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NITROGEN EFFICIENCY FOR WHEAT AS AFFECTED BY AMMONIUM SULPHATE AND COMPOST IN COMBINATION WITH SOME BIO AMENDMENTS UNDER SANDY AND CALCAREOUS SOIL CONDITIONS

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ABSTRACT: A pot experiment was conducted in a green house in the farm of the Faculty of Technology and Development, Zagazig University, Zagazig, Sharkia Governorate, Egypt to study the response of wheat plant to application of N-fertilization from different N- sources *i.e.,* ammonium sulphate (AS) and compost (CO), different nitrogen rates and their combinations as well as bio fertilization from different sources *i.e,* microbien (Mic.) and compost tea (CT) on the production of wheat grown on a sandy and calcareous soils during winter season 2014/ 2015 on dry matter yield(DM), yield components, N content and uptake, grain quality and nitrogen use efficiency, (NUE). The obtained results could be summarized as follows: application of AS solely or in a combination with biofertilizers showed the greatest values of DM yield compared to CO addition or control treatment. Grain protein content significantly increased as affected by N-rate and bio fertilization. The value of NUE was the greatest due to the addition of 50 mg N as AS kg^{-1} soil solely and in a combination with compost tea and microbien. In the calcareous soil, application of 100 mg N as AS kg^{-1} soil combined with (CT+ Mic.) was the most effective on wheat N-uptake at booting and straw at maturity stage compared to other treatments. Similar trend for N-uptake was observed in sandy soil.

Key words: Wheat, bio, compost, compost tea, sandy, calcareous.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the most important cereal crops in Egypt and has a high importance worldwide, measured either by cultivated area or production (Jagshoran *et al.,* 2004). Wheat has got an evolutionary history parallel to the history of human civilization; as it decides the feast or famine for millions of people even today. Wheat provides 37% of the total calories and 40% of the protein in the Egyptian people diet. Total production of wheat in Egypt reached 8.407 million tons in 2011, produced from an area of 3.058 million faddans, (FAO, 2011).

Sandy and calcareous soils represent about 96% of the Egyptian soils. Such soils represent a great hope for the agriculture expansion. Sandy soils are characterized by their poor physical and chemical properties as well as their low capacity to retain water and their low supplying power for nutrients. Calcareous soils have a content of $CaCO_3$ which contributes to the unfavorable structure for plant roots development and unfavorable effect on nutrients availability to plants.

Organic and inorganic fertilizers as well as organic and mineral soil amendments are soil improving agents and very important for agricultural sustainability because of their possible beneficial effects on soil properties and long-term soil productivity. The application of such amendments could improve the retentive capacity of sandy soil for water and fertilization

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nutrients and also may help in improving the unfavorable structure and in increasing nutrients availability in calcareous soil. Most of the newly reclaimed soils are sandy or calcareous, which are poor in their content of organic matter and available nutrients (Aguilera *et al.,* 2012).

Numerous studies reported that combinations of soil organic with soil inorganic fertilizers are more beneficial for soil properties and crop production than either fertilizer applied alone. A combination of manure and chemical fertilizer resulted in consistent availability of NO^-_3 during the growing season (Nyiraneza and Snapp, 2007). Conditioning sandy and calcareous soils became a necessity to increase agricultural production and to overcome the deficiency in food requirements (Hassanien *et al.,* 2007). Efficient use of fertilizers, optimizing crop yield, and minimizing environmental pollution is therefore a critical issue. Increasing the ability of plants to take up minerals could have a dramatic impact on both plant and human health (Rus *et al.,* 2005). In this respect, Mohamed *et al.* (2008) found that addition of compost to sandy calcareous soil increased dry matter yield and NPK uptake by corn plants.

Effective microorganisms (EM) plus organic manure had the highest microbial densities through either a stimulation of soil micro-flora, or input of compost micro-flora or a combination of both. It is known that nitrogen from organic manures is slowly released, since 25-50% of it is released in the first year, While N recovery from organic manure is slightly better than that from fertilizers as CO_2 released by decomposition improves availability from soil (Gopalakrishnan, 2007).

Compost tea is a water extract of plant soluble nutrients and microorganisms from compost. The organisms include bacteria, fungi, protozoa and nematodes. When applied to plant surfaces and drench into the rooting zone, it can protect the plant from diseases and enhance its growth. Crops can directly benefit from the macro-and micronutrients found in compost tea. Foliar fertilization with compost tea allows nutrients to be absorbed by the plants directly through stomata on their leaf surfaces. Compost tea can also provide nutrients to the soil through soil drenches, (Moussa *et al.,* 2006). Meshref *et al.* (2010) found that compost extract have positive effect on N, P and K concentration and its uptake because of the role of organic extracts which develop the root system of plant and improved nutrient uptake.

So, the present research aimed to study the effect of organic manure (compost) and mineral fertilizer (AS) combined with some bio amendmments (CT+Mic.) on NUE, productivity and quality of wheat crop under sandy and calcareous soil conditions.

MATERIALS AND METHODS

This study represents a strategy for understanding the highest efficient use of N under bio source, whether be under demand for agricultural utilization. In addition, it overcome the possible adverse fears of human health through environmental risks as a result of excessive use of the nitrogenous fertilizers as well as support the newly technique of "bio-organic" agriculture. A pot experiment was carried out in the green house in the Farm of the Faculty of Technology and Development, Zagazig University, during the winter season of 2014/2015 to evaluate the effect of different nitrogen sources, a rates and their combinations as well as bio fertilization from different sources on yield, yield components and nitrogen use efficiency of wheat plants grown on a sandy soil collected from El-Khattara farm, El-Sharkia Governorate and calcareous soil obtained from El-Nobarya region, Alexandria Governorate. A representative soil sample (0 – 30 cm) was taken before planting to determine the physical and chemical properties of the two tested soils. The results are recorded in Table 1 according to the methods described by Page *et al.* (1982).

Closed bottom plastic pots filled with 25 kg soil for sandy soil and 20 kg soil for calcareous soil were used. Soil moisture content was adjusted to be around 100% of field capacity.

The study was laid out in a split-split plot design within completely randomized block design with three replicates, nitrogen source was assigned to the main plot as two sources (ammonium sulphate, AS) and compost, (CO). Compost was attained from El-Sharkia for Compost factory, Belbais, Sharkia Governorate. The compost analysis was done according to the standard methods described by Brunner and Wasmer (1978) and the results are shown in Table 2.

Table 1. Physical and chemical properties of the two investigated soils

Properties		Sand	Calcareous
Particle size distribution (%)			
	- Clay	0.60	6.72
	- Silt	4.32	4.18
	- Sand	95.08	89.10
Texture class		**Sand**	**Sand**
	-Organic matter (g kg^{-1})	1.13	8.51
	-$CaCO_3$ (g kg^{-1})	14.1	212
	pH (Soil suspension 1:2.5)	8.31	7.65
	EC (dSm^{-1}) at soil paste extract	0.93	2.01
	Soluble ions ($mmol_c$ l^{-1})		
Cations	- Na^+	0.50	4.93
	- K^+	5.81	1.05
	- Ca^{2+}	2.01	8.11
	- Mg^{2+}	1.01	6.01
Anions	- Cl^-	5.31	1.51
	- HCO_3^-	1.05	9.61
	- $SO_4^=$	2.97	8.98
	- $CO_3^=$	nil	nil
	***Available nutrients (mg kg^{-1})**		
Macro	- N	51.2	70
	- P	4.91	8.61
	- K	70	287
Micro	- Fe	2.45	3.85
	- Mn	0.91	1.35
	- Zn	0.26	0.45

* Available nutrients extracts: N: KCl extract; P: Na-bicarbonate extract; K: NH4-acetate extract; Fe, Mn, Zn and Cu: DTPA-extracts; EC and soluble ions: soil past extract.

Texture according to the international soil texture triangle.

Table 2. Some chemical characteristics of the compost used in the current study

Organic sources	pH	EC (dSm^{-1}) (1:10)	OC (g kg^{-1})	OM (g kg^{-1})	C/N ratio	Total macronutrients (g kg^{-1})			Total micronutrients (mg kg^{-1})		
						N	P	K	Fe	Mn	Zn
CO.	7.05	0.79	344.0	593.0	27.1	12.7	3.11	6.21	436	23.7	9.12

Compost was added one month before wheat planting which was calculated according to its total nitrogen content. The sub plots included nitrogen at four rates (0, 50, 75 and 100 mg N kg^{-1} soil) corresponding to 6.0, 9.0 and 12.0 g pot^{-1} for AS, respectively and 96.2, 144 and 192 g pot^{-1} for CO, respectively added in the sandy soil. While, in the calcareous soil the quantities were corresponding to , 5.0, 7.5 and 10.0 g pot^{-1} for AS, respectively and 77, 115 and 154 g pot^{-1} for CO, respectively. The sub-sub plots had biofertilizers i*.e.,* compost tea (CT) and microbien (Mic.). Microbien was attained from the Bio-fertilizers Production Unit, Soil Microbiology Dept., Soils, Water and Enviro. Res. Inst., Agric. Res. Center, Giza, Egypt. The treatments under study were recorded as follows:

1) AS; without N addition (control) as N1, 50 mg N kg^{-1} soil as N2, 75 mg N kg^{-1} soil as N3 and 100 mg N kg^{-1} soil as N4.
2) CO; without N addition (control) as N1, 50 mg N kg^{-1} soil as N2, 75 mg N kg^{-1} soil as N3 and 100 mg N kg^{-1} soil as N4.

These sources were added solely or in presence of biofertilization which were added in four forms without bio, compost tea (CT), microbien (Mic.) and compost tea+microbien (CT + Mic.).

Preparation of Compost Tea

Compost was blended with distilled water in dilution ratio 1:10 (*W/V*): One kilogram of solid compost was put in plastic tanks and soaked into 10 liter of water. Finished compost with water (mixture) was turned on the aquarium pump. This mixture was soaked over 48 hours and stirred until the water turns into brown in colour and the extract had no smell. After brewing the mixture compost tea was strained by using cheesecloth into another bucket. Compost tea was kept into open plastic tank and analyzed for chemical composition as shown in Table 3.

Microbien is a commercial biofertilizer which is a multi strains with various functional groups including biological nitrogen fixers, nutrients mobilizing microorganisms and root growth microorganisms (El-Kramany *et al.*, 2000). N_2-fixing microorganisms "NFM" microbien (*Azospirillium braselence* + *Azotobacter chroccocum* and *Bacillus megatherium*) as P-solubilizing bacteria. Microbien is produced by the Egyptian Ministry of Agriculture and are inocula in forms of organic, peat like substances to treat seeds at rate of 1.5kg^{-1} material per the amounts of seeds are required for one hectare.

Wheat seeds (*Triticum aestivium* c.v Gmiza 11) were soaked in solutions of bio-fertilizer, microbien and compost tea for 8 hr., before planting. The plots were also supplied with a foliar spray solution of microbien and compost tea on soil and plants at rate 5L solution / 950 L water ha^{-1}. three times 25, 50 and 75 days from sowing. Ammonium sulphate, AS (205 g N kg^{-1}) was the mineral source of nitrogen fertilizer, which was applied at three equal doses after 21, 35 and 50 days of wheat planting. Potassium sulphate (400 g K kg^{-1}) was applied at the rate of 20 mg K kg^{-1} soil in two equal doses after 21 and 45 days from sowing, while ordinary superphosphate (66 g P kg^{-1}) was mixed thoroughly with the soil before sowing at the rate of 6.6 mg P kg^{-1} soil to all plots as recommended doses. Other standard agricultural practices for growing wheat were carried out as recommended by the Ministry of Agriculture. The seeds of wheat were sown, on November, 2014, after the first leaf stage, the seedlings were thinned to be 15 plants pot^{-1}.

Table 3. Chemical analysis of compost tea (mg l^{-1})

EC (dSm^{-1}) (1:10)	pH (1:2.5)	OM	N	P	K	Fe	Mn	Zn
			Soluble macronutrients (%)			Soluble micronutrients (mg Kg^{-1})		

2.3	7.40	44	2.17	0.75	1.33	125	79	66

* Composet : water extract (1 :10 *W/V*)

Growth Characters and Calculations

Plant samples were taken at 45, 70 and 140 days after sowing (DAS) corresponding to tillering, booting and maturity stages, respectively. Dry matter yield (DW) as well as the uptake of N, were measured.

At harvesting stage after 140 DAS, the plants were harvested. Each fresh plant sample was separated into straw and grains, air dried and the following characteristics were recorded.

1000-grain weight (g), plant height (cm), spike weight (g), No. grains spike^{-1}, straw and grain yields, g pot^{-1}.

Representative samples of wheat straw and grains, were, oven dried at 70^{o} C, ground and 0.4 g of each sample was wet digested using H_2SO_4 and $HClO_4$ (4:1ml) mixture to determine total N, P and K using the methods described by, Ryan *et al.* (1996).

Protein content (g kg^{-1}) and Nitrogen Use Efficiency (NUE) were calculated as follows : Protein content (g kg^{-1})= N content (g kg^{-1}) × 6.25 and NUE, to produce yield and is defined here as (the amount of grain yield per unit of applied N) according to, Angas *et al.* (2006).

Statistical Analysis

Results were statistically analyzed using COSTATC software. The ANOVA test was used to determine significantly ($p \leq 0.01$ or $p \leq 0.05$) treatment effect and Duncan Multiple Range Test was used to determine significance of the difference between individual means (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Wheat Yield Components and Dry Matter Yield

Yield components

Results presented in Table 4 show the effect of treatments on yield components of wheat plants grown on sandy and calcareous soils: Results revealed that yield components of wheat plants *i.e.,* each of plant height, 1000-grain weight, spike weight and No. grains pot^{-1} showed the greatest value by applying a mixture of AS + biofertilization and this found true for all nitrogen rates as compared with compost addition. This trend was also found true in both sandy and calcareous soil. At all growth stages this effect may be due to increasing the availability of N and N fixation that would lead to an increase in photosynthesis. Therefore, an increase in accumulation of carbohydrates in seed would occur and would subsequently result in an enhancement in seed parameters. In addition, the bio inoculation increase nutrient uptake which would lead to an increase in cell division in subsurface organs, thereby enhancing plant growth and yield (Omran *et al.,* 2009; Sary *et al.,* 2009 ; Kandil *et al.,* 2011).

Namvar and Khandan (2013) reported that number of spikes per m^2, number of grains per spike and the 1000-grain weight of wheat, increased significantly by N-fertilization and biofertilizer inoculation.

As for N source effect, was in following descending order: AS > CO for calcareous and sandy soils except for 1000-grain weight in sandy soil where the effect was insignificant and the mean of values were highly affected by CO than AS. The effect of N-rates was insignificant in calcareous soil, except for spike weight and followed the order: N4 ≥ N2 ≥ N3 ≥ N1. In calcareous soil, the effect was significant in increasing plant height and No. grains pot^{-1} and followed the descending order: N4 ≥ N3 ≥ N1 ≥ N2 for plant height and N2 ≥ N4 ≥ N3 ≥ N1 for No. grains pot^{-1}, respectively. Regarding the response to biofertilization, the effect was significant only for plant height and 1000-grain weight in calcareous soil and the main effect followed a descending order: CT > without ≥ Mic. ≥ CT + Mic, while the effect of biofertilization was insignificant for spike weight and No. grains pot^{-1} in calcareous soil and for all yield parameters in sandy soil.

The highest increases in plant height (25.1 and 19.9%) were obtained due to addition of 50 mg N as AS kg^{-1} soil + CT in calcareous soil and 100 mg N as AS kg^{-1} soil + CT in sandy soil, respectively. As for 1000-grain weight, the greatest increases (34.2 and 32.8%) were recorded in plants treated with 75 mg N as AS kg^{-1} soil solely in calcareous soil and 100 mg N as AS kg^{-1} soil+ (CT + Mic.) in sandy soil, respectively. The highest values (10.3 and 6.84 g)

Table 4. Yield component of wheat as affected by different N-source and rates as well as bio fertilization grown on two soils

N-source (S)	N-rate, mg kg^{-1} soil (R)	Bio addition source (B)																			
		Without	CT	Mic.	CT+Mic	Mean	Without	CT	Mic.	CT+Mic	Mean	Without	CT	Mic.	CT+Mic	Mean	Without	CT	Mic.	CT+Mic	Mean
		Calcareous soil																			
		Plant height (cm)					**1000 grain weight (g)**					**Spike weight (g)**					**No. grains pot^{-1}**				
	0	56.3	59.5	53.5	57.3	56.7	53.2	54.2	54.5	55.5	54.4	4.52	4.43	4.26	4.47	4.42	58.0	57.7	56.0	57.0	57.2
	50	62.4	70.5	64.5	66.5	66.0	50.4	61.9	58.6	53.4	56.1	7.26	9.01	8.65	6.58	7.87	124	102	110	83.3	105
AS	**75**	66.9	67.1	64.4	61.9	65.1	71.4	69.4	57.7	59.2	64.4	10.1	5.26	7.04	6.73	7.29	101	35.0	81.0	66.7	70.9
	100	64.8	67.2	64.8	64.3	65.3	59.4	58.4	60.6	44.8	55.8	8.87	10.3	9.85	10.2	9.80	114	122	118	135	122
	Mean	62.6	66.1	61.9	62.5	63.2 a	58.6	61.0	57.8	53.3	57.7 a	7.70	7.26	7.45	6.98	7.35 a	99.1	79.3	91.4	85.6	88.8 a
	0	56.3	59.5	53.5	57.3	56.7	53.2	54.2	54.5	55.5	54.4	4.52	4.43	4.26	4.47	4.42	58.0	57.7	56.0	57.0	57.2
	50	53.1	51.9	52.8	49.0	51.7	50.5	50.8	48.2	52.4	50.5	2.90	2.67	2.47	2.69	2.68	35.0	30.3	29.7	35.0	32.5
CO	**75**	51.3	54.4	47.6	48.0	50.3	47.5	60.3	49.1	50.5	51.8	2.32	2.91	2.33	2.19	2.44	28.0	33.7	33.0	34.0	32.2
	100	48.2	48.9	50.5	44.3	48.0	50.8	57.1	45.8	48.1	50.4	1.88	2.29	2.29	2.52	2.25	23.7	28.0	31.0	32.7	28.8
	Mean	52.3	53.7	51.1	49.7	51.7 b	50.5	55.6	49.4	51.6	51.8 b	2.91	3.07	2.84	2.97	2.95 b	36.2	37.4	37.4	39.7	37.7 b
Mean bio		57.4 b	59.9a	56.4b	56.1 b		54.5 ab	58.3 a	53.6 b	52.4 b		5.30	5.16	5.14	4.97		67.6	58.3	64.4	62.6	
Mean N rate		N1: 56.7	N2: 58.8	N3: 57.7	N4: 56.6		N1:54.3	N2: 53.3	N3: 58.1	N4:53.1		N1:4.42b	N2: 5.27 ab	N3:4.86b	N4:6.02a		N1: 57.16	N2: 68.66	N3: 51.54	N4:75.62	
		S:**	R:NS	B:**	SxR:**		S:*	R:NS	B:*	SxR:NS		S:*	R:**	B:NS	SxR:**		S:**	R:NS	B:NS	SxR:**	
		SxB:NS	RxB:NS	SxRxB:NS			SxB:NS	RxB:NS	SxRxB:NS			SxB:NS	RxB:NS	SxRxB:NS			SxB:NS	RxB:NS	SxRxB:NS		
		Sandy soil																			
		Plant height (cm)					**1000 grain weight (g)**					**Spike weight (g)**					**No. grains pot^{-1}**				
	0	45.6	40.1	39.8	41.1	41.6	48.4	43.1	47.4	47.5	46.6	3.56	2.56	2.28	2.79	2.80	54.3	38.7	29.0	35.3	39.3
	50	40.3	43.7	47.3	45.2	44.1	25.1	45.3	49.4	22.5	35.6	5.85	6.34	5.32	5.94	5.86	98.0	100	76.0	129.3	101
AS	**75**	48.9	42.9	51.1	48.1	47.8	44.2	33.4	33.1	47.7	39.6	5.14	6.40	4.95	4.70	5.30	57.7	85.3	90.3	66.0	74.8
	100	51.7	54.7	53.7	47.7	52.0	42.7	39.5	50.4	64.2	49.2	6.84	6.71	5.17	3.44	5.54	94.3	135	60.3	29.0	79.7
	Mean	46.6	45.3	48.0	45.52	46.4 a	40.1	40.3	45.0	45.5	42.7	5.35	5.50	4.43	4.22	4.87 a	76.1	89.8	63.9	64.9	73.7 a
	0	45.6	40.1	39.8	41.1	41.6	48.4	43.1	47.4	47.5	46.6	3.56	2.56	2.28	2.79	2.80	54.3	38. 7	29.0	35.3	39.3
	50	35.1	36.3	35.9	34.2	35.4	42.7	44.7	43.5	45.4	44.1	1.41	1.45	1.58	1.30	1.44	19.3	20.3	19.0	18.7	19.3
CO	**75**	35.3	37.7	36.3	35.9	36.3	45.4	46.9	43.6	45.8	45.4	1.44	1.65	1.41	1.57	1.52	16.7	18.3	17.0	19.7	17.9
	100	32.5	36.6	36.7	39.2	36.3	43.1	31.9	40.2	48.2	40.9	1.09	1.45	1.52	2.34	1.60	12.7	40.7	21.0	29.0	25.8
	Mean	37.2	37.7	37.2	37.6	37.4 b	44.9	41.8	43.7	46.7	44.2	1.88	1.78	1.70	2.00	1.84 b	25.8	29.5	21.5	25. 7	25.6 b
Mean bio		41.9	41.5	42.6	41.55		42.5	41.0	44.4	46.1		3.61	3.64	3.06	3.10		50.9	59.6	42.7	45.3	
Mean Nrate		N1:41.6ab	N2:39.7 b	N3:42.0ab	N4:44.1a		N1:46.6	N2:39.8	N3:42.5	N4:45.0		N1: 2.79	N2:3.64	N3:3.40	N4:3.57		N1:39.3b	N2:60.1a	N3:46.4ab	N4:52.8ab	
F-test		S:*	R:*	B:NS	SxR:**		S:NS	R:NS	B:NS	SxR:NS		S:*	R:NS	B:NS	SxR:**		S:*	R:*	B:NS	SxR:**	
		SxB:NS	RxB:NS	SxRxB:NS			SxB:NS	RxB:NS	SxRxB:NS			SxB:NS	RxB:NS	SxRxB:NS			SxB:NS	RxB:*	SxRxB:NS		

N1, 0 rate; N2, 50 mg pot^{-1}; N3, 75 mg pot^{-1} and N4, 100 mg pot^{-1}

of spike weight were achieved with treatment of 100 mg N as AS kg^{-1} soil + CT in calcareous soil and 100 mg N as AS kg^{-1} soil in sandy soil caused increases of about (129 and 92.1%, respectively). The highest No. grains pot^{-1} (135 and 135) were recorded in the plants treated with 100 mg N as AS kg^{-1} soil + (CT + Mic.) in calcareous soil caused increases of about 133% and 100 mg N as AS kg^{-1} soil + CT, in sandy soil causing 150% increases over the control treatment (without N and bio addition). In this regard, Salem *et al.* (2004) reported that number of grains $spike^{-1}$, grain weight and 1000 grain weight were significantly increased as the addition of N fertilization. These results are in agreement with those of Abedi *et al.* (2010) and Daneshmand *et al.* (2012).

Dry matter yield (DM)

Results shown in Table 5 reveal that application of AS solely or in combination with bio fertilization showed the greatest values of DM compared to CO addition or control treatment. That may be due to the positive effect of the AS fertilizer which enhanced the N use - efficiency for plants. Therefore, the increase in N-fertilization rate would increase metabolic processes and physiological activities rate, and thus, increased dry matter yield (Russel, 1973). Also, Wortman *et al.* (2011) reported that N stimulation of plant growth, which would increase the amount of light energy intercepted by leaves and increase photosynthetic pigments and photosynthesis, and in turn increase synthesized metabolites and consequently plant organs. In addition, Kandil *et al.* (2011) and Joshi *et al.* (2012) indicated that these results may be due to the role of biofertlization in root development and proliferation of plants.

Highest values of wheat DM were (16.2 and 5.93 g pot^{-1}) at tillering stage and straw yield at maturity stage were obtained duo to application of 50 mg N as AS kg^{-1} soil + CT, respectively, and (27.7 g pot^{-1}) for dry matter at booting stage due to application of 100 mg N as AS kg^{-1} soil + (CT + Mic.) in calcareous soil caused increases of about 162, 133 and 169%, respectively as compared to the control. As for sandy soil, the greatest values (12.8, 19.0 and 4.30 g pot^{-1}) for dry matter at tillering stage, booting stage and straw yield at maturity stage were obtained when plants treated with 100 mg N as AS kg^{-1} soil + CT, 50 mg AS kg^{-1} soil + Mic. and 50 mg N as AS kg^{-1} soil + CT, respectively giving increases of 144%, 105% and 112%, respectively as compared to the control treatment.

Regarding the grain yield, the effect of treatments was insignificant in both soils, except for the effect of N-sources in calcareous soil which had significant increase in grain yield and AS was superior to CO. Highest values (7.21 and 5.33 g pot^{-1}) were found due to application of 75 mg N as AS kg^{-1} soil without bio and 100 mg N as AS kg^{-1} soil + CT, respectively representing 134% and 109% increases over the control.

Protein Content and Nitrogen Use Efficiency

Protein content

It can be seen from results presented in Table 6 that the grain protein content of wheat significantly increased as affected by N-rates and biofertilization while, insignificant differences were obtained between N-sources in both soils. The favorable effect of mineral N-fertilization is attributed to its role as one of the most important constituents of all proteins and nucleic acids, and hence protoplasm and chlorophyll (Wortman *et al.*, 2011). As the level of N- supply increases, the extra protein produced allows the plant leaves to grow larger and consequently photosynthesis increases; therefore, 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 hilling rate, which finally increase the amount of protein in grain. These results are in accordance with those reported by Abbas *et al.* (2011) and Joshi *et al.* (2012). The highest values of protein content (123 and 115 g kg^{-1}) were obtained due to the treatment of 100 mg N as AS kg^{-1} soil without biofertilization representing increase percentage of 51.4% and 65.0% in calcareous and sandy soils, respectively.

Table 5. Dry matter (g pot^{-1}) of wheat as affected by different N-source and rates as well as bio fertilization

N-source (S)	N-rate, mg kg^{-1} soil (R)	Bio addition source (B)																			
		Without	CT	Mic.	CT+Mic	Mean	Without	CT	Mic.	CT+Mic	Mean	Without	CT	Mic.	CT+Mic	Mean	Without	CT	Mic.	CT+Mic	Mean
		Calcareous soil																			
		Tillering stage					**Booting stage**					**Maturity stage**									
												Straw					**Grains**				
	0	6.18	6.27	5.12	4.97	5.63	10.3	12.1	8.46	8.97	9.97	2.55	2.88	2.15	2.34	2.48	3.08	3.08	3.07	3.17	3.10
	50	11.7	16.2	10.6	12.3	12.7	18.3	23.3	21.7	22.9	21.6	4.28	5.93	4.53	4.15	4.72	6.23	6.34	6.44	4.31	5.83
AS	**75**	15.1	14.2	9.98	13.8	13.3	22.2	19.8	16.8	25.5	21.0	5.05	4.52	4.22	4.23	4.51	7.21	2.34	4.41	3.89	4.46
	100	16.6	14.2	10.9	13.4	13.8	23.1	21.6	25.7	27.7	24.7	5.38	5.54	4.75	5.36	5.26	6.69	7.14	6.69	5.91	6.61
	Mean	12.4	12.7	9.15	11.1	11.3a	18.7	19.2	18.2	21.3	19.3a	4.31	4.72	3.91	4.02	4.24a	5.80	4.73	5.15	4.32	5.00 a
	0	6.18	6.27	5.12	4.97	5.63	10.3	12.1	8.46	8.97	9.97	2.55	2.88	2.15	2.34	2.48	3.08	3.08	3.07	3.17	3.10
	50	3.55	4.42	3.41	3.46	3.71	6.24	8.66	5.72	6.54	6.79	2.06	2.11	1.86	1.99	2.01	1.79	1.54	1.41	1.84	1.64
CO	**75**	3.94	4.36	3.20	3.42	3.73	6.18	6.29	6.06	6.49	6.25	1.96	2.53	2.04	2.06	2.15	1.34	2.06	1.63	1.73	1.69
	100	3.61	2.97	3.23	3.61	3.36	6.11	6.23	6.28	5.07	5.92	1.64	2.29	2.38	2.19	2.12	1.21	1.62	1.42	1.57	1.45
	Mean	4.32	4.51	3.74	3.86	4.11 b	7.21	8.33	6.63	6.77	7.23b	2.05	2.45	2.11	2.14	2.19b	1.85	2.07	1.88	2.08	1.97 b
Mean bio		8.35 a	8.62a	6.44c	7.50 b		12.9	13.8	12.4	14.0		3.18b	3.58a	3.00 b	3.08b		3.82	3.4	3.51	3.19	
Mean N rate		N1:5.63b	N2:8.20a		N3:8.51a	N4:8.57a	N1:9.97c	N2:14.17b		N3:13.65b	N4:15.32a	N1:2.47c	N2:3.36b		N3:3.32b	N4:3.68a	N1:3.1	N2:3.73		N3: 3.07	N4:4.02
F-test		S:** R:** B:** SxR:** SxB:** RxB:NS SxRxB:NS					S:** R:** B:NS SxR:** SxB:NS RxB:* SxRxB:NS					S:** R:** B:* SxR:** SxB:NS RxB:NS SxRxB:NS					S:** R:NS B:NS SxR:** SxB:NS RxB:NS SxRxB:NS				
		Sandy soil																			
		Tillering stage					**Booting stage**					**Maturity stage**									
												Straw					**Grain**				
	0	5.24	5.74	4.59	6.42	5.50	9.28	6.32	7.07	8.73	7.85	2.03	1.83	1.59	2.11	1.89	2.55	1.62	1.38	1.67	1.80
	50	10.2	11.0	11.1	9.74	10.5	12.0	13.5	19.0	12.7	14.3	3.43	4.30	3.42	3.57	3.68	2.49	4.19	3.55	2.94	3.29
AS	**75**	10.8	11.3	12.6	10.9	11.4	18.8	14.7	14.8	11.4	14.9	3.48	3.60	4.09	2.95	3.53	2.52	3.17	2.89	3.34	2.98
	100	11.6	12.8	12.1	11.1	11.9	17.9	17.3	17.7	15.3	17.1	3.95	3.57	3.61	2.76	3.47	3.97	5.33	3.02	1.60	3.48
	Mean	9.44	10.2	10.1	9.54	9.82 a	14.5	13.0	14.6	12.0	13.5	3.22	3.32	3.18	2.85	3.14 a	2.88	3.58	2.71	2.39	2.89
	0	5.24	5.74	4.59	6.42	5.50	9.28	6.32	7.07	8.73	7.85	2.03	1.83	1.59	2.11	1.89	2.55	1.62	1.38	1.67	1.80
	50	2.13	2.42	2.65	2.34	2.39	4.25	4.19	4.22	4.54	4.30	1.27	1.20	1.13	1.44	1.26	0.83	0.92	0.85	0.85	0.86
CO	**75**	2.67	2.76	2.99	2.61	2.76	4.18	4.00	4.82	5.00	4.50	1.63	1.67	1.38	1.22	1.47	0.76	0.87	0.75	0.89	0.81
	100	2.73	2.27	2.24	4.33	2.90	4.34	3.81	4.65	6.66	4.87	1.20	1.49	1.32	1.61	1.41	0.54	0.77	0.82	1.45	0.90
	Mean	3.19	3.30	3.12	3.93	3.38 b	5.51	4.58	5.19	6.23	5.38	1.53	1.55	1.35	1.59	1.51 b	1.17	1.04	0.95	1.21	1.10
Mean bio		6.31	6.73	6.60	6.73		5.51 ab	4.57b	5.18ab	6.23 a		2.37	2.43	2.26	2.22		2.02	2.31	1.83	1.80	
Mean N rate		N1: 5.5	N2:6.43		N3: 7.08	N4:7.38	N1:7.84a	N2:4.5b	N3:4.3b	N4: 4.86 b		N1: 1.88	N2:2.46	N3:2.50	N4:2.43		N1: 1.80	N2:2.07	N3:1.89	N4:2.19	
F-test		S:* R:NS B:NS SxR:** SxB: NS RxB: NS SxRxB: NS					S:NS R:** B:* SxR:NS SxB:NS RxB:NS SxRxB:NS					S:** R:** B:NS SxR:NS SxB:NS RxB:NS SxRxB:NS					S:NS R:NS B:NS SxR:** SxB:NS RxB:NS SxRxB:NS				

N1, 0 rate; N2, 50 mg pot^{-1}; N3, 75 mg pot^{-1} and N4, 100 mg pot^{-1}

Table 6. Protein content (g kg^{-1}) and nitrogen use efficiency (g g^{-1} N) of wheat grains as affected by different N-source and rates as well as bio fertilization

N-source (S)	N-rate, mg kg^{-1} soil (R)	Bio addition source (B)									
		Without	CT	Mic.	CT+Mic	Mean	Without	CT	Mic.	CT+Mic	Mean
		Grain protein content (g kg^{-1})									
		Calcareous soil					Sandy soil				
AS	**0**	81.2	90.7	86.5	96.1	88.6	69.7	78.4	73.2	80.6	75.5
	50	89.3	85.5	103	108	96.5	73.8	75.7	85.9	91.2	81.7
	75	87.3	89.1	95.7	86.3	89.6	75.4	83.1	87.5	75.8	80.5
	100	123	97.3	106	116	111	115	89.3	94.8	109	102
	Mean	95.2	90.6	97.8	102	96.3	83.5	81.7	85.4	89.1	84.9
CO	**0**	81.2	90.7	86.5	96.1	88.6	69.7	78.4	73.2	80.6	75.5
	50	90.1	99.6	96.1	98.8	96.2	86.5	90.2	89.1	88.6	88.6
	75	95.8	83.9	93.3	86.6	89.9	90.3	74.2	85.7	79.8	82.5
	100	93.5	87.6	85.1	97.2	90.8	87.31	80.4	76.0	87.5	82.8
	Mean	90.2	90.5	90.2	94.7	91.4	83.4	80.8	81.0	84.1	82.3
Mean of bio		92.7b	90.6b	94.0b	98.1 a		83.5b	81.2b	83.2b	86.6 a	
Mean N-rate		88.6c	96.3b		89.8c	101a	75.5d	85.1b		81.5c	92.4a
F.-test		S:NS	R:**	B:**	SxR:**		S:NS	R:**	B:**		SxR:**
		SxB:NS		RxB:**	SxRxB:**		SxB:NS	RxB:**		SxRxB:**	

N-source (S)	N-rate, mg kg^{-1} soil (R)	Nitrogen use efficiency (AUE)									
		Calcareoussoil					Sandy soil				
AS	**0**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	50	125	127	129	86.2	117	49.8	83.8	71.0	49.8	63.4
	75	96.1	31.2	58.8	51.8	59.4	33.6	42.2	38.5	44.5	39.7
	100	66.9	71.4	66.9	59.1	66.1	39.7	53.3	30.2	16.0	34.8
	Mean	71.9	57.3	63.6	49.2	60.5	30.5	44.8	34.9	27.5	34.4
CO	**0**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	50	35.8	30.8	28.2	36.8	32.9	16.6	18.4	17.0	17.0	17.2
	75	17.8	27.4	21.7	23.0	22.4	10.1	11.6	10.0	11.8	10.8
	100	12.1	16.2	14.2	15.7	14.5	5.40	7.70	8.20	14.5	9.00
	Mean	16.4	18.6	16.0	18.9	17.5	8.03	9.43	8.80	10.8	9.27
Mean of bio		44.2	38.0	39.8	34.1		19.3	27.1	21.9	19.2	
Mean N-rate		0.00	75.0	46.2	40.3		0.00	40.3	25.3	21.9	

Nitrogen use efficiency (NUE) kg kg^{-1}

Nitrogen use efficiency is the N applied to produce yield and is defined here as the amount of grain yield per unit of applied N (g of grain yield g^{-1} of N applied). The efficiency of applied N is considered important criterion beside the N-requirements to obtain maximum economic yield. Accordingly, the efficiency of the applied nitrogen for the different treatments was calculated and the results are shown in Table 6. The values of nitrogen use efficiency show that the addition of 50 mg N as AS kg^{-1} soil solely and in combination with compost tea and microbien gave the greatest values of NUE compared to the other treatments. This trend was found true for the two investigated soils. On the other hand, application of compost decreased NUE obviously, and this may be because the nitrogen in the organic compost was not readily available for plant and, therefore the total N applied by fertilizer plus compost content (denominator) was much lower than the actual values. These results are in line with those obtained by Abbas *et al.* (2011) who found that the inoculation with *B. japonicum* increased NUE and nitrogen uptake efficiency compared with the uninoculated treatments. Also, the values of NUE markedly decreased as the nitrogen addition rate increased. Values of NUE ranged from 12.1 – 129 g g^{-1} in calcareous soil and 5.40 – 83.8 g g^{-1} in sandy soil.

The highest NUE value 12.9 g g^{-1} was obtained in calcareous soil when plants treated with 50 mg N as AS kg^{-1} soil + Mic., while the highest NUE value 8.38 g g^{-1} was obtained in sandy soil when plants sprayed with compost tea plus the low rate of AS, N2 (50 mg N kg^{-1} soil) which increased the efficiency use of AS fertilizer by 71.0% compared with the treatment received AS (50 mg N kg^{-1} soil) solely. These results are in agreement with those obtained by Helmy *et al.* (2013).

Nitrogen Content and Uptake

Nitrogen content

Results in Table 7 show that N-content at tillering, booting and straw at maturity stages increased significantly due to addition of all N-sources, rates as well as biofertilization and their combinations which found true at calcareous and sandy soils, except for straw in sandy soil. Also, the treatment consisting of 100 mg N kg^{-1} soil as AS + bio addition of (CT + Mic.) was superior for increasing the N-content as compared to the other treatments. This promoting effect could be related to the N supplementary effect of N_2 fixing bacteria (used as bio N -fertilizer) to plants.

The individual effect of AS, compost and biofertilizer treatments showed a descending increase in the order: AS > CO for N-source at calcareous and sandy soils for all growth stages. As for the N-rates and bio sources at all growth stages, results revealed that addition of AS at 100 mg N kg^{-1} soil combined with (CT + Mic.) were superior to the other added N-rates, AS , CO and bio fertilization sources, respectively.

Highest N-content values (8.40, 40.0 and 8.10 g Kg^{-1}) at tillering, booting and straw at maturity stages in calcareous soil and (7.40, 35.2 and 7.10 g Kg^{-1}) in sandy soil, respectively were obtained due to addition of 100 mg N as AS kg^{-1} soil combined with (CT + Mic.).

Regarding the grain yield, results indicated that addition of different N-sources had insignificant effect on increasing grain yield of wheat, while N-rates and biofertilization significantly affected N-content in grains. The sequence of the superiority for the applied treatments under the current experimental conditions could be arranged into an ascending order: N4 > N2 > N3 ≥ N1 at calcareous soil and N4 > N2 > N3 > N1 at sandy one for N-rates and CT + Mic. > CT ≥ Mic. = without at calcareous soil and CT + Mic. > without ≥ Mic. ≥ CT at sandy soil. Highest N-content values (19.7 and 18.4 g Kg^{-1}) were found owing to 100 mg N as AS kg^{-1} soil without bio in calcareous and sandy soil, respectively.

Nitrogen uptake

Values of N-uptake by wheat straw and grains as affected by application of AS, compost at different rates and biofertilization solely or in combinations are shown in Table 8. The uptake of N in straw followed a pattern similar to that shown by the N-content where they increased significantly by the addition of the aforementioned fertilization treatments during all growth stages, except for bio addition effect which had insignificant effect in increasing N-uptake by straw at maturity stage in calcareous soil and N-uptake at all growth stages in sandy soil.

Table 7. N-content (g kg^{-1}) of wheat as affected by different N-source and rates as well as bio fertilization

N-source (S)	N-rate, mg kg^{-1} soil (R)	Bio addition source (B)																			
		Without	CT	Mic.	CT+Mic	Mean	Without	CT	Mic.	CT+Mic	Mean	Without	CT	Mic.	CT+Mic	Mean	Without	CT	Mic.	CT+Mic	Mean
		Calcareous soil																			
		Tillering stage					**Booting stage**					**Maturity stage**									
												Straw					**Grains**				
	0	6.00	5.20	5.60	6.20	5.70	15.5	17.3	17.6	17.1	16.9	5.50	4.50	5.00	6.10	5.30	13.0	14.5	13.8	15.4	14.2
	50	6.70	5.40	5.80	5.50	5.90	32.8	32.0	33.0	30.9	32.2	6.70	5.90	5.80	6.40	6.20	14.3	13.7	16.5	17.2	15.4
AS	**75**	7.30	5.10	6.80	6.60	6.50	33.6	30.4	28.2	31.7	31.0	7.00	6.20	6.60	6.30	6.50	14.0	14.3	15.3	13.8	14.3
	100	6.90	7.80	8.00	8.40	7.80	30.9	33.0	35.7	40.0	34.9	6.70	7.30	7.80	8.10	7.50	19.7	15.6	16.9	18.5	17.7
	Mean	6.70	5.90	6.60	6.70	6.50 a	28.2	28.2	28.6	29.9	28.7 a	6.50	6.00	6.30	6.80	6.40 a	15.2	14.5	15.7	16.2	15.4
	0	6.00	5.20	5.60	6.20	5.70	15.5	17.3	17.6	17.1	16.9	5.50	4.50	5.00	6.10	5.30	13.0	14.5	13.8	15.4	14.2
	50	4.10	5.60	4.70	5.50	5.00	16.0	16.0	11.2	14.9	14.5	4.00	5.40	4.40	5.00	4.70	14.4	15.9	15.4	15.8	15.4
CO	**75**	4.60	4.20	5.10	5.60	4.90	17.1	12.3	14.9	17.1	15.3	4.10	4.10	4.70	4.30	4.30	15.3	13.4	14.9	13.9	14.4
	100	4.20	5.00	5.50	4.10	4.70	13.3	14.4	11.7	14.9	13.6	3.90	4.60	5.00	4.10	4.40	15.0	14.0	13.6	15.6	14.5
	Mean	4.70	5.00	5.20	5.40	5.10 b	15.5	15.0	13.9	16.0	15.1 b	4.40	4.60	4.80	4.90	4.70 b	14.4	14.5	14.4	15.1	14.6
Mean bio		5.70 c	5.40 d	5.80 b	6.00 a		21.8 b	21.6 b	21.2b	22.9a		5.40 b	5.30 b	5.50 b	5.80 a		14.8 b	14.5 b	15.1 b	15.7 a	
Mean of N-rate		N1:5.7b	N2: 5.4 c		N3:5.6b	N4:6.2a	N1:16.8b	N2: 23.3 a	N3:23.1a	N4:24.2a		N1:5.30b	N2: 5.40 ab		N3:5.40ab	N4:5.90a	N1:14.2c	N2: 15.4 b		N3:14.4c	N4:16.1a
		S:**	R:**	B:**	SxR:**		S:**	R:**	B:**	SxR:**		S:**	R:*	B:**		SxR:**	S:NS	R:**	B:**		SxR:**
		SxB: **		RxB:**	SxRxB:**		SxB: NS	RxB:**		SxRxB:**		SxB:*		RxB:**	SxRxB:*		SxB:NS		RxB:**	SxRxB:**	
		Sandy soil																			
		Tillering stage					**Booting stage**					**Maturity stage**									
												Straw					**Grain**				
	0	4.50	4.10	4.50	5.10	4.50	18.1	16.5	14.9	17.6	16.8	4.20	3.90	4.20	4.60	4.20	11.1	12.5	11.7	12.9	12.1
	50	5.20	4.10	4.90	4.40	4.60	34.1	36.2	33.0	33.0	34.1	6.40	4.90	5.00	5.30	5.40	11.8	12.1	13.8	14.6	13.1
AS	**75**	6.40	4.50	5.70	5.50	5.50	32.0	34.6	33.6	32.5	33.2	6.10	5.70	5.40	5.40	5.70	12.1	13.3	14.0	12.1	12.9
	100	6.00	6.80	6.50	7.40	6.70	31.4	29.8	33.6	35.2	32.5	5.60	6.30	6.50	7.10	6.40	18.4	14.3	15.2	17.4	16.3
	Mean	5.50	4.90	5.40	5.60	5.40 a	28.9	29.3	28.8	29.6	29.1 a	5.60	5.20	5.30	5.60	5.40 a	13.4	13.1	13.7	14.25	13.6
	0	4.50	4.10	4.50	5.10	4.50	18.1	16.5	14.9	17.6	16.8	4.20	3.90	4.20	4.60	4.20	11.1	12.5	11.7	12.9	12.1
	50	4.50	4.80	4.00	4.50	4.40	12.8	10.7	12.8	11.2	11.9	3.10	4.30	3.70	4.20	3.80	13.8	14.4	14.3	14.2	14.2
CO	**75**	4.30	4.10	4.40	4.40	4.30	12.8	11.2	10.7	11.7	11.6	4.10	3.90	3.70	3.30	3.70	14.5	11.9	13.7	12.8	13.2
	100	4.20	4.20	4.60	4.20	4.30	12.8	11.7	10.1	12.5	11.8	4.30	4.60	4.50	4.00	4.30	14.0	12.9	12.2	14.0	13.3
	Mean	4.40	4.30	4.40	4.60	4.40 b	14.1	12.5	12.1	13.3	13.0 b	3.90	4.20	4.00	4.00	4.0 b	13.4	12.9	13.0	13.5	13.2
Mean bio		4.90 b	4.50 c	4.80 b	5.10a		21.5 a	20.9ab	20.4b	21.4 a		4.70	4.70	4.60	4.80		13.4 b	13.0 b	13.3 b	13.9 a	
Mean of N-rate		N1:4.50 c	N2:4.50 c	N3:4.90 b	N4:5.50 a		N1:16.8 b	N2:23 a	N3:22.4 a	N4:22.1 a		N1: 4.2 c	N2:4.6b	N3:4.6b	N4:5.3 a		N1:12.1 d	N2:13.6 b	N3:13.0 c	N4:14.8 a	
F-test		S:**	R:**	B:**	SxR:**		S:**	R:**	B:*	SxR:**		S:**	R:**	B:NS		SxR:**	S:NS	R:**	B:**	SxR:**	
		SxB:*		RxB:**	SxRxB:**		SxB:**	RxB:**		SxRxB:**		SxB:**		RxB:**	SxRxB:**		SxB:NS		RxB:**	SxRxB:**	

Table 8. N-uptake (mg pot^{-1}) of wheat as affected by different N-source and rates as well as bio fertilization

N-source (S)	N-rate, mg kg^{-1} soil (R)	Bio addition source (B)																			
		Without	CT	Mic.	CT+Mic	Mean	Without	CT	Mic.	CT+Mic	Mean	Without	CT	Mic.	CT+Mic	Mean	Without	CT	Mic.	CT+Mic	Mean
		Calcareous soil																			
		Tillering stage					**Booting stage**					**Maturity stage**									
												Straw					**Grains**				
	0	37.1	32.6	28.7	30.8	32.3	160	209	149	153	168	14.0	13.0	10.8	14.3	13.03	40.0	44.7	42.4	48.8	44.0
	50	78.4	87.5	61.5	67.7	73.8	600	746	716	708	693	28.7	35.0	26.3	26.6	29.15	89.1	86.9	106	74.1	89.1
AS	**75**	110	72.4	67.9	91.1	85.4	746	602	474	808	658	35.4	28.0	27.9	26.6	29.48	101	33.5	67.5	53.7	63.9
	100	115	111	87.2	113	106.6	714	713	917	1108	863	36.0	40.4	37.1	43.4	39.23	132	111	113	109	116
	Mean	85.1	75.9	61.3	75.7	74.5 a	555	568	564	694	595 a	28.5	29.1	25.5	27.7	27.7 a	90.45	69.13	82.33	71.48	78.3 a
	0	37.1	32.6	28.7	30.8	32.3	160	209	149	153	168	14.0	13.0	10.8	14.3	13.0	40	44.7	42.4	48.8	44.0
	50	14.6	24.8	16.0	19.0	18.6	100	139	64.1	97.4	100	8.20	11.4	8.20	10.0	9.45	25.8	24.5	21.7	29.1	25.3
CO	**75**	18.1	18.3	16.3	19.2	18.0	106	77.4	90.3	111	96.2	8.00	10.4	9.60	8.90	9.23	20.5	27.6	24.3	24	24.0
	100	15.2	14.9	17.8	14.8	15.7	81.3	89.7	73.5	75.5	80.0	6.40	10.5	11.9	9.00	9.45	18.2	22.7	19.3	24.5	21.2
	Mean	21.3	22.7	19.7	21.0	21.1 b	112	129	94.2	109	111 b	9.15	11.3	10.1	10.6	10.3 b	26.1	29.9	26.9	31.6	28.3 b
Mean bio		53.2 a	49.3a	40.5 b	48.3 a		333 b	348 a	329 b	402 a		18.8	20.2	17.8	19.14		58.3	49.5	54.6	51.5	
Mean of N-rate		32.1 d	46.2 c	51.8 b	61.0 a		168 c	397 a	377 b	472 b		13.0 c	19.3 b	19.4 b	24.3 a		43.98 b	57.19 ab	44.0 b	68.8a	
		S:**	R:**	B:**	SxR:**		S:**	R:**	B:*	SxR:**		S:**	R:**	B:NS	SxR:**		S:*	R:*	B:NS	SxR:**	
		SxB:**		RxB:NS	SxRxB: NS		SxB:*		RxB:*	SxRxB:*		SxB:NS		RxB:NS	SxRxB:NS		SxB:NS		RxB:NS	SxRxB:NS	
		Sandy soil																			
		Tillering stage					**Booting stage**					**Maturity stage**									
												Straw					**Grain**				
	0	23.6	23.5	20.7	32.7	25.1	168	104	105	154	133	8.50	7.10	6.70	9.70	8.00	28.4	20.3	16.2	21.5	21.6
	50	53.0	44.9	54.2	42.8	48.8	409	489	627	419	486	22.0	21.1	17.1	18.9	19.8	29.4	50.8	48.8	42.9	43.0
AS	**75**	69.0	50.8	72.1	60.1	63.0	602	509	497	371	495	21.2	20.5	22.1	15.9	19.9	30.4	42.2	40.5	40.5	38.4
	100	69.3	86.7	78.6	81.9	79.1	562	516	595	539	553	22.1	22.5	23.5	19.6	21.9	73.0	76.2	45.8	27.9	55.7
	Mean	53.7	51.5	56.4	54.4	54.0 a	435	405	456	371	417 a	18.0	17.3	16.9	16.0	17.0 a	38.4	46.8	37.0	34.1	39.1
	0	23.6	23.5	20.7	32.7	25.1	168	104	105	154	133	8.50	7.10	6.70	9.70	8.00	28.4	20.3	16.2	21.5	21.6
	50	9.59	11.6	10.6	10.5	10.6	54.4	44.8	54.0	50.8	51.0	3.90	5.20	4.20	6.00	4.80	11.5	13.3	12.1	12.1	12.2
CO	**75**	11.5	11.3	13.2	11.5	11.9	54.0	44.8	51.6	58.5	52.2	6.70	6.50	5.10	4.00	5.60	11.0	10.3	10.3	11.4	10.7
	100	11.5	9.53	10.3	18.2	12.4	55.6	44.6	47.0	83.3	57.6	5.20	6.90	5.90	6.40	6.10	7.50	9.9	10.0	20.3	11.9
	Mean	14.0	14.0	13.7	18.2	15.0 b	83.0	59.6	64.4	86.7	73.4 b	6.00	6.50	5.40	6.40	6.10 b	15.6	13.4	12.3	16.3	14.4
Mean bio		33.9	32.7	35.0	36.3		259	232	260	229		12.0	11.9	11.1	11.2		27.0	30.1	24.7	25.2	
Mean of N-rate		25.1 a	29.7 c	37.4 b	45.8 a		133 b	269 a	274 a	305 a		8.01 b	12.3a	12.8 a	14.0 a		21.60	27.6	24.6	33.8	
F-test		S:**	R:**	B:NS	SxR:**		S:*	R:**	B:NS	SxR:**		S:**	R:*	B:NS	SxR:**		S:NS	R:NS	B:NS	SxR:**	
		SxB:NS		RxB:NS	SxRxB:NS		SxB:NS		RxB:NS	SxRxB:NS		SxB:NS		RxB:NS	SxRxB:NS		SxB:NS		RxB:NS	SxRxB:NS	

In calcareous soil, the treatment of 100 mg N as AS kg^{-1} soil +(CT+Mic.) was the most effective on N-uptake at booting and straw at maturity stage as compared to the other treatments which gave 593 and 210% increases over the untreated plants (without AS and bio). The highest values, 115 and 132 mg pot^{-1} at tillering stage and grains, respectively were obtained when plants treated with 100 mg N kg^{-1} soil as AS without bio fertilization representing increase percentages of 210% and 230% over the untreated plants.

As for sandy soil, the percentages response of N-uptake by wheat straw over the control were 247, 273 and 176% at tillering, booting and maturity stages, respectively corresponding to 168% by wheat grains due to addition of 100 mg N as AS kg^{-1} soil + (CT + Mic.) at tillering stage; 100 mg N as AS kg^{-1} soil + Mic. at maturity stage for straw; 100 mg N as AS kg^{-1} soil + CT at maturity stage for grains, and 50 mg N as AS kg^{-1} soil + Mic. at booting stage.

Statistical analysis showed that the individual effect of N-sources and N-fertilization rates on N- content in wheat straw and grains was significant and found true in both calcareous and sandy soils, except for N- uptake by grains which had insignificant effect.

Concerning the interaction effect between bio-addition methods × N-fertilization sources and rates, the effect was not significant for N-uptake in sandy soil while, it was significant for N-source × N-rate at all growth stages in the two soils used.

Conclusion

From the present results, biofertilization by compost tea and microbien inoculants could be applied to wheat as a supplement to inorganic N-fertilizer. Seed inoculation with microbien in combination with ammonium sulphate at 100 kg N $fed.^{-1}$ had the highest performance in, yield and seed physical and chemical properties. Finally, it could be recommended that plant growth promoting rhizobacteria (PGPR) should be used to face the problem of excessive N-mineral use for the wheat plants also, completely reserves chemical fertilizer application and leading to plant tolerance improving under sandy and calcareous soil conditions, so that there will be no environmental problems linked to chemical fertilizers.

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كفاءة التسميد النيتروجيني للقمح تحت تأثير التسميد بكبريتات الأمونيوم والكمبوست بالتداخل مع بعض الأضافات الحيوية تحت ظروف الأراضي الرملية والجيرية

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أقيمت تجربة أصص داخل صوبة التجارب الزراعية الخاصة بمزرعة كلية التكنولوجيا والتنمية – جامعة الزقازيق – محافظة الشرقية – مصر وذلك لدراسة مدي استجابة القمح لإضافة التسميد النيتروجيني من مصادر مختلفة تتمثل في كبريتات الأمونيوم والكمبوست بمعدلات إضافة مختلفة و التسميد الحيوي من مصادر مختلفة (الميكروبين و شاي الكمبوست) وتأثير ذلك علي انتاجية القمح النامي تحت ظروف الأراضي الرملية والجيرية وكذلك دراسة المادة الجافة ومكونات المحصول وجودته ومحتواه من النيتروجين وكفاءة النيتروجين المستخدم خلال موسم الشتاء ٢٠١٥/٢٠١٤م ويمكن تلخيص أهم النتائج المتحصل عليها فيما يلي: إضافة كبريتات الأمونيوم مفردا أو بالتداخل مع التسميد الحيوي أعطي أعلي قيم لمحصول المادة الجافة وذلك مقارنة بإضافة الكمبوست أو معاملة المقارنة، أعلي كفاءة للنيتروجين المستخدم كانت نتيجة إضافة ٥٠ مللجم ن كجم$^{-١}$ تربة علي صورة كبريتات الأمونيوم مفردا أو بإضافة نفس المعدل في وجود (شاي الكمبوست + الميكروبين)، في التربة الجيرية أظهرت النتائج أن إضافة ١٠٠ مللجم ن كجم$^{-١}$ تربة علي صورة كبريتات الأمونيوم في وجود (شاي الكمبوست + الميكروبين) هي الأعلى تأثيراً علي كميات النيتروجين الممتص بواسطة نباتات القمح خلال مرحلة التفريع القاعدي و للقش عند مرحلة النضج وذلك مقارنة بباقي المعاملات تحت الدراسة، وتم الحصول على نفس التأثير أيضاً تحت ظروف التربة الرملية.

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