J.Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 7 (5):353 - 363, 2016

Effect of Anhydrous Ammonia and Compost as Well as N_2-Fixing Bacteria on Wheat Plants (*Triticum aestavium* l.) Grown in Clayey Soils

Lamyaa A . Abd El-Rahman
Soils, water and Environmen Res. Inst., Agric. Res. Center (ARC), Giza, Egypt.

ABSTRACT

Two field experiments were conducted on a clayey soil at the experimental farm of Gemmeiza Research Station, Al-Gharbia Governorate, Egypt (region Egypt 30 43 latitude and 31 07 longitude) during winter seasan of 2013/2014 and 2014/2015, to study the response of wheat plants (*Triticum aestivum* cv. Sakha 93) to application of nitrogen fertilizer from two sources *i.e.* Anhydrous Ammonia, (AA) at different rates i.e., 0, 50, 75 and 100 kg N fed.$^{-1}$ and compost (CO) at rates of, 0, 3 and 6 mega gram,(Mg fed.$^{-1}$) in presence or absence of bio inoculation with *Azotobacter chroccocum* on wheat productivity and macronutrient contents. Also, some soil properties after harvest were taken into consideration. The obtained results could be summarized as follows: 1) Straw, grain and biological yields were significantly increased as a result of different treatments application . The corresponding highest values of biological yield (8.86 Mg fed^{-1}) and (3.96 Mg fed^{-1}) for grain yield, respectively were obtained due to the applied treatment of (anhydrous ammonia at 100 kg N fed.$^{-1}$ + 6 Mg fed.$^{-1}$ compost + bio). The same treatment led to a significant increase in 1000-grain weight. 2) Content of N, P & K by wheat straw was significantly affected by the addition of different treatments. The highest values (76.9 and 128.4 kg fed.$^{-1}$) for N and K content, respectively were obtained due to the addition treatment of (100kg N fed.$^{-1}$ as AA + 6 Mg fed.$^{-1}$ compost + bio) while, (26.8 kg fed.$^{-1}$) for P- content was observed owing to (anhydrous ammonia at 100 kg N fed.$^{-1}$ + 6 Mg fed.$^{-1}$ compost). 3) Content of N, P & K by wheat grain was clearly affected by the addition of different treatments. The highest values (87.1, 26.9 and 80.0 kg fed.$^{-1}$), respectively were obtained due to the same treatment of grain yield. 4) Highest protein content and protein yield for grains were obtained due to the addition treatment of (anhydrous ammonia at 100 kg N fed.$^{-1}$ + 6 Mg fed.$^{-1}$ compost + bio). 5) Maximum harvest index and yield efficiency were obtained due to (50 kg N fed.$^{-1}$ as anhydrous ammonia + biofertilization) treatment. 6) The electrical conductivity (EC dSm^{-1}) and soil pH values decreased due to the Addition of treatments as compared with the non-treated plots. 7) Soil available N, P and K were increased due to application of different treatments relative to untreated plots. The highest values were observed due to (anhydrous ammonia at 100 kg N fed.$^{-1}$ + 6 Mg fed.$^{-1}$ compost + biofertilization) treatment.

Keywords: Anhydrous ammonia, compost, Wheat, PGPR bacteria.

INTRODUCTION

Wheat (*Triticum aestavium* 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 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 feddan, (FAO, 2011).

Biofertilizers are applied to seeds, plant surfaces, or soil; they colonize the rhizosphere or the interior of the plant, promoting growth by increasing the supply or availability of primary nutrients to the host plant ,Biofertilizers add nutrients through the natural processes of fixing atmospheric nitrogen, solubilizing phosphorus, and stimulating plant growth through the synthesis of growth promoting substances (Bharathi et al 2013).

The addition of compost to agricultural soils has beneficial effects on crop development and yields by improving soil physical , chemical and biological properties (Zheljazkov & Warman, 2004).

Application of compost and bio-fertilizers to improve soil structure, fertility and consequently development and productivity of wheat plants has received little attention. Thus, inoculation of wheat plants with PGPRs and compost at early stage of development results in positive impact on biomass production by improving soil physical and biological properties, directly affecting root growth, production of phytohormones by bacteria, enhancement mineral uptake and transfer of nitrogen to the plant. Gharib et al (2008) and Abdel-Fattah and Merwad (2015) suggested that increase of N, P, K and protein content in straw and grain as affected by bio-fertilizer inoculation and compost compared with control.

Anhydrous ammonia (82%N) is a liquid under high pressure and must be injected at least six inches deep into a moist soil because it becomes a gas once it is released from the tank. In soil, ammonia reacts with water to form the ammonium (NH_4^+) ion, which is held on clay and organic matter. Anhydrous ammonia is generally the cheapest source of N however; the method of application is less convenient and requires more power to apply than most other liquid or dry materials. (Osman *et al*., 2013). Ismail et al (2013) reported that the application of high rate of anhydrous ammonia alone led to increase of plant characters.

The current investigation aimed to assessing the effect of different anhydrous ammonia injection rates and compost addition as well as inoculation of wheat grains with *Azotobacter chroccocum* strain (PGPR) on some plant characteristics, yield and yield component of wheat grown on a clayey soil. Also, some soil properties which were taken into consideration after harvest in this study.

MATERIALS AND METHODS

Two field experiments were conducted on a clayey soil at the Experimental Farm of Gemmeiza Research Station, Al-Gharbia Governorate, Egypt during winter season of 2013/2014 and 2014/2015 ,seasons to study the response of wheat plants (*Triticum aestivum* cv. Sakha 93) to application of nitrogen fertilizer from two sources *i.e*., Anhydrous Ammonia, (AA) at different rates i.e., 0, 50, 75 and 100 kg N fed.$^{-1}$ and compost (CO) at rates of, 0, 3 and 6 mega gram, Mg fed.$^{-1}$ in presence or absence of bio inoculation with *Azotobacter chroccocum* on wheat productivity and macronutrient contents. Also, some soil properties after harvest were taken into consideration. A representative soil sample of the field was taken from 0 – 30 cm layer and used for determining some physical and chemical properties of the studied soil according to Page *et al*. (1982) and Klute, (1986). whose results are presented in Table 1

Compost manure was prepared according to Nasef *et al*.,(2009) . The CO manure was mixed thoroughly with the soil one month before sowing at rate of 0, 3 and 6 mega gram, Mg fed.$^{-1}$ (Mg = 10^6 g = 1000 kg). The final product was chemically analyzed according to Brunner and Wasmer (1978). The chemical compositions of the organic sources are shown in Table 2.

Table (1) some physical and chemical properties of the experiment of soil

Particle size distribution: Coarse sand (%)	Fine sand (%)	Silt (%)	Clay (%)	Texture	O.M (g kg^{-1})	$CaCO_3$ (g kg^{-1})
4.87	15.10	25.81	54.22	Clayey	6.91	21.9

pH (1:2:5)	EC, dS m^{-1} soil paste ex.	Cations (mmolc L^{-1}) Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Anions (mmolc L^{-1}) HCO_3^-	Cl^-	SO_4^{--}
7.93	2.15	3.22	7.19	10.24	0.85	1.25	8.22	12.03

Available of Macronutrients (mg kg^{-1}) N	P	K
42.0	5.20	189

Table (2). Chemical composition of the compost used in the experiment.

Moisture %	pH (1:10)	EC (dSm^{-1})	O.M (g kg^{-1})	C/N ratio	Macronutrients % N	P	K	Micronutrients (mg kg^{-1}) Fe	Mn	Zn
27.0	7.51	3.90	457	20.32	0.55	0.63	1.22	295	75.3	36.0

In both seasons, the treatments were arranged in a 3-factor split-split plot in a randomized complete block design with three replications. The plot area was 50 m^2 (5 X 10 m). The Main plots, were assigned to anhydrous ammonia, AA, 0, 50, 75 and 100 kg N fed.$^{-1}$ was injected directly into the moderately moister (20 % moisture content) soil at 15cm depth with 30 cm spacing between points of injection before 5 days from planting according to the injection technique previously used by Farrag *et al*.,(2011). Sub-plots were assigned to compost (CO): 0, 3 and 6 Mg fed.$^{-1}$. Sub–sub plots were assigned to bio fertilizers: without and with *Azotobacter chroccocum*. Each plot was sown with grains of wheat cultivar (*Triticum aestivum* cv. Sakha 93) on the 2nd and 5th of November 2013 and 2014, respectively. Grains were inoculated with *Azotobacter chroccocum* strain (PGPR) biofertilizer supplement by Bio-fertilizer Production Unit, Department of Microbiology, Soils, Water and Environment Research Institute, Agricultural Research Center, Giza, Egypt. Grains of wheat were coated with the gum media carrying the bacteria strain on the same day of sowing at rate of 700g per 60 kg grains. More of bacteria strain was added three times at 30, 45 and 55 days after sowing (DAS) as liquid spray on soil and plant at a rate of 20L per 400 L water fed.$^{-1}$.

All plots of the experiment were fertilized with the recommended doses of P and K as follows: 6.54 kg P fed.$^{-1}$ as single superphosphate (15%p2o5) during seedbed preparation and potassium was added at 19.92 kg K fed.$^{-1}$ as potassium sulphate (48%k2o), Agricultural practices for growing wheat were carried out as recommended by the Ministry of Agriculture. harvested on the 15th and 20th of April 2014 and 2015

At harvest, ten plants were taken randomly from each plot and tagged for yield assessment. No. spikes, spikes weight, grain weight plant^{-1}, straw weight plant^{-1} and 1000-grain weight were measured. In addition, plants in an area of 2 m^2 of each plot were harvested, air dried, then straw yield, grain yield, biological yield were estimated.

- Grain protein contents were calculated by multiplying grain N% by **5.7.**
- Grain protein yield in kg fed.$^{-1}${protein content g kg^{-1} x grain yield Mg fed.$^{-1}$}.
- Harvest Index (HI): (grain yield / biological yield) x100
- Yield efficiency: (grain yield / straw yield) x 100.
- N, P and K content and uptake by plant (straw and grains).

Macronutrients content of grain and straw samples were determined in aliquots of digested solutions resulting from the digestion of grain and straw samples by a mixture of H_2SO_4 and $HClO_4$ acids after drying in an oven at 70º C as described by Ryan *et al*. (1996).

Soil characteristics

After harvest, representative soil samples of the field were taken (0 – 30 cm layer) from each plot. Samples were analyzed for EC (in soil paste extract), pH (in 1: 2.5 soil: water suspension) and available N, P and K according to Page *et al*. (1982).

Statistical analysis

Data of the two seasons were subjected to statistical analysis of variance (ANOVA), and the least significant differences (L.S.D) at 5% level according to Snedecor and Cochran, (1982).

RESULTS AND DISCUSSION

Effect of anhydrous ammonia, compost and bio-fertilizer on some soil properties

Soil Salinity (EC_e) and Soil pH

Data in Table 3 reveal that the value of soil salinity EC decreased when the organic amendments were applied in combination with N-fertilizer as compare with the control treatment (no-N added). Hence, the increase in N-rate led to the decrease in EC especially in presence of bio addition. This may be due to the acids produced from organic matter degradation and fertilizers reactions in the soil . Such products reduce the deleterious effect of Na-salts, and improve soil structure, increasing aggregate stability and drainable pores. Consequently, these created conductive pores enhancing the leaching process of soluble salts through irrigation fractions.(Shaban and Omar 2006) and Ashmaye *et al*., (2008). Also, compost addition would improve soil conditions for plant growth. Improvement in porosity and aggregation may have occurred due to the applied compost and biofertilizer and hence enhanced the leaching of salts Zaka et al., (2005). Organic acids must have provided a substantial modification of soil physical properties, especially soil structure as well as soil aggregation and drainable pores. Consequently, these favorable conditions would positively affect soil permeability and encourage downward movement of water carrying Na-salts out of the soil. These results are in agreement with those of Bassiouny and Shaban (2010) and Rashed et al. (2011).

The effect is more pronounced and gave the lowest EC value (1.09 dSm^{-1}) in soil treated with 100 kg N $fed.^{-1}$ (AA) + compost, 6 Mg $fed.^{-1}$ + biofertilization causing decreases of 44.4% as compared to non-treated plants. The used treatments could be arranged according to their effects on reducing EC of soil in the following descending order: AA0 > AA50 > AA70 > AA100. Ismail et al (2013) indicated that the EC soil decreased with increasing rates of Anhydrous ammonium (110kgN than 70 kg N).This trend was found true with CO.M (6 Mg $fed.^{-1}$) > CO.M (3 Mg $fed.^{-1}$) when added solely or in combination with biofertilization. These results are in agreement with those obtained by Nasef et al. (2009) who found that beside of the improvement in soil aggregation caused by compost, its decomposition when combined with bio-fertilizers released acids therefore; such conditions facilitated leaching of soluble salts and decreased soil salinity.

Soil pH:

Data in Table 3 show the effect of AA and organic-N fertilization on some chemical properties of the soil at the end of the experiment. The values of pH were slightly decreased as affected by all the studied treatments for the combined data of two seasons.

Table (3). Effect of anhydrous ammonia, compost and bio fertilization on soil EC and pH after harvest.

Anhydrous Ammonia rate, (AA) (kg $fed.^{-1}$)	Compost rate, (CO) (Mg $fed.^{-1}$)	Bio addition, (B)				
		With	Without	Mean	With	Without
		EC (dSm^{-1})			pH	
	0	1.87	1.96	1.92	7.88	7.91
0	3	1.44	1.57	1.51	7.87	7.88
	6	1.29	1.33	1.31	7.83	7.85
Mean		1.53	1.62	1.62		
	0	1.83	1.92	1.88	7.88	7.90
50	3	1.35	1.41	1.38	7.81	7.84
	6	1.22	1.30	1.26	7.80	7.82
Mean		1.47	1.54	1.54		
	0	1.77	1.85	1.81	7.85	7.89
75	3	1.28	1.33	1.31	7.80	7.82
	6	1.17	1.20	1.19	7.78	7.80
Mean		1.41	1.46	1.46		
	0	1.65	1.66	1.66	7.85	7.86
100	3	1.18	1.21	1.20	7.79	7.80
	6	1.09	1.13	1.11	7.77	7.78
Mean		1.31	1.33	1.33		
Grand mean of bio		1.43 b	1.49 a	1.49 a		
F-test:		AA: **	CO: **	AA:		CO:
		B: *	AAxCO: ns	B:		AAxCO:
		AAxB: ns	COxB: ns	AAxB:		COxB:
		AAxCOxB: ns			AAxCOxB:	
Means of compost						
Whitout		1.81 a			----	
3		1.35 b			----	
6		1.22 c			----	
Grand mean		1.46			----	

These results are in agreement with those of Siam *et al*. (2013) who reported that the decrease in pH was marked particularly when N and compost fertilization were combined. The highest decrease in pH value (7.77) was achieved by treating the soil with 100 kg N $fed.^{-1}$ (AA) + compost, 6 Mg $fed.^{-1}$ + biofertilization. Such decreases in soil pH might be attributed to the effect of microorganisms on decomposing organic matter releasing organic acids and producing several phytohormones such as indole acetic acid and cytokinins. The positive relationship between soil and bio-fertilizers in reduces the hazards of soil salinity and enriches nutrients in soil (Rashed, 2006). These results are similar to those obtained by Abdel Lattif (2007), Poraas *et al*. (2008) and Attia *et al*. (2014).

Available macronutrients (N, P and K)

Data presented in Table 4, show available N, P and K (mg kg^{-1}) as affected by the used treatments and their combinations on the studied soil . Available N, P and K significantly increased as affected by the treatments and their combination. Available N ranged between 42.7 to 59.0 mg kg^{-1} in presence of bio-inoculation and 41.0 to 57.2 mg kg^{-1} in absence of bio-inoculation. Available P ranged between 5.93 to 7.98 mg kg^{-1} in combination with bio fertilization and 5.89 to 7.95 mg kg^{-1} without bio fertilization. Available K ranged between 198 to 242 mg kg^{-1} in presence of bio-inoculation and 192 to 235 mg kg^{-1} in absence of bio-inoculation. The soil treated with 100 kg N $fed.^{-1}$ from AA + 6 Mg $fed.^{-1}$ compost gave the highest values of available N, P and K especially when combined with biofertilization.

The positive effect of compost is partially due to a slow release of N from manure, as suggested by Bhandari *et al.* (2002). The P and K fractions added through organic manures upon its decomposition with time may account for the increases in both P and K. (Yadvinder *et al.*, 2004). Also the production of organic and inorganic acids during the degradation of such organic materials (as well as humates) as a result of the microorganisms activities must have contributed to a decrease in soil pH which would reduce P fixation and produce more chelating ions, leading to an increase in available forms of elements in the rhizosphere zone. These results are in agreement with those obtained by Ewees and Abdel Hafeez (2010).

Interaction effects of anhydrous ammonia rates, compost and biofertilizer inoculation were in significant for available N, P and K.

Table (4). Effect of anhydrous ammonia, compost and bio fertilization on N, P andK content in soil after harvest.

Anhydrous Ammonia rate, (AA) (kg fed.$^{-1}$)	Compost rate, (CO) (Mg fed.$^{-1}$)	Bio addition, (B) With	Without	Mean	With	Without	Mean	With	Without	Mean
		Macronutrient contents (mg kg^{-1}) in soil								
			N			P			K	
	0	42.7	41.0	41.9	5.93	5.89	5.91	198	192	195
0	3	44.2	42.5	43.4	6.89	6.23	6.56	204	195	200
	6	45.7	44.8	45.3	6.95	6.44	6.70	208	198	203
Mean		44.2	42.8	43.5 d	6.59	6.19	6.39 b	203	195	199 c
	0	44.5	43.7	44.1	5.98	5.90	5.94	200	197	199
50	3	47.3	45.0	46.2	6.94	6.89	6.92	213	201	207
	6	49.3	48.2	48.8	7.04	6.98	7.01	219	207	213
Mean		47.0	45.6	46.3 c	6.65	6.59	6.62 b	211	202	206 bc
	0	46.1	45.0	45.6	6.12	5.92	6.02	206	198	202
75	3	52.1	48.9	50.5	7.22	7.12	7.17	215	208	212
	6	54.0	53.7	53.9	7.78	7.48	7.63	221	214	218
Mean		50.7	49.2	50.0 b	7.04	6.84	6.94 b	214	207	210 b
	0	46.9	45.9	46.4	6.77	6.32	6.55	211	203	207
100	3	58.5	55.9	57.2	7.90	7.88	7.89	235	228	232
	6	59.0	57.2	58.1	7.98	7.95	7.97	242	235	239
Mean		54.8	53.0	53.9 a	7.55	7.38	7.47 a	229	222	226 a
Grand mean of bio		49.2 a	47.7 b		6.96	6.75		214 a	206 b	
F-test:		AA: **		CO: **	AA: **		CO: **	AA: **		CO: **
		B: **		AAxCO: **	B: ns		AAxCO: ns	B: **		AAxCO: ns
		AAxB: ns		COxB: *	AAxB: ns		COxB: ns	AAxB: ns		COxB: ns
		AAxCOxB: ns			AAxCOxB: ns			AAxCOxB: ns		
Means of compost										
Whitout			44.5 c			6.10 b			201 b	
3			49.3 b			7.13 a			212 a	
6			51.5 a			7.33 a			218 a	
Grand mean			48.4			6.85			210	

The maximum available N, P and K (59.0, 7.98 and 242 mg kg^{-1} soil, respectively) were achieved due to application of AA100 + 6 Mg fed.$^{-1}$ compost when inoculated with *Azotobacter* and the corresponding increments over the non-treatment plants were 43.9, 34.9 and 26.0%, respectively.

Yield and yield components

Table 5 reveals that 1000-grain weight significantly increased due to anhydrous ammonia, compost and biofertilization solely or in combinations. Namvar and Khandan (2013) reported that 1000-grain weight of wheat increased significantly by N-fertilization and biofertilizer inoculation. These results are in agreement with those of Sary *et al.* (2009) and Kandil *et al.* (2011). As for N effect, there was a significant difference between the AA rates of 100, 75 and 50 kg N fed.$^{-1}$ and following the descending order: AA100 > AA75 > AA50 > AA0 for 1000-grain weight. Regarding the response to compost addition, the main effect followed a descending of: 6 Mg fed.$^{-1}$ > 3Mg fed.$^{-1}$ > none. In this regard, Ashoub *et al.* (2005) found that the rate of 80 kg N fed^{-1} as anhydrous ammonia produced the increase of 1000 grains weight. Salem *et al.* (2004) reported that straw weight, number of spikes/m^2, number of spikes/ spiklets, grain weight, 1000 grain weight and grain (ardab) were significantly increased as the addition of N fertilization. These results are in agreement with Abedi *et al.* (2010) and Daneshmand *et al.* (2012).

The highest increase in 1000-grain weight (17.7%) was recorded in plants treated with AA100 + 6 Mg fed.$^{-1}$ compost + biofertilization.

Straw, grain and biological yields

The data of straw, grain and biological yields of wheat plants are presented in Tables 5 and 6. The obtained results exhibited significant increases due to application of AA and compost while, biofertilization had in significant effect as compared to the non-treated plants.

The favorable effect of nitrogen fertilizer may be due to 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 leaves and seeds (Wortman *et al.*, 2011). Growth promoting substances (phytohormones) which would be produced by these organisms play a key role in plant growth and promote seed germination and root elongation. Root development and proliferation of plants in response to biofertilizer activities enhance water and nutrients uptake (Kandil *et al.*, 2011) and Joshi *et al.*, 2012). These results agree with those obtained by, Siam *et al.* (2013) and Piccinin *et al.* (2013).

Interaction effects of anhydrous ammonia rates and compost addition were significant for yields of straw, grains and grains + straw (biological). A descending order characterized the effects of N fertilization on straw, grain and biological yields as follows: AA100 ≥ AA75 > AA50 ≥ AA0. As for the main effect of compost addition; the order was: 6 Mg fed.$^{-1}$ > 3 Mg fed.$^{-1}$ > without. Awad *et al.* (2011) indicated that the increase rate of N fertilizer from 60 to 80 kg N fed^{-1} combined with anhydrous ammonia resulting in an increase the grain yield of wheat.

Table (5). Effect of anhydrous ammonia, compost and bio fertilization on 1000-grain weight, straw and grain yields

Anhydrous Ammonia rate, (AA) (kg fed.$^{-1}$)	Compost rate, (CO) (Mg fed.$^{-1}$)	Bio addition, (B) With	Without	Mean	With	Without	Mean	With	Without	Mean
		1000-grain weight			Straw yield			Grain yield		
	0	41.7	40.7	41.2	3.12	2.93	3.03	2.89	2.25	2.57
0	3	43.0	42.6	42.8	3.69	3.45	3.57	3.13	2.75	2.94
	6	43.9	43.0	43.5	3.88	3.77	3.83	3.28	2.95	3.12
Mean		42.9	42.1	42.5 d	3.56	3.38	3.47 b	3.10	2.65	2.88 b
	0	41.9	40.9	41.4	3.18	2.98	3.08	2.95	2.70	2.83
50	3	45.2	43.1	44.2	3.97	3.88	3.93	3.25	3.00	3.13
	6	45.6	43.5	44.6	4.12	4.05	4.09	3.33	3.15	3.24
Mean		44.2	42.5	43.4 c	3.76	3.64	3.70 b	3.18	2.95	3.06 b
	0	42.2	41.0	41.6	3.77	3.94	3.86	3.10	3.00	3.05
75	3	46.2	44.8	45.5	4.60	4.37	4.49	3.55	3.30	3.43
	6	47.0	45.0	46.0	4.88	4.49	4.69	3.80	3.60	3.70
Mean		45.1	43.6	44.4 b	4.42	4.27	4.34 a	3.48	3.30	3.39 ab
	0	42.7	41.7	42.2	4.30	4.25	4.28	3.40	3.38	3.39
100	3	47.3	45.0	46.2	4.75	4.85	4.80	3.87	3.72	3.80
	6	47.9	47.0	47.5	4.90	4.97	4.94	3.96	3.84	3.90
Mean		46.0	44.6	45.3 a	4.65	4.69	4.67 a	3.74	3.65	3.70 a
Grand mean of bio		44.6 a	43.2 b		4.10	3.99		3.38	3.14	
F-test:		AA: **	CO: **		AA: **	CO: **		AA: **	CO: *	
		B: **	AAxCO: **		B: ns	AAxCO: ns		B: ns	AAxCO: ns	
		AAxB: ns	COxB: ns		AAxB: ns	COxB: ns		AAxB: ns	COxB: ns	
		AAxCOxB: ns			AAxCOxB: ns			AAxCOxB: ns		
Means of compost										
Whitout		41.6 c			3.56 b			2.96 b		
3		44.7 b			4.20 a			3.32 ab		
6		45.4 a			4.38 a			3.49 a		
Grand mean		43.9			4.04			3.26		

Table (6). Effect of anhydrous ammonia, compost and bio fertilization on biological Yield, harvest index and yield efficiency

Anhydrous Ammonia rate, (AA) (kg fed.$^{-1}$)	Compost rate, (CO) (Mg fed.$^{-1}$)	Bio addition, (B) With	Without	Mean	With	Without	Mean	With	Without	Mean
		Biological yield			Harvest index (HI)			Yield efficiency (YE)		
	0	6.01	5.18	5.60	48.0	43.4	45.8	92.6	76.8	84.7
0	3	6.82	6.20	6.51	45.9	44.4	45.2	84.8	79.7	82.3
	6	7.16	6.72	6.94	45.8	43.9	44.9	84.5	78.2	81.4
Mean		6.66	6.03	6.35 b	46.6	43.9	45.3	87.3	78.2	82.8
	0	6.13	5.68	5.91	48.1	47.5	47.8	92.8	90.6	91.7
50	3	7.22	6.88	7.05	45.0	43.6	44.3	81.9	77.3	79.6
	6	7.45	7.20	7.33	44.7	43.8	44.3	80.8	77.8	79.3
Mean		6.94	6.59	6.76 b	45.9	45.0	45.5	85.2	81.9	83.5
	0	6.87	6.94	6.91	45.1	43.2	44.2	82.2	76.1	79.2
75	3	8.15	7.67	7.91	43.6	43.0	43.3	77.2	75.5	76.4
	6	8.68	8.09	8.39	43.8	44.5	44.2	77.9	80.2	79.1
Mean		7.90	7.57	7.73 a	44.2	43.6	43.9	79.1	77.3	78.2
	0	7.70	7.63	7.67	44.2	44.3	44.3	79.1	79.5	79.3
100	3	8.62	8.57	8.60	44.9	43.4	44.2	81.5	76.7	79.1
	6	8.86	8.81	8.84	44.7	43.6	44.2	80.8	77.3	79.1
Mean		8.39	8.34	8.37 a	44.6	43.8	44.2	80.5	77.8	79.2
Grand mean of bio		7.47	7.13		45.3	44.1		83.0	78.8	
F-test:		AA: **	CO: **		AA: ns	CO: ns		AA: ns	CO: ns	
		B: ns	AAxCO: ns		B: ns	AAxCO: ns		B: ns	AAxCO: ns	
		AAxB: ns	COxB: ns		AAxB: ns	COxB: ns		AAxB: ns	COxB: ns	
		AAxCOxB: ns			AAxCOxB: ns			AAxCOxB: ns		
Means of compost										
Whitout		6.52 b			45.5			83.7		
3		7.52 a			44.2			79.3		
6		7.87 a			44.4			79.7		
Grand mean		7.30			44.7			80.9		

Harvest Index (HI): (grain yield / biological yield) x100
Yield efficiency: (grain yield / straw yield) x 100.

The maximum grain and biological yields (3.96 and 8.86 Mg fed.$^{-1}$, respectively) were achieved due to application of AA100 + 6 Mg fed.$^{-1}$ + bio and the corresponding increments over the non-treatment plants were 76.0 and 71.0%, respectively. With respect to straw yield, the greatest value (4.97 Mg fed.$^{-1}$) was observed due to addition of AA100 + 6 Mg fed.$^{-1}$ without bio inoculation giving increases of 69.6% over the non-treated.

Harvest index and Grain yield efficiency

Values of harvest index and yield efficiency as affected by AA rates, compost and biofertilization when applied solely or in combinations are shown in Table 6. Harvest index of wheat increased due to the addition treatments. Harvest index of plants treated with 50 kg N fed.$^{-1}$ as AA + bio was the highest giving increase of 10.8% as compared to the non-treated plants. The favorable effect of mineral N- fertilization is due to N being essential for plant growth. Therefore, the increase in N-fertilization rate would increase metabolic processes and physiological activities rate, and thus, increased yield with good quality of grains would occur (Russel, 1973). These results are in a harmony with that obtained by Sugar and Berzsenyi, (2012).

Grain yield efficiency, which is the ratio of grain yield to straw yield at maturity varied between 77.2% to 92.8% in the plants treated with biofertilization and 76.1% to 90.6% in absence of biofertilization. The plants treated with 50 kg N fed.$^{-1}$ as AA + bio gave the highest yield efficiency value 92.8 giving increases of 20.8%, as compared to the non-treated plants. Abdel Aziz *et al.* (2010) stated that the highest value of wheat grain was obtained by the application of 50 kg fed.$^{-1}$ anhydrous ammonia + 10m^3 fed.$^{-1}$ compost with *Bacillus polymyxa*.

Grain proteinpercent and protein yield (Kg / Fed)

It can be seen from results presented in Table 7 that the grain protein % of wheat is significantly increased as affected by the treatments of AA rates, compost addition and biofertilization. These results are in accordance with those reported by Abbas *et al.* (2011) and Joshi *et al.* (2012). In this regard, Namvar and Khandan (2013) reported that inoculation with *Azotobacter sp.* and *Azospirillium sp.* increased wheat grains protein content by 10%. Increasing N rate was associated with increases grain protein content and grain protein yield.

The highest value of protein % (13.8 %) was obtained due to the treatment 100 kg N fed.$^{-1}$ as AA + 6 Mg fed.$^{-1}$ compost + biofertilization representing increase percentage of 30.2% as compared to the non-treated plants. These results are in agreement by Abdel-Fattah and Merwad (2015) who indicated that the application of biofertilizer inoculation and compost had significant effects on protein content of wheat grains. Rana et al (2012) showed that the increase of protein content 18.6 % in grain wheat as affected by bio-fertilizer inoculation. Regarding the grain protein yield, results given in Table 7 reflected significant increases in the grain protein yield as affected by application of the treatments and the effect followed a trend rather similar to that of protein % . The increase in protein yield could be attributed to the increases in wheat grain yield and the increases in protein percent, due to added treatments . (Ewees and abdel Hafeez, 2010).

Table (7). Effect of anhydrous ammonia, compost and bio fertilizationon protein % and protein yield of wheat grains.

Anhydrous Ammonia rate, (AA) (kg fed.$^{-1}$)	Compost rate, (CO) (Mg fed.$^{-1}$)	Bio addition, (B)					
		With	Without	Mean	With	Without	Mean
		Protein (%)			Protein Yield (kg fed.$^{-1}$)		
	0	11.8	10.6	11.2	341	239	290
0	3	12.1	11.1	11.6	379	305	342
	6	12.4	11.4	11.9	407	336	372
Mean		12.1	11.0	11.6	376	293	335 b
	0	12.1	10.8	11.5	357	292	325
50	3	12.4	11.6	12.0	403	348	376
	6	12.7	12.1	12.4	423	381	402
Mean		12.4	11.5	12.0	394	340	367 b
	0	12.2	10.9	11.6	378	327	353
75	3	12.4	12.2	12.3	440	403	422
	6	13.1	12.8	13.0	498	461	480
Mean		12.6	12.0	12.3	439	397	418 ab
	0	12.4	11.3	11.9	422	382	402
100	3	13.4	12.8	13.1	519	476	498
	6	13.8	13.1	13.5	546	503	525
Mean		13.2	12.4	12.8	496	454	475 a
Grand mean of bio		12.6	11.7		426	371	
F-test:		AA: ns		CO: ns	AA: **		CO: *
		B: ns		AAxCO: ns	B: ns		AAxCO: ns
		AAxB: ns		COxB: ns	AAxB: ns		COxB: ns
			AAxCOxB: ns			AAxCOxB: ns	
Means of compost							
Whitout			11.5			342 b	
3			12.3			409 ab	
6			12.7			444 a	
Grand mean			12.2			398	

Also, exudation of plant growth regulators such as auxins, gibberellin and cytokinin by *Azotobacter sp.* and *Azospirillium sp.* bacteria (Vessy, 2003) contribute to such positive effect. The increases of protein yield followed the sequence: AA100 ≥ AA75 > AA50 ≥ AA0 as for anhydrous ammonia addition rates and 6Mg fed.$^{-1}$ compost ≥ 3Mg fed.$^{-1}$ compost ≥ without as for compost.

The highest value of protein yield (546 kg fed.$^{-1}$) was obtained due to the same treatment which resulted in the highest protein % .

Macronutrients percent and content in Straw

Data in Tables (8 and 9) shows that N, P and K percent and content in wheat straw were increased due to addition of different rates of anhydrous ammonia, compost addition and bio inoculation with *Azotobacter* and their combinations. These increases were insignificant for N, P and K % and significant for N, P and K content.

The treatment of 100 kg N fed.$^{-1}$ AA + 6 Mg fed.$^{-1}$ compost + bio was superior for increasing the percent of N, P and K as compared to the non-treated plants. These results may indicate the importance of nitrogen application in clayey soil for maximum production of wheat. The response of wheat to added N could be attributed to the poor soil fertility level of available N in the experimental field (42.0 mg kg^{-1} soil) as shown in Table 1. Highest N, P and K % in straw (1.57, 0.54 and 2.62%, respectively) were obtained due to the addition of 100 kg N fed.$^{-1}$ as AA + 6 Mg fed.$^{-1}$ compost under biofertilization.

For N, P and K content in straw results show a significant response to anhydrous ammonia rates and compost addition while it was insignificant response to biofertilization. On the other hand, the main effect of anhydrous ammonia rates shows descending order as follow: AA100 ≥ AA75 ≥ AA50 ≥ AA0 for N and P-content and AA100 ≥ AA75 > AA50 ≥ AA0 for K-content . The main effect of compost addition rate the corresponding order was: 6Mg fed.$^{-1}$ ≥ 3Mg fed.$^{-1}$ > without compost for N, P and K-content . Highest N and K contents in straw (76.9 and 128.4 kg fed.$^{-1}$, respectively) were obtained due to the addition of 100 kg N fed.$^{-1}$ as AA + 6Mg fed.$^{-1}$ compost + bio causing 132 and 107% increases, respectively over the non-treated plants. Ismail, (2004) pointed out that nitrogen uptake increased significantly due to nitrogen addition in different forms.

Angas *et al.*, (2006) found that N uptake by barley was increased by increasing N rate up to 63 Kg N fed.$^{-1}$. Maximum value (26.8 kg fed.$^{-1}$) of P- content by wheat straw was observed by the combination of 100 kg N fed.$^{-1}$ as AA + 6Mg fed.$^{-1}$ compost.

Table (8). Effect of anhydrous ammonia, compost and bio fertilization on N, P and K percent in straw.

Anhydrous Ammonia rate, (AA) (kg fed.$^{-1}$)	Compost rate, (CO) (Mg fed.$^{-1}$)	Bio addition, (B) With	Without	Mean	With	Without	Mean	With	Without	Mean
		Macronutrient contents (%) in straw								
		N			P			K		
	0	1.30	1.13	1.22	0.35	0.28	0.32	2.22	2.12	2.17
0	3	1.37	1.26	1.32	0.38	0.33	0.36	2.30	2.22	2.26
	6	1.40	1.33	1.37	0.44	0.38	0.41	2.35	2.26	2.31
Mean		1.36	1.24	1.30	0.39	0.33	0.36	2.29	2.20	2.25
	0	1.36	1.22	1.29	0.37	0.32	0.35	2.24	2.15	2.20
50	3	1.42	1.34	1.38	0.45	0.37	0.41	2.33	2.27	2.30
	6	1.45	1.39	1.42	0.48	0.43	0.46	2.38	2.36	2.37
Mean		1.41	1.32	1.36	0.43	0.37	0.40	2.32	2.26	2.29
	0	1.40	1.27	1.34	0.38	0.35	0.37	2.26	2.18	2.22
75	3	1.48	1.38	1.43	0.46	0.44	0.45	2.39	2.34	2.37
	6	1.55	1.43	1.49	0.51	0.48	0.50	2.48	2.38	2.43
Mean		1.48	1.36	1.42	0.45	0.42	0.44	2.38	2.30	2.34
	0	1.44	1.33	1.39	0.40	0.38	0.39	2.27	2.21	2.24
100	3	1.52	1.45	1.49	0.49	0.47	0.48	2.48	2.44	2.46
	6	1.57	1.52	1.55	0.54	0.54	0.54	2.62	2.56	2.59
Mean		1.51	1.43	1.47	0.48	0.46	0.47	2.46	2.40	2.43
Grand mean of bio		1.44	1.34		0.44	0.40		2.36	2.29	
F-test:		AA: ns	CO: ns		AA: ns	CO: ns		AA: ns	CO: ns	
		B: ns	AAxCO: ns		B: ns	AAxCO: ns		B: ns	AAxCO: ns	
		AAxB: ns	COxB: ns		AAxB: ns	COxB: ns		AAxB: ns	COxB: ns	
		AAxCOxB:ns			AAxCOxB: ns			AAxCOxB: ns		
Means of compost										
Whitout		1.31			0.35			2.21		
3		1.40			0.42			2.35		
6		1.46			0.48			2.42		
Grand mean		1.39			0.42			2.33		

Table (9). Effect of anhydrous ammonia, compost and bio fertilization on N, P and K contents of wheat straw

Anhydrous Ammonia rate, (AA) (kg fed.$^{-1}$)	Compost rate, (CO) (Mg fed.$^{-1}$)	Bio addition, (B) With	Without	Mean	With	Without	Mean	With	Without	Mean
		Macronutrient uptake (kg fed.$^{-1}$) by wheat straw								
		N			P			K		
	0	40.6	33.1	36.9	10.9	8.20	9.55	69.3	62.1	65.7
0	3	50.6	43.5	47.1	14.0	11.4	12.7	84.9	76.6	80.8
	6	54.3	50.1	52.2	17.1	14.3	15.7	91.2	85.2	88.2
Mean		48.5	42.2	45.4 c	14.0	11.3	12.7 c	81.8	74.6	78.2 b
	0	43.2	36.4	39.8	11.8	9.5	10.7	71.2	64.1	67.7
50	3	56.4	52.0	54.2	17.9	14.4	16.2	92.5	88.1	90.3
	6	59.7	56.3	58.0	19.8	17.4	18.6	98.1	95.6	96.9
Mean		53.1	48.2	50.7 bc	16.5	13.8	15.1 bc	87.3	82.6	84.9 b
	0	52.8	50.0	51.4	14.3	13.8	14.1	85.2	85.9	85.6
75	3	68.1	60.3	64.2	21.2	19.2	20.2	109.9	102.3	106.1
	6	75.6	64.2	69.9	24.9	21.6	23.3	121.0	106.9	114.0
Mean		65.5	58.2	61.8 ab	20.1	18.2	19.2 ab	105.4	98.4	101.9 a
	0	61.9	56.5	59.2	17.2	16.2	16.7	97.6	93.9	95.8
100	3	72.2	70.3	71.3	23.3	22.8	23.1	117.8	118.3	118.1
	6	76.9	75.5	76.2	26.5	26.8	26.7	128.4	127.2	127.8
Mean		70.3	67.4	68.9 a	22.3	21.9	22.1 a	114.6	113.1	113.9 a
Grand mean of bio		59.4	54.0		18.2	16.3		97.3	92.2	
F-test:		AA: **	CO: *		AA: **	CO: **		AA: **	CO: **	
		B: ns	AAxCO: ns		B: ns	AAxCO: ns		B: ns	AAxCO: ns	
		AAxB: ns	COxB: ns		AAxB: ns	COxB: ns		AAxB: ns	COxB: ns	
		AAxCOxB: ns			AAxCOxB: ns			AAxCOxB: ns		
Means of compost										
Whitout		46.8 b			12.7 b			78.7 b		
3		59.2 a			18.0 a			98.8 a		
6		64.1 a			21.1 a			106.7 a		
Grand mean		56.7			17.3			94.7		

Macronutrients percent andcontent in Grains

Data in Tables 10 and 11 pointed out that application of anhydrous ammonia, compost and biofertilization treatments were increased the concentration and contents of N, P and K% wheat grains as compared to the untreated treatment.

Nitrogenpercent and content

Results given reflect significant increases in the N content of wheat grains as affected by application of the. The highest increase in nitrogen % 30.2% was recorded in the plants treated AA100 + 6 Mg fed.$^{-1}$ compost + bio. The highest N-content in grains (87.1 kg fed.$^{-1}$) was given by AA100 + 6 Mg fed.$^{-1}$ compost under bio inoculation with an increase of 129%. This may be due to organic manure being a product which contains many elements therefore improving soil fertility as well as increasing availability of nutrients and, consequently increasing plant growth, yield and chemical composition (El-Sharkawy and Abdel-Razzak, 2010). The obtained results support other results obtained by Jhaa *et al.* (2011); Raissi *et al.* (2012); Swetal *et al.* (2012) and Hassan and Ali (2013). The main effects of anhydrous ammonia and compost addition on grain-N content show the following order: AA100≥ AA75 ≥ AA50 ≥ AA0 and 6 Mg fed.$^{-1}$ compost > 3 Mg fed.$^{-1}$ compost > without compost, respectively.

Table (10). Effect of anhydrous ammonia, compost and bio fertilization on N, P and K % in wheat grains.

Anhydrous Ammonia rate, (AA) (kg fed.$^{-1}$)	Compost rate, (CO) (Mg fed.$^{-1}$)	Bio addition, (B)								
		With	Without	Mean	With	Without	Mean	With	Without	Mean
		Macronutrient contents (%) in grains								
		N			P			K		
	0	1.88	1.69	1.79	0.51	0.48	0.50	1.76	1.66	1.71
0	3	1.93	1.77	1.85	0.55	0.52	0.54	1.84	1.74	1.79
	6	1.98	1.83	1.91	0.58	0.55	0.57	1.89	1.85	1.87
Mean		1.93	1.76	1.85	0.55	0.52	0.53	1.83	1.75	1.79
	0	1.93	1.72	1.83	0.53	0.53	0.53	1.78	1.70	1.74
50	3	1.98	1.85	1.92	0.59	0.57	0.58	1.93	1.85	1.89
	6	2.03	1.94	1.99	0.62	0.59	0.61	1.97	1.92	1.95
Mean		1.98	1.84	1.91	0.58	0.56	0.57	1.89	1.82	1.86
	0	1.95	1.75	1.85	0.55	0.56	0.56	1.79	1.73	1.76
75	3	1.99	1.95	1.97	0.60	0.59	0.60	1.95	1.91	1.93
	6	2.10	2.04	2.07	0.65	0.63	0.64	1.98	1.95	1.97
Mean		2.01	1.91	1.96	0.60	0.59	0.60	1.91	1.86	1.89
	0	1.98	1.80	1.89	0.56	0.59	0.58	1.80	1.78	1.79
100	3	2.15	2.05	2.10	0.63	0.63	0.63	1.98	1.95	1.97
	6	2.20	2.10	2.15	0.68	0.66	0.67	2.02	1.99	2.01
Mean		2.11	1.98	2.05	0.62	0.63	0.63	1.93	1.91	1.92
Grand mean of bio		2.01	1.87		0.59	0.58		1.89	1.84	
F-test:		AA: ns		CO: ns	AA: ns		CO: ns	AA: ns		CO: **
		B: ns		AAxCO: ns	B: ns		AAxCO: ns	B: ns		AAxCO: ns
		AAxB: ns		COxB: ns	AAxB: ns		COxB: ns	AAxB: ns		COxB: ns
		AAxCOxB: ns			AAxCOxB: ns			AAxCOxB: ns		
Means of compost										
Whitout			1.84			0.54			1.75 b	
3			1.96			0.59			1.89 a	
6			2.03			0.62			1.95 a	
Grand mean			1.94			0.58			1.86	

Phosphorus percent andcontent

Phosphorus % and content in wheat grains increased insignificantly as a result of anhydrous ammonia application, compost addition and bio inoculation. The highest P content and uptake (0.68 % and 26.9 kg fed.$^{-1}$, respectively**)** in grains was obtained owing to AA100 + 6 Mg fed.$^{-1}$ compost under biofertilization. The positive effect of organic manure reflects the different characteristics of the added chicken manure (chemical composition and nutritional status).

Table (11). Effect of anhydrous ammonia, compost and bio fertilization on N, P and K content wheat grain.

Anhydrous Ammonia rate, (AA) (kg fed.$^{-1}$)	Compost rate, (CO) (Mg fed.$^{-1}$)	Bio addition, (B)								
		With	Without	Mean	With	Without	Mean	With	Without	Mean
		Macronutrient uptake (kg fed.$^{-1}$) by wheat grains								
		N			P			K		
	0	54.3	38.0	46.2	14.7	10.8	12.8	50.9	37.4	44.2
0	3	60.4	48.7	54.6	17.2	14.3	15.8	57.6	47.9	52.8
	6	64.9	54.0	59.5	19.0	16.2	17.6	62.0	54.6	58.3
Mean		59.9	46.9	53.4 b	17.0	13.8	15.4	56.8	46.6	51.7 b
	0	56.9	46.4	51.7	15.6	14.3	15.0	52.5	45.9	49.2
50	3	64.4	55.5	60.0	19.2	17.1	18.2	62.7	55.5	59.1
	6	67.6	61.1	64.4	20.6	18.6	19.6	65.6	60.5	63.1
Mean		63.0	54.3	58.7 b	18.5	16.7	17.6	60.3	54.0	57.1 ab
	0	60.5	52.5	56.5	17.1	16.8	17.0	55.5	51.9	53.7
75	3	70.6	64.4	67.5	21.3	19.5	20.4	69.2	63.0	66.1
	6	79.8	73.4	76.6	24.7	22.7	23.7	75.2	70.2	72.7
Mean		70.3	63.4	66.9 ab	21.0	19.7	20.4	66.6	61.7	64.2 ab
	0	67.3	60.8	64.1	19.0	19.9	19.5	61.2	60.2	60.7
100	3	83.2	76.3	79.8	24.4	23.4	23.9	76.6	72.5	74.6
	6	87.1	80.6	83.9	26.9	25.3	26.1	80.0	76.4	78.2
Mean		79.2	72.6	75.9 a	23.4	22.9	23.2	72.6	69.7	71.2 a
Grand mean of bio		68.1	59.3		20.0	18.2		64.1	58.0	
F-test:		AA: **		CO: *	AA: ns		CO: ns	AA: **		CO: **
		B: ns		AAxCO: ns	B: ns		AAxCO: ns	B: ns		AAxCO: ns
		AAxB: ns		COxB: ns	AAxB: ns		COxB: ns	AAxB: ns		COxB: ns
		AAxCOxB: ns			AAxCOxB: ns			AAxCOxB: ns		
Means of compost										
Whitout			54.6 b			16.0			51.9 b	
3			65.4 ab			19.6			63.1 a	
6			71.1 a			21.8			68.1 a	
Grand mean			63.7			19.1			61.0	

The organic manures would create favorable soil physical and chemical conditions, which favorably affect the solubility and availability of nutrients and thus increase the uptake of nutrient. The released N is essential for plant growth and development involved in vital plant functions such as photosynthesis, DNA synthesis, protein formation and respiration (Diacono et al., 2013). These results coincide with the results of Abbas et al. (2011) and Namvar and Khandan (2013).

Potassium percent and content

As shown in Table 9, K % and content in grains followed a rather similar trend as that of N and increased significantly owing to application of the treatments. The highest K % and content of wheat (2.02 % and 80.0 kg fed.$^{-1}$, respectively) were obtained due to 100 kg N fed.$^{-1}$ as AA and 6 Mg fed.$^{-1}$ compost treatment under biofertilization. Increases were 21.7% and 114%, respectively over the non-treated. This may contribute much to the increase in dry matter accumulation at the different growth periods and consequently increasing uptake of nutrients. Mohammed, (2002) stated that the uptake of N, P and K by all plant tissues grown, on both sandy loam and sandy clay loan soils were increased significantly with increasing N-application up to 120 kg N fed.$^{-1}$.

As for the main effect of N application, the pattern is AA100 > AA75 ≥ AA50 > AA0. The main effect of compost shows: 6 Mg fed.$^{-1}$ compost > 3 Mg fed.$^{-1}$ compost > without compost. El- Mesalhy and Zahran, (2003) pointed out that potassium percentage in barley was significantly increased by increasing N rate up to 90 kg N fed.$^{-1}$.

CONCLUSION

Based on the foregoing results, it can be concluded that the highest values of wheat yield, yield components as well as N, P and K content and uptake were obtained with the plants supplied with anhydrous ammonia, 100kg N fed.$^{-1}$ + 6 Mg fed.$^{-1}$ compost + biofertilization which were superior to the other treatments.

Biofertilizers application in agriculture will have greater impact on organic agriculture and also on the control of environmental pollution, soil health improvement and reduction in input use. So, we recommend using a mixture of selected effective microorganisms active in nitrogen fixation, hormonal production and enzyme production in combination with compost in a cumulative manner in agriculture production.

Finally, under the current experimental conditions, it could be concluded that this work hand granted evidence to the effective role of applied compost manure at the rate of 6 Mg fed.$^{-1}$ in combination with anhydrous ammonia under bio inoculation with *Azotobacter chroccocum* at the rate of 100 kg N fed.$^{-1}$ to achieve the greatest growth parameters, yield and quality of wheat plants.

REFERENCES

Abbas, M.H.H., Ahmed, O.A.I., Manal, A.H. El-Gamal and Haythum, M.S.(2011). Integrated effect of mineral nitrogen, bio and organic fertilization on soybean productivity. Egypt. J. Biotechnol. 39: 43 – 63.

Abdel Aziz, I.M., Mazen, O.A.O., Awadalla, H.A. and Nadia, M. Hemeid, (2010). Wheat production as affected by anhydrous ammonia, organic compost and biofertilizer application. Egypt. J. Appl. Sci., 25(8B): 598 – 613.

Abdel-Fattah, M.K. and Merwad, M.A. (2015). Effect of different sources of nitrogen fertilizes combined with vermiculite on productivity of wheat and availability of nitrogen in sandy soil in Egypt. American Journal of Plant Nutrition and Fertilization Technology . 5 :50- 60.

Abdel Lattif, M.K. (2007). Improving the efficiency of potassium fertilization in some Egyptian soils. Ph.D. Thesis, Fac. Agric., Al-Azhar Univ., Cairo, Egypt.

Abedi, T., Alemzadeh, A. and Kazemeini, S.A.(2010). Effect of organic and inorganic fertilizers on grain yield and protein banding pattern of wheat. Australian J. Crop Sci., 4(6): 384–389.

Ashmaye, S.H., Shaban, Kh.A. and Abd El-Kader, M.G. (2008). Effects of mineral nitrogen, sulphur, organic and bio-fertilizer on maize productivity in saline soil of Sahl El-Tina. Minufiya, J. Agric. Res., 33(1): 195 – 209.

Ashoub, M.A., Esmail, A.M., Abdel Aziz, I.M.A. and Mazen, O.A.O. (2005). Effect of anhydrous ammonia application in rice field as a mean for minimizing pollution from nitrogen fertilization. J. of Environmental Sci., 11(4): 123 – 139.

Attia, A. Manal, Amal, H. El-Guibali; Kh.A. Shaban and Abdel Mhosen, M.I. (2014). Influence of applied biofertilizer on productivity, quality and nutrients content of some soybean cultivars under saline conditions. J. Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 5 (12): 1647 – 1666.

Awad, A.M., Moursy, M.E., Mazen, O.A.O. and Darwish, D.S.(2011). Effect of different N-fertilizer sources and rates on wheat grain yield under calcareous soils conditions at Nubaria area. C.F., *Anhydrous Ammonia Use in Agriculture*. (Ibrahim, M.A. and Osman, A.O., 2011) 2011/11313

Bassiouny, H.M and Shaban, Kh.A. (2010). Economic analysis for the efficiency use of mineral and bio-fertilizers on saline soil. Zagazig, J. Agric. Res. 37 (5): 1313- 1330.

Bhandari, A.L., Ladha, J.K., Pathak, H., Padre, A.T., Dawe, D. and Gupta, R.K. (2002). Yield and soil nutrient changes in a long-term rice–wheat rotation in India. Soil Sci. Soc. Am. J., 66: 162–170.

Bharathi, V., Sudhakar, R., Parimala, K. and Reddy, V.A. (2013) Evaluation of Bioagents and Biofertilizers for the Management of Seed and Seedling Diseases of Sesamum indicum (Sesame). eSci Journal of Plant Pathology, 2, 179- 186

Brunner, P.H. and Wasmer, H.R. (1978). "Methods of analysis of sewage sludge solid wastes and compost". W.H.O. International Reference Center for Wastes Disposal (H-8600), Dulendr of Switzerland.

Daneshmand, N.G., Bakhshandeh, A. and Rostami, M.R. (2012). Biofertilizer affects yield and yield components of wheat. Inter. J. Agric. 2(6): 699–704.

Diacono, M., Rubino, P. and Montemurro, F. (2013). Precision nitrogen management of wheat; a review. Agronomy for Sustainable Development, 33(1): 219–241

El-Mesalhy, M. A. and Zahran, F.A. (2003). Effect of bio and mineral nitrogen fertilization on barley crop grown on a sandy soil. Egypt. J. of Agric. Res., 81 (3): 921 – 935.

El-Sharkawy, G.A. and Abdel-Razzak, H.S. (2010). Response of cabbage plants (*Brassica oleraceae* var. capitata L.) to fertilization with chicken manure, mineral nitrogen fertilizer and humic acid. Alex. Sci. Exch. J., 31: 416 – 432.

Ewees, M.S.A. and Abdel Hafeez, A.A.A. (2010). Response of Maize grain to a partial substitution of N-mineral by applying organic manure, bio-inoculation and elemental sulphur as an alternative strategy to avoid the possible chemical pollution. Egypt. J. Soil Sci., 50(1): 141 – 166.

FAO, (2011). Review of the wheat sector and grain storage issues. Economist, Investment Centre Division. FAO. Pakistan.

Gharib, F.A.; Mossa, L.A. and Massoud, O. N. (2008). Effect of compost and bio-fertilizers on growth, yield and essential oil of sweet marjoram (Majorana hortensis) plant. Inter. J. of Agric. and Biol. 10 (4): 381-387.

Hassan, F.A.S. and Ali, E.F. (2013). A comparative study between traditional mineral nutrition and other alternative sources on anise plant. Europe. J. Sci. Res., 106(2): 201 – 212.

Ismail, A. O. A. ; Farag, F.A. Hassanein, A.H.A. and Abd-Elrahman, A. H. (2013).Effect of soil amendments and anhydrous ammonia application and their interactions on some soil properties and wheat productivity under salt affected soil conditions. J. Soil and Agric. Eng. Mansoura Univ. 4(10): 1085- 1100.

Ismail, M. M. A. (2004). The dynamic of the N-turnover of plant residues in the soil using nuclear technique. Ph D. Thesis, Faculty of Agric., El-Zagazig Univ. Egypt.

Jagshoran, R.K. Sharma and S.C. Tripathi. (2004). New varieties and production. The Hindu, Survey of Indian Agriculture, 33-35.

Jhaa, P., Ramb, M., Khanb, M.A., Kiranb, U. and Mahmooduzzafara, M.Z.(2011). Impact of organic manure and chemical fertilizers on artemisinin content and yield in *Artemisia annua* L. Industrial Crops and Products, 33: 296 – 301.

Joshi, R.A., Prasanna, R., Shivay, Y.S. and Nain, L. (2012). Biofortification of wheat through inoculation of plant growth promoting rhizobacteria and cyanobacteria. Euro. J. Soil Biology, 50: 118 – 126.

Kandil, A.A., El-Hindi, M.H., Badawi, M.A., El Morarsy S.A. and Kalboush, F.A.H.M. (2011). Response of wheat to rates of nitrogen, biofertilizers and land leveling. Crop & Enviro. 2(1): 46–51.

Kas, M., Haberletes, J. and Matejkov, S. (2010). Crop productivity under increasing nitrogen rates and different organic fertilization system in a long-term IOSDV experiment in the Czech Republic. Arch. Agr. Soil Sci. J., 56: 451 – 461.

Klute, A. (1986) "Methods of Analysis". Part 1, Soil Physical Properties. ASA and SSSA, Madison, WI.

Mohammed, S.S. (2002). Integrated nitrogen management to wheat through mineral and biofertilization along with organic municipal-wastes in some newly reclaimed soils of Egypt 2-Uptake and availability of nutrients. Zagazig j. Agric. Res., 29 (2): 569 – 592.

Namvar, A. and Khandan, T. (2013). Response of wheat to mineral nitrogen fertilizer and biofertilizer (*Azotobacter sp.* and *Azospirillium sp.*) inoculation under different levels of weed interference. Ekologija, 59(2): 85 – 94.

Nasef, M.A., Shaban, Kh.A. and Abdel Hameed, A.F. (2009). Effect of compost and bio-fertilizer application on some chemical soil properties and rice productivity under saline soil condition. J. Agric. Mansoura Univ., 34 (4): 2609- 2623.

Osman, A. S., R.M. El- Shahat and H.M. Seyam. (2000). Response of wheat to fertilization treatments of nitrogen, azolla and micro-nutrients. Fayoum J. Agric. Res. & Dev., 14 (2): 68 – 74.

Osman E.A.M., EL- Masry, A.A. and Khatab, K.A. (2013). Effect of nitrogen fertilizer sources and foliar spray of humic and/or fulvic acids on yield and quality of rice plants. Advances in Applied Sci. Res., 4(4):174-183.

Page, A.L.; Miller, R.H. and Keeney, D.R. (1982). "Methods of Chemical Analysis". Part 2: Chemical and microbiological properties (Second Edition). American Society of Agronomy, Inc. and Sci. Soc. of America, Inc. Publishers, Madison, Wisconsin U.S.A.

Piccinin, G.G., Braccini, A.L., Dan, L.G.M., Scapim C.A., Ricci, T.T. and Bazo, G.L. (2013). Efficiency of seed inoculation with *Azospirillum brasilense* on agronomic characteristics and yield of wheat. Industrial Crops and Products, 43:393–397.

Poraas, M.M.E., Salwa, A.I. Eisa, Shaban, Kh.A. and Sallam, A.M. (2008). Effect of applied organic and bio-fertilizers on the productivity and grains quality of maize grown in saline soil. Egypt J. Soil Sci., 48(4): 485 – 500.

Raissi, A., Galavi, M., Ramroudi, M., Mousavi, S.R. and Rasoulizadeh, M. (2012). Effects of phosphate bio-fertilizer, organic manure and chemical fertilizers on yield, yield components and seed capabilities of isabgol (*Plantago ovate*). Int. J. Agri. Crop. Sci., 4(24): 1821 – 1826.

Rashed, F.M., Kesba, H.H., Saleh, W.D. and Moselhy, M.A. (2011). Impact of rice straw compost on microbial population plant growth nutrient uptake and root-knot nematode under greenhouse conditions. Afr. J. Agric. Res., 6: 1188 – 1203.

Rashed, S.H. (2006). Effect of bio and organic fertilization on maize (*Zea mays*). MSc. Thesis, Fac. Agric., Mansoura Univ., Egypt.

Russel, E. W. 1973. Soil conditions and plant growth.10 th Ed., Longman Group Ltd., London.

Russell, A.E., Laird, D.A. and Mallarino, A. P. (1973). Nitrogen fertilization and cropping system impacts on soil quality in Midwestern Mollisols. Soil Sci. Soc. Am. J. 70: 249 – 255.

Ryan, J., Garabet, S., Harmsen, K. and Rashid, A. (1996). "A soil and plant analysis". Manual Adapted for the West Asia and North Africa Region. ICARDA, Aleppo, Syria, 140.

Salem, F.C., Gebrail, M.Y., Easa, M.O. and Abd El-Warth, M. (2004). Raising the efficiency of nitrogen fertilization for wheat plants under salt affected soils by applying some soil amendments. Minufiya J. Agric. Res. 29 4 : 1059 – 1073.

Sary, G.A., El-Naggar, H.M., Kabesh, M.O., ElKramany, M.F. and Akhoum, G.Sh.H. (2009). Effect of bio-organic fertilization and some weed control treatments on yield and yield components of wheat. World J. Agri. Sci., 5(1): 55–62.

Shaban, Kh.A. and Omar, M.N.A. (2006). Improvement of maize yield and some soil properties by using nitrogen mineral and PGPR group fertilization in newly cultivated saline soils. Egypt. J. Soil Sci., 46(3): 329 – 342.

Snedecor, G. W. and Cochran, W.G. (1982). Statistical Methods 7 th ed. Iowa State University Press, Ames., Iowa, U.S.A.

Sugar, E. and Berzsenyi, Z. (2012). Effect of N fertilization on the dynamics of dry matter production and leaf area of wheat (*Triticium aestavium* L.) varieties in different years. Acta Agronomica Hungarica, 60(4): 385 – 396.

Swetal, R., Singh, P.P. Naruka, I.S. and Rathore, S.S. (2012). Effect of nitrogen and phosphorus on growth, yield and quality of black cumin (*Nigella sativa* L.). Inter. J. Seed Spices, 2(2): 5 – 8.

Vessey, J.K. (2003). Plant growth promoting rhizobacteria as biofertilizers. Plant and Soil. 255:571–586.

Wortman, S.E., Davis, A.S., Schutte, B.J. and Lindquist, J.L. (2011). Integrating management of soil nitrogen and weeds. Weed Sci., 59: 162 170.

Yadvinder, S., Singh, B., Ladha, J.K., Khind, C.S., Gupta, R.K., Meelu, O.P. and Pasuquin, E. (2004). Long-term effects of organic inputs on yield and soil fertility in rice–wheat rotation. Soil Sci. Soc. Am. J., 68: 845 – 853.

Zaka, M.A., Obaid, U.R., Rafa, H.U. and Khan, A.A. (2005). Integrated approach for reclamation of salt affected soils. J. Agric. and Soc. Sci., 1 (2): 94–97.

Zheljazkov, V.D. and Warman, P.R. (2004). Source-Separated Municipal Solid Waste Compost Application to Swiss Chard and Basil. J. Environ. Qual., 33: 542–52

تأثير الأمونيا اللامائية و الكمبوست في وجود البكتريا المثبتة للنيتروجين علي نبات القمح (*Triticum aestavium* L.) النامي في الأراضي الطينية

لمياء عبد الحليم عبد الرحمن
معهد بحوث الأراضي و المياه والبيئة – مركز البحوث الزراعية –الجيزة - مصر

تم دراسة استجابة نباتات القمح (*Triticum aestavium* L.) صنف سخا ٩٣ للتسميد بالأمونيا اللامائية التي أضيفت بمعدلات ٠ ، ٥٠، ٧٥،و ١٠٠ كجم ن فدان-١ في أرض طينية و التسميد العضوي بالكمبوست بمعدلين هما ٣ ميجاجرام (طن) كمبوست فدان-١ ، ٦ ميجاجرام (طن) كمبوست فدان-١ مع التلقيح الحيوي أو عدم التلقيح ببكتريا *Azotobacter chroccocum* علي جودة وأنتاجية القمح ومحتوي وأمتصاص العناصر الكبري وكذلك بعض صفات التربة بعد الحصاد. لذا تم أجراء تجربتين حقليتين بمزرعة التجارب الخاصة بمحطة البحوث الزراعية بالجميزة - محافظة الغربية - جمهورية مصر العربية خلال موسم الشتاء لعامين متتالين هما ٢٠١٤/٢٠١٣ و ٢٠١٥/٢٠١٤ ويمكن تلخيص أهم النتائج المتحصل عليها كما يأتي : (١) أزداد محصول القش و الحبوب و المحصول البيولوجي لنبات القمح معنوياً بإضافة المعاملات المختلفة و كانت أعلى قيم لمحصول الحبوب و المحصول البيولوجي (٣.٩٦ و ٨.٨٦ ميجاجرام / فدان) عل التوالي تم التحصل عليها نتيجة معاملة الإضافة " ١٠٠ كجم ن فدان-١ من الأمونيا اللامائية + ٦ ميجاجرام فدان-١ كمبوست في وجود التسميد الحيوي . وأدت نفس المعاملة لأعطاء أعلي قيمة لوزن ١٠٠٠ حبة.(٢) أزداد امتصاص النيتروجين و الفسفور و البوتاسيوم بواسطة القش لنباتات القمح و كانت أعلى القيم للنيتروجين ، و البوتاسيوم هي (٧٦.٩ و ١٢٨.٤ كجم / فدان) علي التوالي قد تم التحصل عليها نتيجة نفس المعاملة السابقة للمحصول بينما أعلي قيمة للفوسفور الممتص (٢٦.٨ كجم / فدان) قد تحصل عليها نتيجة لمعاملة الإضافة (١٠٠ كجم ن فدان-١ من الأمونيا اللامائية + ٦ ميجاجرام فدان-١ كمبوست).(٣) أزداد امتصاص النيتروجين و الفسفور و البوتاسيوم معنوياً بواسطة الحبوب لنباتات القمح بإضافة المعاملات المختلفة و كانت أعلى القيم للنيتروجين ، الفوسفور و البوتاسيوم هي (٨٧.١ ، ٢٦.٩ و ٨٠.٠ كجم / فدان) علي التوالي قد تم التحصل عليها نتيجة المعاملة ١٠٠ كجم ن فدان-١ من الأمونيا اللامائية + ٦ ميجاجرام فدان-١ كمبوست في وجود التسميد الحيوي.(٤) أعلى قيمة لمحتوي البروتين ومحصول البروتين للحبوب تم التحصل عليها نتيجة لنفس المعاملة السابقة.(٥) أعلى قيم لدليل الحصاد و الكفاءة المحصولية تم التحصل عليها نتيجة المعاملة (٥٠ كجم ن فدان-١ من الأمونيا اللامائية في وجود التسميد الحيوي).(٦) كان هناك إنخفاضاً في درجة الملوحة في منطقة انتشار الجذور كما إنخفض رقم الحموضة بالتربة pH نتيجة للإضافات تحت الدراسة مقارنة بالنباتات الغير معاملة.(٧) أعلى قيم للنيتروجين ، الفسفور و البوتاسيوم الميسرة بالتربة بعد الحصاد تم التحصل عليها نتيجة لمعاملة الإضافة (١٠٠ كجم ن فدان-١ من الأمونيا اللامائية + ٦ ميجاجرام فدان-١ كمبوست في وجود التسميد الحيوي) و التي تعتبر الأكثر تفوقاً علي باقي المعاملات تحت الدراسة.