Minufiya J. Agric. Res. Vol.36 No. 3: 757-774 (2011) "http://www.mujar.net"

EFFECT OF FERTILIZATION WITH BIO- AND MINERAL -N ON YIELD AND YIELD COMPONENT OF RICE GROWN ON A CLAYEY SOIL

Manal F. Tantawy, A. Kh. Amer and Kadria M. El-Azab
Soils, Water and Environment Res. Inst., Agric. Res. Center, Giza, Egypt

(Received: Mar. 21, 2011)

ABSTRACT: *A field experiment was carried out on a clayey soil during two successive growth summer seasons 2009 and 2010 to study the effect of application rates and forms of mineral N (ammonium sulphate and urea) and biofertilizer (Cyanobacterine) on the growth of rice plant (Oryza sativa), yield and yield component. Nitrogen fertilizers were added at rates of 40,60,80, and 100% of recommended dose (RD) .Application rate of biofertilizer was 1 kg/fed. The experiment was carried out in split split plot design with six replicates. The results showed that plant height, number of spikes / plant, spike length and the yields of straw and grains were increased significantly with the increase of added N. More increases of these parameters were associated with the treatment of biofertilization. Also, the values of the previous parameters were higher when ammonium sulphate was added than those when urea was added. Nitrogen and K concentration (%) and uptake (kg/fed) by straw and grains were increased with the increase of added N individually or in combination with biofertilizer. On the other hand , increasing of added N resulted in a decrease of P concentration (%) in the straw and grains, but P uptake (kg/fed) was increased especially with the combined treatments of mineral N and biofertilization. Straw concentration (%) of N, P and K were decreased with the increase of plant age. The soil contents (mg/kg) of available N, P and K varied widely from fertilization treatment to another.*

Key words: *Rice plants, Nitrogen fertilizer, Biofertilizer, Vegetative growth parameters and Chemical composition.*

INTRODUCTION

Rice is one of the most important crops in Egypt and its production plays a significant role in the strategy to over come food shortage. It is grow on about one million feddans (about 0.42 million ha). Because the limited of irrigation water for cultivation in Egypt, further increase in the rice production per unit area is needed. This can be achieved through varietals improvement, optimization of agricultural practices as well as the control of weeds, diseases and insects.

Rice plant is adopted to grow in flooded soils (lowland), but it also grows well in non-flooded (upland soils). The major portions of rice crop in Egypt grow under lowland conditions that are under flooded or submerged conditions. Flooding has an important impact on soil physical, chemical, and biological properties as well as transformation of nutrients and their availability to rice. Flooding paddy soils causes a number of electrochemical changes in the soil that in general, benefit the rice plant. Many nutrients become more easily available to the crop and most nutrients toxicities and deficiencies are associated with submergence (Ponnamperuma, 1972).

Nitrogen is an element required for plant growth. It is a fertilizer in a balance and rational way to keep high and stable yield in important component of proteins, enzymes and vitamins in plant. It is a central part of the chlorophyll and essential photosynthetic molecule. The excessive application of mineral fertilizers led to increase production cost. The residual of mineral fertilizers has seriously affected the quality of agricultural products people's health and caused environmental pollution. Therefore a great interest has been generated to apply bioorganic and inorganic fertilizers to establish a good ecoenvironment (Basak, 2006).

The biofertilizers (microbial inoculants) in many plants have been established, which effectively supplement the need of nitrogen and reduce the cost of production and environmental pollution via reducing the rates of mineral- N fertilizers used (Ouda, 2000). Several researches reported that the inoculation of some plants with biofertilizers (singly, combinations with mineral fertilizers) improved plant growth, yield and chemical composition (Abd El-Fattah and Sorial, 2000 and Abdel-Mouty *et al.*, 2002). The combination of biofertilizers with suitable rate of mineral N fertilizers could help to increase the efficiency of these fertilizers and to reduce the extensive use of mineral-N fertilization (Gadallah *et al.*, 2004).

The aim of this investigation is to study, the effect of mineral N sources and rates applied individually or combined with biofertilizer on yield and yield component of rice plant grown on a clayey soil. Available nutrients in the soil after harvesting was also considered.

MATERIALS AND METHODS

A field experiment was conducted at Mashala Village, El- Santa City, El-Gharbiya Governorate, Egypt during two successive summer seasons ,2009 and 2010 to study the effect of fertilization with biofertilizer (cyanobacterine) and mineral nitrogen on growth, yield and yield component of rice plant (*Oryza sativa*), Giza 101 cv. grown on a clayey soil under flooded paddy conditions. The design of the experiment was spilt-spilt plot with six replicates. All agricultural practices begning from preparation of nursery bed to harvesting were carried out as recommended by Ministry of Agriculture. Rice (Giza 101) grains were sown in the nursery bed at latter week of April 2009 and 2010. After 35 days from sowing, the plants were transplanting to the experimental field which planted per hill (25 hills per m^2). Before transplanting, surface soil sample (0-20 cm) was taken, air-dried, ground, good mixed, sieved through a 2 mm sieve, kept and analyzed for some physical and chemical properties according to the methods described by Jackson (1973), Cottenie *et al.* (1982) and Page *et al.* (1982). The obtained data were recorded in Table (1).

Table (1): Some physical and chemical properties of the studied soil.

Particles size distribution (%)			Textural grade	pH (1:2.5) Soil: water suspension	EC (dS/m)	O.M (%)	CaCO3 (%)	Available nutrients (ug/g)				
Sand	Silt	Clay						N	P	K	Fe	Zn
20.10	25.80	54.10	clayey	8.12	1.85	3.40	4.60	45	7.21	413	2.50	0.45

The experimental plots were 96 unit including 2 treatments of biofertilizer × 2 mineral nitrogen forms × 4 rates of each form × 6 replicates. The area of each plot was 21 m^2 (6 m length x3.5 m width). Before transplanting, all plots were fertilized by ordinary superphosphate (15.5% P_2O_5) at rate of 100 kg/fed. Also, before transplanting the experimental plots were divided into two main groups (48 plots/main group), which treated with nitrogen forms ,i.e., urea (46% N) and ammonium sulphate (21.5% N).The sub main plots were biofertilizer treatments,i.e., without addition and added cyanobacterine at rate of 1 kg/fed after twenty days from transplanting. The used biofertilizer was mixed with fine sand before application. The sub sub plots were treated with urea or ammonium sulphate at rates of 40,60,80 and 100 % of recommended dose (RD) of nitrogen (RD = 175 unit N/ fed) . The rate of N was added in two doses , the first dose was 40 % from RD which applied during land preparation and the residual (second dose) was applied after 35 days of transplanting . All plots were fertilized with potassium sulphate (48% K_2O) at rate of 100 kg/fed, after 20 days from transplanting.

During growth period the moisture content must be still at flooding conditions. Plant samples were taken from each plot at three growth periods. i. e. tillering, poding (45 and 80 days from transplanting, respectively) and at harvesting stage. The plant samples which taken at tillering and poding stages (first and second samples) were shoots (straw) only, while the third sample taken at harvesting stage were straw and grains (the hole plant). In the third sample, the grains were separated from straw. All plant samples were air-dried separately, oven-dried at 70°C, weighted, ground and digested for chemical determinations according to Chapman and Pratt (1961). Nitrogen, P and K content in the digests were determined according to the methods described by Cottenie *et al.* (1982) and Page *et al.* (1982). After harvesting, surface soil samples (0-20 cm) were taken separately from each experimental plot, and prepared for chemical analysis as prementioned. Two forms of available N (NH^+_4 and NO^-_3) were extracted using K_2SO_4 1% according to the method described by Jackson (1973). Also, available P and K were determined by extracting the soil with ammonium bicarbonate- DTPA according to Soltan pour (1985). The obtained data were exposed to proper statistical analysis of variance (ANOVA) by using Minitab computer program and least significant difference (L.S.D) were calculated at level of 5% (Barbara and Brain, 1994).

RESULTS AND DISCUSSION

Vegetative Growth Parameters:

The data presented in Tables (2 and 4) show the effect of applied N-mineral forms and rates individually or combined with biofertilizer on some vegetative growth parameters of rice plant and its statistical analysis. All measured parameters were slightly increased with increasing N-rates either without or with biofertilizer. These increases may be due to the enhanced effect of N on plant growth and many of biological activities within plant tissues (Mengel and Kirkby, 1987 and El-Mleegy, 2007). However, the treatment of biofertilizer resulted in a more increase of plant height, spike length and number of spikes /plant .This data reflect the importance of biofertilizers to rice plant growth , where it augmented the dry weights of rice straw and grain yields . All observations emphasize the beneficial effect of biofertilizers on plant growth by enhancing the availability of nutrients in soil as a result of increasing microbial activities in soil. Whereas , the inoculation by biofertilizers promoted the values of available N , P and other nutrients in soil . This increment may be ascribed to the ability of organisms to fix N in rhizosphere , which is reflected on increasing the availability of N .On the other hand it has an effective role in solubilizing the insoluble phosphates and makes it available to plant. Nitrogenase activity in rhizosphere of rice plants with applied biofertilizers was greater. These materials encourage microbial activity in soil, increasing mineralization, nutrient availability and productivity. Karlidag *et al.* (2007) suggested that plant growth promoting rhizobacteria stimulate plant growth by facilitating the uptake of mineral and micronutrients by the plant for a better growth and productivity. Recently Abou-Hussien *et al.* (2010); El-Baalawy (2010) and Tantawy *et al.* (2010) obtained similar results with artemisia, wheat and peanut plants, respectively.

Table (2): Mean values (2009 and 2010) of some vegetative growth parameters of rice plant as affected by the studied treatments.

Nitrogen treatments		Without biofertilizer			With biofertilizer		
Source	Rate% of RD*	Plant height (cm)	Spike length (cm)	No. of spikes/plant	Plant height (cm)	Spike length (cm)	No. of spikes/plant
Urea (U)	40	73.5	18.8	8.2	69.0	17.0	7.2
	60	75.5	19.1	8.6	74.6	18.7	8.2
	80	76.8	19.2	8.7	75.9	19.0	9.7
	100	77.3	20.1	9.6	80.0	20.0	9.9
	Mean	75.8	19.3	8.8	74.9	18.7	8.8
Ammonium sulphate (A.S)	40	71.6	18.9	8.3	76.1	18.2	7.7
	60	72.5	19.0	8.7	78.7	20.1	9.2
	80	79.0	19.6	9.2	80.8	21.2	9.6
	100	80.1	21.0	10.4	86.1	21.9	10.4
	Mean	75.8	19.6	9.2	80.4	20.4	9.2

*RD = Recommended dose

Table (3): Mean values (2009 and 2010) of rice yield (straw and grains) as affected by the studied treatments.

Nitrogen treatments		Without biofertilizer				With biofertilizer			
Source	Rate % of RD*	Grains (kg/fed.)	Straw (kg/fed.)	Whole plant (kg/fed.)	Harvest index (%)	Grains (kg/fed.)	Straw (kg/fed.)	Whole plant (kg/fed.)	Harvest index (%)
Urea (U)	40	3270.7	5375.9	8646.6	37.83	3177.8	5512.5	8690.3	36.57
	60	3400.7	5437.2	8837.9	38.48	3575.5	6893.2	10468.7	34.15
	80	3509.3	5861.1	9370.4	37.45	3685.5	6983.2	10668.7	34.54
	100	4040.4	6228.6	10269.0	64.87	3735.9	7131.6	10867.5	34.38
	Mean	3555.3	5725.7	9281.0	62.09	3543.7	6630.2	10173.9	34.83
Ammonium sulphate (A.S)	40	3328.5	5065.2	8393.7	39.65	3565.8	5588.5	9154.3	38.95
	60	3333.5	5717.3	9050.8	36.83	3622.5	6253.0	9875.5	36.68
	80	3655.4	5775.0	9430.4	38.76	3723.4	7410.7	11134.1	33.44
	100	4203.7	6818.7	11022.4	38.14	3922.8	7444.9	11367.7	34.51
	Mean	3630.3	5844.1	9474.4	38.32	3708.6	6674.3	10382.9	35.72

*RD = Recommended dose

Table (4): Statistical analysis of the studied parameters and yield of rice as affected by different treatments under study.

The studied treatments		Plant height (cm)	Spike length (cm)	No.of spikes/ plant	Grains (kg/fed.)	Straw (kg/fed.)	Whole plant (kg/fed.)	Harvest index (%)
Biofertilizer (A)	0	75.79	19.46	8.96	3592.78	5784.88	9377.65	35.43
	+	77.65	19.51	8.99	3637.53	6652.20	10278.35	41.50
Nitrogen sources (B)	U	75.33	18.99	8.76	3549.48	6177.91	9727.39	37.12
	A.S	78.11	19.99	9.19	3680.83	6259.16	9928.61	39.81
Rate of added N(% of RD) (C)	40	72.55	18.23	7.85	3358.45	5385.53	8721.23	36.05
	60	75.33	19.23	8.68	3483.05	6075.18	9558.23	36.54
	80	78.13	19.75	9.30	3643.40	6507.50	10150.90	38.25
	100	80.88	20.75	10.08	3975.70	6905.95	10881.65	43.03
L.S.D.at 0.05 level	A	1.55	0.31	0.31	0.31	2.79	5.90	1.49
	B	1.92	1.20	0.34	0.22	2.10	2.32	0.97
	C	0.59	NS	NS	0.15	1.62	1.95	0.59
	AB	NS	NS	NS	0.31	2.97	3.28	1.37
	AC	0.84	NS	NS	0.22	2.30	2.76	0.83
	BC	1.19	NS	0.53	0.31	3.25	3.91	1.18
	ABC	1.68	NS	NS	0.43	4.60	5.52	1.67

* O =without ,+ = with , U=urea , A.S=ammonium sulphate
* RD = recommended dose, NS = non significant

Regarding the effect of mineral N sources on growth parameters as presented in Tables (2 and 4), it may be noticed that, ammonium sulphate was associated with an increase of these parameters compared with those of urea. This is mainly attributed due to the presence of sulphate (S) which played an important role in the plant growth (Basak, 2006). So, the high obtained values of the studied growth parameters were associated with ammonium sulphate at high application rate combined with biofertilizer.

Yield and Yield Component :

The data presented in Tables (3 and 4) show that, increasing rates of added mineral N fertilizers resulted in a significant increase of dry weight of both straw and grains, where the obtained increases associated the treatments of ammonium sulphate were higher than those resulted in the treatments of urea. This trend was similar with that prementioned with vegetative growth. This data also show that, biofertilizer application resulted in a significant increases of straw and grains dry weight. These increases were more clear and had superior effect in the treatments of ammonium sulphate with biofertilizer. The beneficial effect of either mineral N fertilizers or biofertilizer was reported by many investigators such as (Abou Hussein and Salwa Hammad, 2009; El-Mleegy, 2007 and Sadek, 2010).

Under different fertilization treatments in this study, the yield of grains were lower than those of straw. So, the calculated values of harvesting index (HI%) were lower than 40%. The highest values of HI were recorded with the combined treatments of ammonium sulphate and biofertilizer especially at the high application rate of ammonium sulphate. This trend was found in the growth seasons. Biswas *et al.* (2000) and Salhyabama *et al.* (2004) reported such beneficial effect of rice plant growth.

Straw Content of Nutrients:

The data presented in Tables (5 and 6) show N, P, and K concentrations (%) of rice straw at tillering and poding stages as effected by individual or combined treatments of N and biofertilizer. These data reveals that, at two growth periods, N content slightly increased with increasing N rates ,but these increases was not significant. However, the increase of N content resulted from the treatments of ammonium sulphate was higher than that associated the same application rate of urea. Also, with the different treatments of N, N content at poding stage was lower than that at tillering stage. This trend was attributed to dilution effect as reflected on harvest index (HI %) which were lower than 40 % and also to the translocation of nutrients from stems and leaves for formation of grains. In this connection , Belder *et al.* (2005) and El-Baalawy (2010) obtained similar results. Recently, Khattab (2010) reported that, the content (%) of macro-and micro- nutrients in rice straw were decreased with the increase of the plant age.

Also, data in Tables (5 and 6) noticed that, biofertilizer application individually or in combination with mineral N fertilizers resulted in an increase of straw content (%) of N. This increase was more clear in combined treatments especially at high application rates of ammonium sulphate. Also, this content of N at tillering stage was lower than that at poding stage. Tantawy *et al.* (2010) and Shaban *et al.* (2010) obtained similar effect of biofertilizer on N concentration in peanut and rice plants, respectively.

Table (5): Mean values (2009 and 2010) N, P and K concentration (%) in straw of rice plant (at tillering and poding stages) as affected by the studied treatments.

Nitrogen treatments		Without biofertilizer						With biofertilizer					
		Tillering stage			Poding stage			Tillering stage			Poding stage		
Source	Rate % of RD*	N	P	K	N	P	K	N	P	K	N	P	K
Urea (U)	40	1.45	0.25	3.33	1.45	0.23	3.10	1.48	0.29	3.58	1.46	0.27	3.45
	60	1.50	0.22	3.47	1.48	0.22	3.25	1.50	0.25	3.60	1.50	0.24	3.60
	80	1.57	0.22	3.53	1.53	0.20	3.62	1.60	0.23	3.65	1.57	0.22	3.75
	100	1.58	0.20	3.97	1.55	0.19	3.75	1.63	0.22	3.95	1.59	0.18	3.80
	Mean	1.53	0.22	3.58	1.50	0.21	3.43	1.55	0.25	3.70	1.53	0.23	3.65
Ammonium sulphate (A.S)	40	1.47	0.33	3.26	1.50	0.31	3.23	1.50	0.40	3.53	1.48	0.36	3.45
	60	1.54	0.25	3.37	1.53	0.25	3.32	1.57	0.35	3.63	1.54	0.30	3.65
	80	1.60	0.22	3.52	1.55	0.20	3.40	1.63	0.29	3.73	1.59	0.25	3.68
	100	1.63	0.20	3.70	1.60	0.18	3.63	1.67	0.24	3.78	1.63	0.24	3.74
	Mean	1.56	0.25	3.46	1.55	0.24	3.40	1.59	0.32	3.67	1.56	0.29	3.63

*RD = Recommended dose

Table (6): Statistical analysis of nutrients content in straw of rice plants as affected by different treatments under study.

The studied treatments		Tillering stage N	Tillering stage P	Tillering stage K	Poding stage N	Poding stage P	Poding stage K
Biofertilizer (A)	0	1.543	0.236	3.519	1.524	0.223	3.413
	+	1.573	0.284	3.681	1.545	0.258	3.640
Nitrogen sources (B)	U	1.539	0.235	3.565	1.516	0.219	3.513
	A.S	1.576	0.285	3.635	1.553	0.261	3.540
Rate of added N(% of RD) (C)	40	1.475	0.215	3.425	1.473	0.198	3.308
	60	1.528	0.240	3.518	1.513	0.218	3.455
	80	1.600	0.268	3.608	1.560	0.253	3.613
	100	1.628	0.318	3.850	1.593	0.293	3.730
L.S.D.at 0.05 level		NS	NS	NS	NS	NS	NS
	A	NS	0.04	0.26	NS	0.04	0.22
	B	NS	0.04	NS	NS	0.02	0.12
	C	NS	NS	NS	NS	NS	NS
	AB	NS	NS	NS	NS	NS	NS
	AC	NS	NS	NS	NS	NS	NS
	BC	NS	NS	NS	NS	NS	NS
	ABC						

* O =without ,+ = with , U=urea , A.S=ammonium sulphate

* RD = recommended dose, NS = non significant

Data in Tables (5 and 6) show that, under different treatments of N fertilizers, P concentration (%) was decreased significantly with the increase of added N. This decrease was more clear with the treatments of ammonium sulphate which may be resulted from the antagonism relation between P and SO_4^{-} for uptake by plants (Marschner, 1998). Also, this decrease of P concentration (%) was increased with the increase of plant age. In this respect but with other plants, El-Baalawy (2010) and Sarhan *et al.* (2004) obtained similar results. On the other hand, the treatment of biofertilizer resulted in a clear and significant increase of P concentration (%) in rice straw comparing without addition .However, this increase was higher at tillering stage than that found at poding stage. This trend show the enhanced effect of biofertilizer on nutrients uptake by plants via increasing the roots growth and proliferation (Basak, 2006 and Marschner, 1998) , they found similar effects of biofertilizer with wheat and rice, respectively.

The data of K concentration (%) presented in Table (5 and 6) show that, individual and compound treatments of mineral N and biofertilizer resulted in an increase of K concentration. At the same treatment of mineral N combined with or without biofertilizer, K concentration at tillering stage was higher than that at poding stage. Also, K concentrations (%) associated the treatments of urea were little higher than those associated the treatments of ammonium sulphate. These findings were in agreement with the findings of El-Baalawy (2010); El-Mleegy (2007), Tantawy *et al.* (2010) and Shaban *et al.* (2010).

Data in Table (7 and 8) show N, P and K concentration (%) and uptake (kg/fed) by straw of rice plant as affected by individual or combined application of both mineral N and biofertilizer at harvesting stage. Nitrogen content was increased with the increase of added N up to 80 % RD , the obtained increases associated the treatments of ammonium sulphate were higher than those with the treatments of urea. Also , N content was increased upon treating the soil with combined application. The obtained increases of N content with different treatments under study were significant. So, the high content of N was found in the combined treatment of high application rate of ammonium sulphate with biofertilizer. Comparing the data in Tables (5) and (7) may be observed that, the lowest N content of rice plant straw was found in the sample taken at harvesting stage which attributed to dilution effect resulted from the increase of plant dry matter yield which increased with the increase of plant age. In this respect and with other plants, Abou Hussien and Salwa Hammad (2009), Sadek (2010) and Tantawy *et al* . (2010) obtained on similar results.

Table (7): Mean values (2009 and 2010)of nitrogen, phosphorus and potassium concentration (%) and uptake (kg/fed) by straw of rice plant at harvesting stage as affected by the studied treatments.

Nitrogen treatments		Without biofertilizer						With biofertilizer					
		N		P		K		N		P		K	
Source	Rate % of RD*	Conc. (%)	Uptake (kg/fed.)	Conc. (%)	Uptake (kg/fed.)	Conc. (%)	Uptake (kg/fed.)	Conc. (%)	Uptake (kg/fed.)	Conc. (%)	Uptake (kg/fed.)	Conc. (%)	Uptake (kg/fed.)
Urea (U)	40	0.47	25.27	0.37	19.89	1.38	74.19	0.58	31.97	0.40	22.05	2.15	118.52
	60	0.52	28.27	0.35	19.03	1.57	85.36	0.62	42.74	0.38	26.19	2.27	156.48
	80	0.65	38.10	0.25	14.65	1.92	112.53	0.70	48.88	0.30	20.95	2.90	202.51
	100	0.60	37.37	0.20	12.46	2.03	126.44	0.65	46.36	0.20	14.26	3.73	266.01
	Mean	0.56	32.25	0.29	16.51	1.73	99.63	0.64	42.49	0.32	20.86	2.76	185.88
Ammonium sulphate (A.S)	40	0.52	26.34	0.25	12.66	1.63	82.56	0.55	30.74	0.40	22.35	2.33	130.21
	60	0.55	31.45	0.22	12.58	1.72	98.34	0.58	36.27	0.33	20.63	2.73	170.71
	80	0.65	37.54	0.20	11.55	1.73	99.91	0.70	51.87	0.30	22.23	3.38	250.48
	100	0.62	42.28	0.15	10.23	1.92	130.92	0.67	49.88	0.18	13.40	3.47	258.34
	Mean	0.59	34.40	0.21	11.76	1.75	102.93	0.63	42.19	0.30	19.65	2.98	202.44

*RD = Recommended dose

Table (8): Statistical analysis of nutrients concentration and uptake the studied parameters by straw of rice plants at harvesting stage as affected by different treatments under study.

The studied treatments		Nitrogen concent. (%)	Nitrogen uptake (kg/fed)	Phosphorus concent. (%)	Phosphorus uptake (kg/fed)	Potassium concent. (%)	Potassium uptake (kg/fed)
Biofertilizer (A)	0	0.573	33.328	0.249	14.131	1.738	101.281
	+	0.631	42.339	0.311	20.258	2.870	194.158
Nitrogen sources (B)	U	0.599	37.370	0.254	15.704	2.244	142.755
	A.S	0.605	38.296	0.306	18.685	2.364	152.684
Rate of added N(% of RD) (C)	40	0.530	28.580	0.183	12.588	1.873	101.360
	60	0.568	34.683	0.263	17.345	2.073	127.723
	80	0.635	43.973	0.320	19.238	2.483	166.358
	100	0.675	44.098	0.355	19.608	2.788	195.428
L.S.D.at 0.05 level	A	NS	NS	NS	2.54	0.04	1.77
	B	0.06	2.05	0.04	2.08	0.07	5.94
	C	0.03	2.42	0.02	1.58	0.05	4.57
	AB	NS	2.90	NS	NS	0.11	8.41
	AC	NS	NS	0.03	2.24	0.07	6.47
	BC	NS	NS	NS	NS	0.10	9.16
	ABC	NS	NS	NS	NS	0.14	12.95

* O = without ,+ = with , U=urea , A.S = ammonium sulphate

* RD = recommended dose, NS = non significant

Concerning the data of P concentration (%) and uptake (kg/fed) as listed in Table (7), it was noticed that, at harvesting stage and with urea and ammonium sulphate, increasing of added N resulted in a decrease of P concentration (%) and uptake (kg/fed) by straw of rice plant. The obtained decrease of P concentration with the treatments of urea was little lower than resulted from the treatments of ammonium sulphate. On the other hand, addition of N with biofertilizer was followed by the increase of both P concentration and uptake comparing without biofertilizer.

Potassium concentration (%) and uptake (kg/fed) by straw of rice plant at harvesting stage were significantly increased with the increase of added N alone or in combination with biofertilizer, where the high content of K was found with the high application rate of ammonium sulphate and biofertilizer. Also, K concentration (%) at harvesting stage was lower than that at early growth stage (Tables 7 and 8). These results show enhanced effect of both mineral N and bio fertilizer on rice plant growth and K uptake. These results are in agreement with those obtained by Salhyabama *et al.* (2004) and Sarhan *et al.* (2004).

Grains Content of Nutrients :

The data presented in Tables (9 and 10) show that, N concentration (%) and uptake (kg/fed) by grains of rice plant were greater affected by the studied treatments where these contents were increased with the increase of added N as individual or in combination with biofertilizer. The highest N contents were found in the combined treatments especially with high application rate of ammonium sulphate. These increases of N concentration (%) were significant with the individual treatments of mineral N, but it's were non significant in the combined treatments. On the other hand , the increases of N uptake by grains were significant with both mineral N and bio fertilize treatments. The data in Table (9) also show that, grains content (%) of protein takes the same trend with that obtained in N concentration (%), where it's obtained by multiple the content of N (%) by 5.75 (A. O. A. C., 1985). Generally, the treatments of ammonium sulphate resulted in higher increases of N and protein content (%) than those of urea treatments. These results are in agreement with the findings of Sadek (2010), Shaban *et al.* (2010) and Tantawy *et al.* (2010) with different plants.

Phosphorus concentration (%) and uptake (kg/fed) by grains of rice plant were affected by the studied treatments, where P concentration (%) was decreased with the increase of added N especially with the treatments of ammonium sulphate (Tables, 9 and 10). On the other hand, biofertilization treatment resulted in an increase of P concentration (%). With different fertilization treatments, clear increases of P uptake were found especially with the combined treatments of mineral N and biofertilization. El-Baalawy (2010), Salhyabama *et al.* (2004) and Sarhan *et al.* (2004) obtained similar results. Generally, K concentration (%) and uptake were increased significantly with the individual and combined treatments of both mineral N and biofertilizers (Tables, 9 and 10). The highest grains content of K were associated with the combined treatments of mineral N and biofertilization especially at the high application rate of ammonium sulphate. Abou Hussien and Salwa Hammad (2009) and Sadek (2010) obtained similar results.

Table (9): Mean values (2009 and 2010) of nitrogen , phosphorus , potassium and protein content of grains as affected by the studied treatments .

Nitrogen treatments		Without biofertilizer							With biofertilizer							
Source	Rate % of RD*	N		P		K		Protein	N		P		K		Protein
		Conc. (%)	Uptake (kg/fed.)	Conc. (%)	Uptake (kg/fed.)	Conc. (%)	Uptake (kg/fed.)	(%)	Conc. (%)	Uptake (kg/fed.)	Conc. (%)	Uptake (kg/fed.)	Conc. (%)	Uptake (kg/fed.)	(%)
Urea (U)	40	1.05	34.34	0.61	19.95	0.58	18.97	6.04	1.11	35.27	0.65	20.66	0.65	20.66	6.38
	60	1.12	38.09	0.55	18.70	0.60	20.40	6.44	1.15	41.12	0.60	21.45	0.71	25.39	6.61
	80	1.15	40.36	0.50	17.55	0.64	22.46	6.61	1.25	46.07	0.58	21.38	0.77	28.38	7.19
	100	1.16	46.87	0.47	18.99	0.65	26.26	6.67	1.27	47.45	0.54	20.17	0.80	29.89	7.30
	Mean	1.12	39.92	0.53	18.80	0.62	22.02	6.44	1.20	42.48	0.59	20.92	0.73	26.08	6.87
Ammonium Sulphate (A.S)	40	1.09	36.28	0.55	18.31	0.63	20.97	6.27	1.13	40.29	0.60	21.39	0.71	25.32	6.50
	60	1.15	38.34	0.51	17.00	0.67	22.33	6.61	1.18	42.75	0.57	20.65	0.75	27.17	6.79
	80	1.19	43.50	0.50	18.28	0.68	24.86	6.84	1.22	45.43	0.53	19.73	0.79	29.41	7.02
	100	1.19	50.02	0.48	20.18	0.71	29.85	6.84	1.24	48.64	0.52	20.40	0.85	33.34	7.13
	Mean	1.16	42.04	0.51	18.44	0.67	24.50	6.64	1.19	44.28	0.56	20.54	0.78	28.81	6.86

*RD = Recommended dose

Table (10): Statistical analysis of nutrients concentration and uptake by grains as affected by different treatments under study.

The studied treatments		Nitrogen		phosphorus		potassium		Protein (%)
		Concent. (%)	Uptake (kg/fed.)	Concent. (%)	Uptake (kg/fed.)	Concent. (%)	Uptake (kg/fed.)	
Biofertilizer (A)	0	1.138	40.975	0.521	18.620	0.645	23.263	6.540
	+	1.194	43.378	0.574	20.729	0.754	27.445	6.865
Nitrogen sources (B)	U	1.158	41.196	0.533	19.493	0.675	24.051	6.655
	A.S	1.174	43.156	0.563	19.856	0.724	26.656	6.750
Rate of added N(% of RD) (C)	40	1.095	36.545	0.503	19.235	0.643	21.480	6.298
	60	1.150	40.075	0.528	19.450	0.683	23.823	6.613
	80	1.203	43.840	0.558	19.935	0.720	26.278	6.915
	100	1.215	48.245	0.603	20.078	0.753	29.835	6.985
L.S.D.at 0.05 level	A	0.02	0.30	NS	0.12	NS	0.69	NS
	B	0.04	0.51	0.04	0.29	0.06	0.38	0.24
	C	0.02	0.24	0.04	0.29	0.03	0.24	0.23
	AB	NS	0.73	NS	0.41	NS	0.55	NS
	AC	NS	NS	NS	NS	NS	NS	NS
	BC	NS	0.48	NS	0.59	NS	0.49	NS
	ABC	NS	0.68	NS	0.83	NS	0.69	NS

* O = without ,+ = with , U=urea , A.S = ammonium sulphate

* RD = recommended dose, NS = non significant

Soil Content of Available Nutrients:

Soil content (mg/kg) of available N, P and K were slightly affected by the studied treatments (Tables, 11 and 12). Soil content of available N was increased with the increase of added N. This increase was more obvious when biofertilizer was added. With all fertilization treatments, the soil content of NH_4^+ was greater higher than that of NO_3^-, where the content of NH_4^+ represent in soil more than 80% of total available N, presumably due to the added N form. Soil content (mg/kg) of available P was decreased with the increase of added N, but increased with the addition of biofertilizer. Also, data in Tables (11 and 12) show clear decrease of soil content (mg/kg) of available K. This decrease was increased with the increase of added N. These findings are in agreement with those obtained by Abou Hussien *et al.* (2010); El-Mleegy (2007), Shaban *et al.* (2010) and Tantawy *et al.* (2010).

Table (11): Mean values (2009 and 2010) of nitrogen, phosphorus and potassium content in soil as affected by the studied treatments at harvest.

Nitrogen treatments		Without biofertilizer							With biofertilizer						
Source	Rate % of RD*	Total Av.N (mg/kg)	Available NO_3^- (mg/kg)	Available NO_3^- % of total Av.N	Available NH_4^+ (mg/kg)	Available NH_4^+ % of total Av.N	P (mg/kg)	K (mg/kg)	Total Av.N (mg/kg)	Available NO_3^- (mg/kg)	Available NO_3^- % of total Av.N	Available NH_4^+ (mg/kg)	Available NH_4^+ % of total Av.N	P (mg/kg)	K (mg/kg)
Urea (U)	40	47.4	11.5	24.3	35.9	75.7	6.78	387.2	48.9	12.7	26.0	36.2	74.0	7.13	390.4
	60	47.7	7.2	15.1	40.5	84.9	6.48	375.1	50.6	9.1	18.0	41.5	82.0	6.75	375.2
	80	52.6	4.8	9.1	47.8	90.9	6.36	370.0	51.5	2.3	4.5	49.2	95.5	6.60	372.4
	100	55.2	6.3	11.4	48.9	88.6	6.30	361.9	53.4	7.2	13.5	46.2	86.5	6.48	365.6
	Mean	50.7	7.5	14.6	43.3	85.4	6.48	373.6	51.1	7.8	15.3	43.3	84.7	6.74	375.9
Ammonium sulphate (A.S)	40	45.5	10.9	24.0	34.6	76.0	6.50	375.3	46.5	11.0	23.7	35.5	76.3	6.75	380.6
	60	46.5	8.3	17.8	38.2	82.2	6.25	370.1	47.9	8.4	17.5	39.5	82.5	6.61	376.2
	80	48.9	7.6	15.5	41.3	84.5	6.20	360.5	51.2	2.7	5.3	48.5	94.7	6.41	365.4
	100	50.2	3.9	7.8	46.3	92.2	6.15	355.0	49.8	3.1	6.2	46.7	93.8	6.30	364.1
	Mean	47.8	7.7	16.1	40.1	83.9	6.28	365.2	48.9	6.3	12.9	42.6	87.1	6.52	371.6

*RD = Recommended dose

Table (12): Statistical analysis of available nutrients in soil as affected by different treatments under study at harvest.

The studied treatments		Total Av.N (mg/kg)	Available NO3⁻ (mg/kg)	Available NO3⁻ %of total Av.N	Available NH4⁺ (mg/kg)	Available NH4⁺ %of total Av.N	P (mg/kg)	K (mg/kg)
Biofertilizer (A)	0	49.250	7.063	14.338	41.688	84.375	2.378	369.388
	+	49.975	7.563	15.625	42.913	85.663	2.625	373.738
Nitrogen sources (B)	U	48.313	6.988	14.725	41.325	84.763	2.396	368.400
	A.S	50.913	7.638	15.238	43.275	85.275	2.606	374.725
Rate of added N(% of RD) (C)	40	47.075	4.350	8.600	35.550	75.500	2.308	361.650
	60	48.175	5.125	9.725	39.925	82.900	2.393	367.075
	80	51.050	8.250	17.100	46.700	90.275	2.523	374.150
	100	52.150	11.525	24.500	47.025	91.400	2.783	383.375
L.S.D.at 0.05 level	A	NS	0.55	NS	NS	NS	NS	NS
	B	2.14	0.68	1.34	2.00	0.76	0.18	4.22
	C	NS	0.34	0.29	NS	0.96	0.15	3.40
	AB	NS	0.96	1.90	NS	1.07	NS	NS
	AC	NS	0.49	0.41	NS	1.37	NS	NS
	BC	NS	0.69	0.58	NS	1.93	NS	NS
	ABC	NS	NS	0.83	NS	NS	NS	NS

* O = without ,+ = with , U=urea , A.S = ammonium sulphate

* RD = recommended dose, NS = non significant

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تأثير التسميد الحيوي و النيتروجين المعدني علي محصول الأرز و مكوناته النامي في أرض طينية

منال فتحي طنطاوي ، أحمد خليل عامر ، قدرية مصطفى العزب
معهد بحوث الأراضي والمياه والبيئة- مركز البحوث الزراعية- الجيزة- مصر

الملخص العربي:

أجريت تجربة حقلية في أرض طينية خلال موسمي نمو صيف متتاليين لعامي ٢٠٠٩-٢٠١٠م، لدراسة تأثير بعض صور الأسمدة النيتروجينية (كبريتات الأمونيوم – اليوريا) ومعدل إضافتها و كذلك السماد الحيوي (سيانو باكترين) على النمو والمحصول والتركيب الكيميائي لنبات الأرز. و كان معدل السماد النيتروجيني المضاف هو ٤٠ و ٦٠ و ٨٠ و ١٠٠ % من الجرعة الموصى بها والتي كانت تساوي ١٧٥ وحدة نيتروجين لكل فدان. ومن ناحية أخرى، كان معدل إضافة السماد الحيوي ١ كجم/فدان. و أجريت التجربة في تصميم قطع منشقة مرتين في ستة مكررات. و أوضحت النتائج ما يلي:

زيادة قيم طول النبات وعدد السنابل لكل نبات وطول السنبلة والوزن الجاف لكل من القش والحبوب زيادة معنوية بزيادة المضاف من النيتروجين، وكانت هذه الزيادة أكثر وضوحاً في معاملات التسميد الحيوي وكانت القيم المتحصل عليها للقياسات السابقة المصاحبة لمعاملات كبريتات الأمونيوم أعلى من تلك الناتجة عن معاملات اليوريا. كما ازداد التركيز (%) وكذلك الممتص (كجم/فدان) من عناصر النيتروجين والبوتاسيوم بالقش والحبوب بزيادة المضاف من النيتروجين وكانت هذه الزيادة معنوية وأيضاً كانت هذه الزيادة أكثر وضوحاً مع إضافة السماد الحيوي. ومن ناحية أخرى، تناقص تركيز (%) الفوسفور في كل من القش والحبوب بزيادة المضاف من السماد النيتروجيني بينما أدى السماد الحيوي إلى زيادة الممتص من الفوسفور بكل من القش والحبوب. تناقص تركيز (%) كل من النيتروجين والفوسفور والبوتاسيوم في القش بزيادة عمر النبات. كما اختلف محتوى الأرض من النيتروجين والفوسفور والبوتاسيوم الميسر اختلافاً واسعاً من معاملة تسميد إلى أخرى.