of the recommended rate of mineral N-fertilizer.

(2) Uninoc.: without inoculation.

(3) Inoc.: inoculated with N_2-fixers (bio-N-fertilizer).

(4) Biological yield per plant = straw plus grain.

Table (3): Cont'd.

(B)- Sandy clay loam calcareous soil

Treatments		At tillering stage (45-day)			At flowering stage (90-days)			Straw yield (g/plant)			Grain yield (g/plant)			Biological yield (g/plant)			Grain protein Content (%)			Grain protein yield (g/plant)		
Organic manure	N-rate	Unino.	Inoc.	Mean	Unino.	Inoc.	Mean	Unino.	Inoc.	Mean	Unino.	Inoc.	Mean	Unino.	Inoc.	Mean	Unino.	Inoc.	Mean	Unino.	Inoc.	Mean
None	N1	0.25	0.30	0.28	0.51	0.65	0.58	0.75	0.85	0.80	0.35	0.40	0.38	1.10	1.25	1.18	6.85	7.20	7.03	2.40	2.88	2.64
	N2	0.33	0.36	0.35	0.78	0.85	0.82	0.88	0.98	0.63	0.45	0.52	0.49	1.33	1.50	1.42	7.70	8.36	8.03	3.47	4.35	3.91
	N3	0.36	0.37	0.37	0.87	0.90	0.89	0.95	0.96	0.96	0.53	0.55	0.54	1.48	1.51	1.50	8.25	8.50	8.38	4.37	4.68	4.52
	Mean	0.31	0.35	0.33	0.72	0.80	0.76	0.86	0.93	0.90	0.44	0.49	0.47	1.30	1.42	1.37	7.60	8.02	7.81	3.41	3.97	3.69
MTR	N1	0.40	0.53	0.47	0.83	1.02	0.93	1.12	1.41	1.27	0.45	0.55	0.50	1.57	1.96	1.77	7.15	8.30	7.72	3.22	4.57	3.89
	N2	0.55	0.67	0.61	1.40	1.70	1.55	1.59	1.75	1.67	0.56	0.66	0.61	2.15	2.41	2.28	8.90	9.51	9.21	4.98	6.28	5.62
	N3	0.65	0.70	0.68	1.61	1.72	1.67	1.73	1.76	1.75	0.60	0.68	0.64	2.33	2.44	2.39	9.45	9.49	9.47	5.67	6.45	6.06
	Mean	0.53	0.63	0.59	1.28	1.48	1.38	1.48	1.64	1.56	0.54	0.63	0.59	2.02	2.27	2.15	8.50	9.10	8.80	4.62	5.77	5.20
SSC	N1	0.51	0.62	0.57	1.14	1.21	1.18	1.40	1.61	1.51	0.55	0.66	0.61	1.95	2.27	2.12	8.05	9.20	8.63	4.43	6.07	5.25
	N2	0.64	0.73	0.69	1.45	1.73	1.59	1.72	1.93	1.83	0.65	0.77	0.71	2.37	2.70	2.54	9.80	10.52	10.16	6.37	8.10	7.24
	N3	0.70	0.75	0.73	1.43	1.77	1.60	1.74	1.95	1.85	0.70	0.79	0.75	2.44	2.74	2.60	10.05	10.40	10.23	7.04	8.22	7.63
	Mean	0.62	0.70	0.66	1.34	1.57	1.46	1.62	1.83	1.73	0.63	0.74	0.69	2.25	2.57	2.42	9.30	10.04	9.67	5.94	7.45	6.70
Average		0.49	0.56	0.53	1.11	1.28	1.20	1.32	1.47	1.39	0.54	0.62	0.58	1.86	2.09	2.98	8.47	9.05	8.76	4.66	5.73	5.20

	F-test	LSD(0.05)	F-test	LSD(0.05)	F-test	LSD(0.05)	F-test	LSD(0.05)	F-test	LSD(0.05)	F-test	LSD(0.05)	F-test	LSD(0.05)
N (A) =	**	0.057	**	0.091	**	0.105	**	0.043	**	0.108	**	0.251	**	0.312
INOC (B) =	**	0.046	**	0.075	**	0.086	**	0.035	**	0.088	**	0.205	**	0.255
OM (C) =	**	0.057	**	0.091	**	0.105	**	0.043	**	0.108	**	0.251	**	0.312
AxB =	*	0.070	NS	0.129	*	0.135	*	0.050	**	0.152	*	0.355	NS	0.441
AxC =	*	0.083	**	0.158	NS	0.183	NS	0.075	*	0.162	NS	0.435	NS	0.540
BxC =	NS	0.070	NS	0.129	*	0.135	**	0.050	NS	0.152	NS	0.355	**	0.441
AxBxC =	NS	0.139	NS	0.227	*	0.235	*	0.077	NS	0.264	*	0.512	*	0.564

clay loam calcareous soil were, in respective, 35.2, 54.9, 27.3, 30.1, 28.1, 20.1 and 54.5%. over the control treatment (1/3 N-dose, i.e. 40 kg N fed-1).

The favourable effect of mineral N-fertilization with its increased rates on the previously mentioned traits of wheat might be explained in the light of the fact that nitrogen is essential nutrient for plant growth and, it is one of the most important constituents of all proteins and nuclic acids and hence of all protoplasm and chlorophyll. As the level of N-supply increases, the extra protein produced allows the plant leaves to grow larger and consequently to have a larger surface available for photosynthesis proportional to the rise of N-supplied; therefor, the increase in N-fertilization level led to an increase in metabolic processes and physiological activities necessary for more plant organs formation, more dry-matter accumulation and enhancing the grain filling rate, which finally increase the amount of protein in grain. Thus, more crop yield with good quality of grains (Russell, 1973 and Kotb, 1998). Also, the effect of N-availability at critical stages of spike initiation and development on plant metabolism in way leading to increase synthesis of amino acids and their incorporation in grain protein could be behind the increase of protein content due to increasing the application rate of N-fertilizer (Kotb, 1998). It is note worthy to mention that, the increment of protein yield per plant as a result of rising the N-fertilizer rate was reflection to the increase of both protein content (%) and grain yield (Table 3, A & B). The obtained results are in good agreement with those of Attallah & El-Karamity (1997), Eman & Ab-Warda (1998), Kotb (1998), El-Sherbieny et al. (1999) and Omran et al. (1999).

II- Effect of bio- N-fertilization:

Microbial inoculation of wheat seeds with mixture of non-symbiotic N2-fixers (i.e., Azotobacter, Azospirillum and Bacillus) had highly significant influence on all studied plant criteria, in both studied soils (Table 3, A & B). Increases induced by biofertilization reached 16.3, 15.8, 14.0, 31.1, 18.9, 8.8 & 43.4 % on sandy loam non-calcareous soil, and 14.6, 15.3, 11.1, 15.3, 12.3, 6.9 & 23.0 % on sandy clay loam calcareous one, for dry weight at fillering & flowering stages, straw, grains and biological yield as well as content and yield of grain protein, respectively over the control treatment (non bio-N-fertilization). Such results could be ascribed to the role of N2-fixing bacteria (added as bio-N-fertilizer) through supplying wheat roots with fixed nitrogen and producing physiological active compounds, in addition to a number of other characteristics, resulted in stimulating higher wheat growth and yield (Boddey et al., 1986 & Shabaev et al., 1991). In this respect, Neyra & Dobereiner (1977) reported that Azospirillum associated with roots of grasses may benefit the plant both by producing growth hormones and by N-fixation, particularly at later stages of growth where plants need for nitrogen increases during flowering and seed formation. Kotb (1998) showed that the increased uptake of N by wheat plants due to inoculation with a mixture of Azospirillum & Bacillus might be the cause of increasing protein content in grains. Bashan et al., (1990) found that Azospirillum and Pseudomonas improved wheat growth by increasing significantly roots and shoots weights.

The obtained results have been confirmed the synergestic effect of diazotrophic bacteria applied as bio-N-fertilizer. Meanwhile, they are in well cope with others; Abdel Aleem & Sabry (1994); Attallah & El-Karamity (1997) and Kotb (1998) who worked on various types of N2-fixers applied either alone or in combinations under new land conditions of Egypt.

III- Effect of soil organic amendments:

The overall values of wheat characters attained by amending the soils either with matured town refuse (MTR) or sewage sludge compost (SSC) manure were shown to be highly significant increased, comparing to unamended soils. Superiority of SSC over MTR, with high significant differences, was recorded for all plant parameters tested in both concerned soils, irrespective of other treatments (Table 3, A & B).

Upon the application of SSC, the maximum percent increase was 79.1, 80.5, 52.1, 72.0, 57.7, 20.2 & 108.1 % in sandy loam non-calcareous; and 100.0, 92.1, 92.2, 46.8, 76.6, 23.8 & 81.6 % in sandy clay loam calcareous soil for dry weights at growth stages of tillering & flowering, straw, grains, biological yield and grain protein (content & yield) over the control treatment (without organic manure addition), respectively.

The positive effect of such organic applications on the aforementioned traits of wheat could be attributable to improving the hydro-physical, physico-chemical and biological properties (as well as nutritional status, as shown in the second part of study) of the treated soils, in turn influencing the development of plants and crop production (Thind et al., 1993 and Obi & Edo, 1995). It may also be related to the encouragement and important role of added organic materials in the metabolism of plant which may refer to their contents of macro-nutrients, such as N and P (Table 2); consequently N & P increased the growth and crop yield (Parr & Colacicco, 1987 and Matus & Rodriguez, 1994). Superiority of SSC manure over MTR, for all wheat traits studied in both soil types could be explained by narrower C/N ratio of SSC (Table 2) which increased inorganic N in soil media due to lowering immobilization of native soil N or added N by soil micro-organisms and reducing their competition with plant on soil available N (Russell, 1973 and Aoyama & Nozawa, 1993). This trend is confirmed by increasing N uptake by plants organs i.e., shoots, straw and grains as well as the increased availability of soil N (as shown in the second part of study). El Sokkray & El-Keiy (1989) reported that the beneficial effect of sewage sludge on grain yield of wheat may be due to its potentially value as a source of macro and micro nutrients. Also, it may serve as a good natural soil conditioner due to its higher content of organic carbon (as given in Table 2). The results, obtained her, are in good stand with those of Gommaa (1991) on wheat, Abou Bakr & Omar (1996) on sunflower and Rabie et al. (1997) on both faba-bean and sorghum, under Egyptian soil conditions.

IV- Interaction effects :

A). Mineral N-fertilizer levels vs. bio N fertilization:

It was found that wheat plants fertilized with full N dose (120 kg mineral N fed-1) and bio fertilized with N2-fixers exhibited the maximal values, while the lowest ones recorded with 1/3 N dose (40 kg N fed-1) alone, for all plant parameters in both studied soils. Although this trend, the addition of 2/3 N dose (80 kg N fed-1) combined with N2-fixing bacteria (bio fertilizer) was the most beneficial and compatible treatment, because of it had the highest percent increase over non-bioferilized treatments. Also, differences among the combination of 120 or 80 kg N fed-1 and bio fertilizer were not significant for all plant traits, in both types of soil (Table 3, A & B). This suggest that N-fertilization of 2/3 N dose plus diazotrophic bacteria of N2 fixation was satisfied demands wheat crop.

Consequently, substantial amount of N-fertilizer (i.e., 1/3 recommended dose of N fertilizer) could be saved by using bio-N-fertilization, which avoid excessive chemical N-fertilizer applications and environmental pollution.

These findings are supported by many researchers, Fayez et al. (1986) stated that mineral N-fertilizer was required to enhance response of wheat plant to inoculation with N2-fixing bacteria and higher rates repressed the response. Omar et al. (1991) found that the inoculation of wheat seeds with Bacillus polymyxa and Azotobacter brasileuse can save 41.6 & 37.5% of N-fertilizer, respectively. Soliman et al. (1995) reported that wheat seeds inoculated with Azotobacter and/or Azospirillum can save about 25 kg N fed-1 without much affecting the grain yield, in sandy soil.

It is worthy to mention that, the rate of profit due to application of reduced level of mineral N-fertilizer in conjunction with N2-fixing bacteria depending on: soil properties, characteristics of N2-fixer and method of inoculation, genotype of the plant cultivar, agricultural practices and climatic conditions, as reported by Kotb (1998).

B)-Mineral N-fertilizer levels vs. soil organic amendment:

Combinations of N-fertilizer and organic manures revealed higher figures than each one when was individually added, for all plant characters studied in both soils. The response significantly varied from plant trait to another with all applied treatments. The combined treatment of 120 kg N fed–1 (full N-dose) and SSC-manure gave the maximum values. It was observed that, the percent increment of values decreased as N-fertilizer level increased from 80 to 120 kg N fed–1 when the soils treated with the organic ameliorants, comparing to non-organically amended ones. Therefore, the differences between treatments of 120 & 80 kg N fed-1. combined either with SSC or MTR did not reach the significant level, for most parameters on both soils (Table 3,A& B). Generally, it is quite evident from data that, dual treated plants with 2/3 N-recommended rate plus SSC-application were more or less similar to those received full N-dose either organically amended or not with SSC or MTR. The results could be explained on the basis that the used organic manures were rich in total-N and with narrow C/N ratio (i.e., below 20:1) (Table 2); therefore, canceled the significant difference among treatments of 120 & 80 kg mineral N fed-1. On the other hand, mineralization of organic materials applied in combination with 120 kg N fed-1 resulted in higher inorganic N accumulation which inhibited the biological activity, especially N2-fixers (nitrogenase activity), in the soil media. While in the soils fertilized with moderate rate of N-fertilizer (i.e.; 80 kg N fed-1), the microbial degradation of added organics was enhanced, in turn enhancing the conditions for plant growth and its production (Table 3 ,A & B); as well as nutrients uptake as given in the second part of study (Millet & Feldman, 1986 and DA-Silva et al., 1993).

The present findings, in general, are in harmony with those obtained by other authors: Abou-Bakr & Omar (1996) found that the composted town-refuse added with mineral fertilization (NPK) at the recommended dose or half of their amounts gave the highest values of seed yield and its components as well as oil (content & yield) of sunflower, grown on sandy clay loam soil. Sharma (1997)reported that mineral fertilizer-N could be saved without sacrificing yield and quality of soybean-safflower crops by using farmyard manure and/or crop residues along with reduced levels of fertilizer nutrients. Csatho & Arendas (1997) stated that, as soil organic matter content increased, lower application rates of mineral fertilizers were recommended.

C)- Bio-N-fertilization vs. soil organic amendments:

All plant characters tested on both used soils appeared more response to combinations of bio-N-fertilizer and organic applications than any one of them was added. In this regard, the combined treatment of bio-fertilizer and SSC-waste was the best, it gave the highest mean values of all examined parameters. This treatment manifested significant differences from that of biofertilizer and manured with MTR-waste for yield per plant of straw and grains, in addition to protein percent and its yield on both types of soil. However, the latter treatment (inoculation plus MTR) significantly differed from that of SSC applied alone and non-significantly in sandy loam non-calcareous and sandy clay loam calcareous soils, respectively, for most plant traits (Table 3, A&B).

Such encouragement effect of bio-N-fertilization in association with organic amendments on wheat crop and other parameters must be attributed to more regular supply of N and other nutrients to plants (as shown by nutrients uptake and availability in the second part of study). Muneshwat et al. (1998) found that higher accumulation rate of available-N was recorded with the incorporation of organic material (FYM) and inoculation of seed over the control treatment, under soybeans-wheat cropping system. Khamis & Metwally (1998) reported that incorporation of organic materials inoculated with microbial decomposeres and Azotobacter bacteria resulted in conditioning the decomposing effects in the soil and consequently favourably increased the grain and straw yield of wheat. In general, the above findings could lead to mention that application of composted organic wastes with bio-N-fertilization may be more useful as partially substitute to mineral N-fertilizers.

The obtained results are supported by those reported by Dubey & Gupta (1996), on legumes with free-living N2-fixing bacteria and organic materials; Zaghloul et al. (1996), on wheat with Azospirillum and sewage-sludge and El-Komy et al. (1998), on maize with Azospirillum and FYM.

D)- Mineral N-fertilizer levels, bio-N-fertilization vs. Soil organic amendments:

Data indicate a positive response of wheat to the triple interaction of N-fertilizer, bio-fertilizer and organic manures. The top values of all plant attributes in both soils brought by combination of 120 kg N fed-1, bio-fertilization and SSC-manure. This did not significantly differ from that of 80 kg N fed-1, bio-fertilizer and organic material (either SSC or MTR). Also, nonsignificant differences were recorded between treatment of 120 or 80 kg N fed-1, bio-fertilizer plus MTR and that of 120 kg N fed-1 associated with SSC, addition to without bio-N-fertilization, for most cases in both soils (Table 3, A & B). These results mean that, when wheat seeds inoculated with appropriate bacterial mixture of active N2-fixers and the soil treated with composted organic manures along with mineral N-fertilization of moderate level (80 kg N fed-1) could be attained well plant growth and production of wheat crop without much affecting the optimum crop yield and grain quality.

Generally, the above results are in accordance with those of El-Sersawy et al. (1997), who found that the most effective treatment for high grain and straw yield of wheat grown on calcareous soil was that of 60 kg N fed-1, bio-N-fertilizer and organic materials and Singh et al. (1997), who reported that the highest yields of wheat and rice were yielded by conjunctive use of NPK fertilizer, bio-N-fertilizer (cyanobacteria) and farmyard manure, on calcareous alluvial soil.

The effect of soil type:

It is clear from data, as the used soils are subjected to comparing the mean values of all studied plant characters, sandy clay loam calcareous soil showed relatively lower mean figures than sandy loam non-calcareous one for the all, under the different treatments applied either alone or together (Table 3, A & B). This is mainly referred to the associated properties of the soil, which seemed to be the principal factor limiting the productivity rather than the initial fertility status. In this concern, the former soil had CaCO3 content, 30%; EC (dSm-1), 4.19; ESP, 9.70 and pH of 7.91; while the corresponding values of the second soil were 1.60, 0.25, 3.35 and 7.52, respectively (Table 1), which reflected on soil fertility in turn on growth characters and crop productivity (Russell, 1973).

CONCLUSION

Increasing the productivity of wheat crop with good grain quality under newly-reclaimed soils conditions of Egypt, was not only by using high rates of mineral N-fertilizer, but also by better management of its application to the soil through moderate level (80 kg N fed^{-1}., i.e., 2/3 recommended rate) comparing to 120 kg N fed^{-1} (full N-dose) and inoculation of seeds with suitable mixture of effective free-living N_2-fixing bacteria along with manuring the soil with matured organic materials, such as SSC & MTR. On the other side, such management will decrease the enormous consumption of chemical N-fertilizers and meanwhile will minimize health and environmental risks, which are prospectively fulfilled.

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إدارة النيتروجين المتكامله لمحصول القمح من خلال التسميد المعدنى والبيولوجى للنيتروجين والمخلفات العضوية فى بعض الأراضى المستصلحة حديثاً بمصر

١- حالة النمو الخضرى والمحصول وجودة الحبوب.

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أجريـت تجـربه أصص خضرية تحت ظروف الصوبة على نباتات القمح (صنف جيزة ١٦٣) النامية فى تربه رملية (من الإسماعيلية) وجيريه (من مريوط) مستصلحه حديثا ، بهدف دراسة التأثير التكاملى للتسميد المعدنى والحيوى للنيتروجين مع أسمده عضـويه لبعض المخلفات المحلية (سماد مخلفات المجارى الصلبة، قمامة المدن) على الـنمو والمحصـول وجوده الحبوب. وقد أختبرت ثلاثة مستويات من السماد المعدنى لـلأزوت (كبريـتات الآمونيوم) من المعدل الكامل الموصى به (١/٣، ٢/٣ والمعدل الكـامل (تكـافىء ٤٠، ٨٠ و١٢٠كجـم نيتروجيـن/فدان على التوالى) ، كما أجرى التسـميد الحيوى للنيتروجين بتلقيح البذور بمخلوط مناسب من البكتريا النشطه الحرة المثبـته لـلأزوت الجوى (*أزوتوباكتر ، أزوسبيريللم ، وباسلس*) وتم استخدام سماد مخلفـات الصـرف الصـحى الصـلبة (كمبوست) وسماد قمامة المدن (المتخمر التام النضـج) بمعـدل ٢٠م٣/فدان كإضافات عضويه للتربة، وقد تم قياس النمو الخضرى بـتقدير تـراكم المـادة الجافـه للنبات عند مراحل التفريع والتزهير ، وعند الحصاد (الحـبوب والقـش والمحصول البيولوجى/نبات) ومحتوى الحبوب من البروتين (%) وغلته/نبات. وكانت أهم النتائج المتحصل عليها كالآتى:-

١- أدت زيـادة معـدل التسـميد المعدنى للأزوت حتى المستوى الكامل الموصى به (١٢٠ كجـم ن /فـدان) إلـى زيادة عاليه المعنوية لجميع الصفات المدروسة، بفروق معنوية بين معدلات السماد، فى كل من الأراضى المختبره.

٢- كـان للتسميد النتروجينى الحيوى أثر عالى المعنوية فى زيادة جميع قيم القياسات النباتية بالمقارنة بمعامله الكنترول.

٣- اسـتجابه النباتات للتسميد العضوى كانت عاليه المعنوية، وقد تفوق سماد مخلفات الصـرف الصحى الصلبة معنويا على سماد قمامة المدن لجميع قياسات نباتات القمح فى الأراضى تحت الدراسة.

٤- كـان للـتفاعل بيـن التسميد المعدنى والحيوى للنيتروجين أثر إيجابى ، بلغ حد المعنوية لمعظم الصفات كما أظهرت المعاملة المشتركة لمعدل ٨٠كجم ن /فدان (٢/٣ المعـدل الكـامل الموصى به) مع السماد الحيوى كفاءه أكبر ، وكانت الزيادة المئوية

للقيم الخاصة بالقياسات النباتية أعلى عن المتحققة بإضافة المستوى الكامل مع أو بدون التسميد الحيوى، فى كل من نوعى التربة.

٥- التفاعل المتبادل بين التسميد المعدنى والعضوى كان ذو أثر إيجابى على جميع صفات النبات وصل إلى حد المعنوية فى أغلبها، وأظهرت القيم الخاصة بالمعاملة المشتركة لـ ٣/٢ المستوى الكامل للأزوت المعدنى مع كمبوست الصرف الصحى تماثلاً أكبر أو أقل عن تلك التى أضيف فيها المعدل الكامل (١٢٠ كجم ن/فدان) مقروناً بالتسميد العضوى بأى من المخلفات العضوية المختبرة أو بدونها.

٦- أدى التفاعل بين التسميد الحيوى والعضوى إلى زيادة جميع قيم القياسات النباتية، معنويا فى معظم صفات النبات. وقد تفوقت المعاملة المشتركة للسماد الحيوى وكمبوست سماد مخلفات الصرف الصحى الصلبة معنوياً عن تلك التى لم يتم تسميدها بالسماد الحيوى مقرونا بالسماد الناضج لقمامة المدن بالنسبة لمحصول الحبوب والقش ومحتوى البروتين وغلته وذلك فى كل من الأراضى المختبرة. كما وأن المعاملة المشتركة الأخيرة أظهرت تفوقاً معنوياً فى التربة الرملية وغير معنوى فى الجيرية عن المعاملة المنفردة لسماد مخلفات الصرف الصحى الصلبة (بدون تسميد حيوى) فى أكثر القياسات النباتية تحت الدراسة.

٧- أدى التسميد الثلاثى المشترك (المعدنى والحيوى والعضوى) إلى زيادة فى المحصول وكذا الصفات النباتية وصلت حد المعنوية فى أغلبها فى كل من نوعى التربة، وكانت أفضل المعاملات المشتركة هى ٨٠كجم ن معدنى/فدان (٣/٢ المعدل الموصى به) والسماد الحيوى وإضافة سماد مخلفات الصرف الصحى الصلبة، حيث لم تظهر فروق معنوية بمعظم القيم عن تلك المستخدم فيها المعدل الكامل (١٢٠ كجم ن /فدان) والتسميد الحيوى مع إضافة أى من المواد العضوية المختبرة.

٨- تحت جميع المعاملات المضافة سواء منفردة أو مشتركة معاً، أظهرت التربة الجيرية قيماً أدنى نسبياً عن الرملية لجميع قياسات النبات تحت الدراسة وقد يرجع ذلك لمحتواها العالى من كربونات الكالسيوم وتأثيرها السلبى على حاله الخصوبة بها.

مما سبق يتضح أن زيادة إنتاج محصول حبوب القمح مع جودة عالية تحت ظروف الأراضى المستصلحة حديثاً (رملية أو جيرية) لا يتم باستخدام معدلات عالية من التسميد المعدنى للنيتروجين فقط، بل بإدارة جيده ومتكاملة لهذا العنصر عن طريق إضافته بمعدل مناسب (٣/٢ المستوى الموصى به حاليا) مع استخدام مخلوط ملائم من البكتريا الفعالة المثبتة للأزوت الجوى فى تلقيح البذور مع تسميد التربة بالمخلفات العضوية بعد معالجتها، حيث يعد ذلك أنسب الوسائل للحد من الاستخدام الإسراف لأسمده النيتروجين المعدنية وتقليل المخاطر البيئية الناجمة عن التلوث النيتروجينى المعدنى وتراكم النفايات العضوية دون إعادة تدويرها.