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EFFECT OF BIO-FERTILIZER AND ORGANIC MANURE ON A NEWLY RECLAIMED SALINE SOIL AND RICE PRODUCTIVITY

Awatef A. Mahmoud, Kh. A. Shaban and Mona G. Abd El-Kader

Soils, Water and Environment Research Institute, Agric. Res. Centre Giza, (Egypt)

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ABSTRACT: ***A field experiment at Sahl El-Hossinia , El-Sharkia Governorate Egypt , was conducted to study the effect of applied bio-fertilizer (Azospirillum brasilense NO 40 (Salt Tolerant PGPR) ; Chicken manure (10m^3 fed^{-1}) and mineral nitrogen (urea 46 % N) at the of rate 25 , 50 and 100 kg N fed^{-1}) on the availability of N, P , K , Fe , Mn and its Zn in soil and concentration in straw and grain of rice plant and rice productivity in newly reclaimed saline soil .The experiment is carried on during two successive summer seasons 2007 and 2008 at private farm at khaled ben El-Waled village. This area was irrigated with El-Salam canal (Nile water mixed drainage water 1:1). The results indicated that all applied fertilization treatments appeared a significant increase in the straw and grain /plant, straw yield (ton /fed) as well as weight of 1000g grain. A significant increase in straw and grain (g) / plant, grain and straw yield ton fed^{-1} as well as the weight of 1000 g grain. The N, P and K concentrations in grains and straw of rice plant tended to increase with increasing rate of nitrogen addition but however an apposite trend was observed with bio-fertilizer. An augmentation increases in the Fe, Mn, Zn, and Cu content of rice plant, with a more pronounced increase with residual effect of long term application. A significant enhancement in the available N, P and K , Fe, Mn, Zn and Cu content in soil, as compared to the other experimental units treated with mineral N alone.***

Key Words: ***Bio-fertilizer – Chicken manure – saline soil – rice productivity.***

INTRODUCTION

In Egypt, there is an urgent need for the horizontal and vertical expansion in agricultural production to meet the demands of increased population. So, the agricultural projects of salt affected soils at South Port Said and El-Hossinia are made to bring additional new areas. To achieve this target, a reclamation technique in this area with reuse the agriculture drainage water is applied for reclamation and irrigation the salt affected soils. Also El-Salam canal project comes beforehand of projects relying on this strategy, by using 2.3 milliard m^3 annually from agricultural drainage water.

On the other hand water resources of the El- salam canal project followed by:-

1- From Nile Damietta branch 2.11 milliard m^3 annually. 2- From lower Serw drain 0.435 milliard m3 annually. 3- From Bahr Hadoose drain 1.905 milliard m3 annually. Total 4.45 milliard m3 annually, (Shaban, 2005).

Rice is one of the most important crops in Egypt and its production plays a significant role in the strategy to overcome food shortage. It is grown on about one million feddans (about 0.42 million ha). Because of the limited land available 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. Organic manures are will established to be involved in fertilization of plants in almost all countries around the world , due to their beneficial effect on the physical , chemical and biological characteristics of the soils , which in turn , influence the growth and increase production of plants (Youssef *et al*, 2001) . El-Rewainy (1994) , found that the inoculation of rice –grass with *Azospirillum brasilense* under different levels of salinity resulted in significant improvement in fresh and dry mass of shoots and roots as well as in nitrogen content compared with un inoculated plants. Rashed, *et al*. (2006) reported that the soil content of available N- increased as the level of mineral N fertilizer increased. He also found that biological N-fertilization increased the soil content of available N and P by the lowest or even without mineral N- fertilization, but declined the soil content of available N and P at the highest levels of mineral N – fertilization. Ali *et al*. (2005) reported that the pH and EC values were slightly decreased with application FYM at the rate of 2 to 3 % to sandy soil after harvesting maize. Kavitha and Subramanian (2007) reported that the soil available nitrogen content was found to be high in the plots where the enriched compost was applied along with inorganic fertilizer with the values of 38.87 mg kg^{-1} and 32.87 mg kg^{-1}, respectively. The soil available P and K were also increased with enriched compost application to about 22.46 kg ha^{-1} and 647 kg ha^{-1} compared with control values of 19.44 kg ha^{-1} and 518 kg ha^{-1}, respectively. El- Maghraby *et al*. (1997) found that the long term application of farmyard manure improved soil pH, EC and humus content, which was reflected on increasing the N, P and K as well as trace elements content either in straw or in grains of wheat. El-Meneasy *et al*. (2005) reported that using NPK with organic fertilizer was more effective on grain and straw and total yield. Mahmoud *et al*. (2004) stated that application of chicken manure with or without azolla caused a higher increase in the percentage of NPK and its uptake and crude protein of rice grain compared with inorganic fertilizer treatment. Zayed *et al*. (2005) mentioned that applied FYM at the level of 5.0 ton /fed produced the highest mean values of plant height , 1000 – grain weight , number of panicles / m^2 , panicle weight , number of filled grains / panicle as well as grain yield and straw yield rice as compared to other FYM treatments.

The current investigation aimed to study the effect of the applied bio-fertilizer (*Azospirillum brasilense NO 40* (Salt Tolerant PGPR) and humic acid alone and in combination with nitrogen mineral fertilizer at different rates on growth and chemical composition of rice plant grown (Giza 178) on a salt affected soil irrigated with irrigation water of El-Salam canal likewise, some soil chemical characteristics. Efficient plant nutrition management should ensure both enhanced and sustainable agricultural production and safeguard the environment. Chemical, organic or microbial fertilizer has its advantages and disadvantages in terms of nutrient supply, soil quality and crop growth. Developing a suitable nutrient management system that integrates use of these three kinds of fertilizers may be a challenge to reach the goal of sustainable agriculture; however much research is still needed.

MATERIALS AND METHODS

Two field experiments were conducted on salt affected clay soil at Khaled Abn El-Waled village of Sahl El-Hossinia at El-Sharkia Governorate, during the summer growing excessive seasons of 2007 and 2008. This work aimed to studying the effect of chicken manure, bio-fertilizer and N-mineral fertilizer on improving saline soil properties and rice productivity. Sahl El-Hossinia plain with area is a bout 48.000 feddans. This area is irrigated from El-Salam canal (Nile water mixed with agriculture drainage water 1: 1). Water analysis for El-Salam canal during two seasons with 4 month period 1) Sample taken in May. (2) Sample taken in June. (3)Sample taken in July. (4) Sample taken in September is shown in Table (2). Experimental treatments were three addition rates of 25 – 50 and 100 kg N/ fed, as urea 46 % N at equal 3 doses, after 21, 45 and 65 days of rice planting. Other plots were planted with inoculated grain with *Azospirillum brasilense NO 40* (Salt Tolerant PGPR). These grains were coated with the gum media carrying the bacteria strain on the same day of sowing. The inoculated grain plots received a liquid bacteria strain three times after 23, 46 and 68 days of planting according to Omar *et al*. (2000). The other plots were treated with chicken manure at the rate of 10 ton fed^{-1} and applied 20 day's before rice planting during soil tillage. The analysis of chicken manure was carried out according to standard methods as described by Brunner and Wasmer (1978) and is shown in Table (3) .

Process of soil tillage follows: Leveling the soil surface by using laser technique, deep sub-soiling plough, and establishment of field drains at a distance of 10 m between each of two drains and at a depth of 90 cm at drain beginning, establishment of an irrigation canal in the middle part of the experimental pilot unit. The pilot units are subjected to continuously and alternatively leaching processes before rice planting.

Calcium super-phosphate (15.5% P_2O_5) was added at a rate of 30 kg P_2O_5 /fed during soil preparation while potassium sulphate (48 % K_2O) at a rate of 100 kg K_2O/fed was added at three doses after 21, 42 and 62 days of planting to conserve it from leaching due to soil leaching requirement . A split plot

design with 3 replicates was applied. The type of fertilization was the main plot and the other three rates of nitrogen were the sub main plot . The obtained data were statistically analyzed according to Snedecore and Cochran (1979).

Rice grains (Oriza Stiva) Sakha (101) was obtained from the Field Crop, Res. Inst., ARC. The experiments were started on the 5th of May 2007 in the 1st season and the 3rd of May 2008 in the second one.

Soil analysis:

The soil sample was collected from the surface (0– 30) cm. Soil was air-dried, passed through 2 mm sieve and mixed thoroughly according to Piper (1950). Calcium carbonate was determined using a Calcimeter and calculated as CaCO3 %. Organic matter was determined as described by (Jackson, 1973) .Total soluble salts were determined in the saturated soil paste according to (Jackson, 1973). The pH was measured using a pH meter in soil suspension (1: 2.5) soil water ratio (Richards 1954). Soluble cations and anions were determined in soil paste extract according to Black (1962) . Available nitrogen was determined according to the modified Kjeldahal method by Black, (1962). The phosphorous was extracted by 0.5 N sodium bicarbonate and determined calorimetrically according to Olsen s' method (Jackson, 1973). The available K was determined using the flame photometer (Soltanpour and Schwab, 1977). Available micronutrients were extracted using ammonium bicarbonate (DTPA) and determined using Inductively Coupled Plasma (ICP) Spectrometry model 400, as described by Soltanpour and Schwab, (1977). Soil analysis before rice planting is shown in Table (1) and the mean values of water analysis during rice planting in two seasons are shown in table (2) .

Plant analysis:

Rice was harvested and grain was separated. Straw and grains were air dried and recorded as yield in ton /fed. Plant samples of ten plants were collected from each plot one day before harvesting , divided into grains and straw , air dried at 70 C^{o} in oven , weight to obtain dry matter of grains and straw per plant. The plant part samples were ground, 0.5 g of each sample was digested using H_2SO_4- $HClO_4$, mixture according to the methods described by Soltanpoure , (1985). The plant content of N, P, K, Fe, Mn, Zn, B and Pb was determined in plant digestion using the methods described by Jackson (1973), Cottenie *et al.* (1982) and Page *et al*. (1982).

Table (1): Physical and chemical properties of experimental soil used before planting.

Depth	Particulars size distribution (%)				Texture Classes	O.M (%)	$CaCO_3$ (%)
	Coarse sand	Fine sand	Silt	Clay			
0 - 30	2.5	38.9	16.6	42.0	Clay	0.41	7.9

0 - 30	pH (1:2.5)	EC (dS/m)	Cations (meq/l)				Anions (meq/l)			
			Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	CO^{--}_3	HCO^{-}_3	Cl^{-}	SO^{--}_4
	8.45	23.5	17.3	21.7	196	0.37	nil	10.57	168	56.8

Available macro-microelements content in soil used before planting:

0-30	Macro elements (mg/kg)			Microelements (mg/kg)		
	N	P	K	Fe	Mn	Zn
	44	4.5	185	10.65	7.89	0.37

Table (2): Chemical analysis of irrigation water from El-Salam Canal during two seasons of rice planting.

Properties	Seasons	El-Salam Canal			
	*period	1	2	3	4
PH (1:2.5)	1st	8.12	8.17	8.22	8.17
	2nd	8.07	8.11	8.18	8.13
EC (dS m^{-1})	1st	1.65	1.77	1.71	1.82
	2nd	1.53	1.69	1.59	1.78
NO_3(mg^{-1})	1st	22.35	25.62	21.83	19.58
	2nd	20.01	27.87	23.51	22.71
NH_4(mg^{-1})	1st	12.64	16.83	18.41	14.09
	2nd	15.31	17.43	19.46	19..16
P (mg^{-1})	1st	3.98	4.12	4.14	4.07
	2nd	4.10	4.23	4.28	4.16
K (mg^{-1})	1st	5.78	5.89	6.06	5.84
	2nd	5.99	6.05	6.15	6.03
Fe (mg^{-1})	1st	3.10	3.13	3.15	3.02
	2nd	3.22	3.24	3.18	3.20
Mn (mg^{-1})	1st	1.66	1.70	1.67	2.72
	2nd	1.68	1.84	1.80	1.77
Zn (mg^{-1})	1st	0.63	0.79	0.72	0.69
	2nd	0.75	0.84	1.00	0.98

(1) Sample taken in May. (2) Sample taken in June.
(3)Sample taken in July. (4) Sample taken in September

Table (3): some chemical properties of different organic fertilizer used in this study

Organic manure	pH (1:2.5)	EC (dSm^{-1})	C/N	N	P	K	Fe	Mn	Zn	Cu
			(%)				DTPA extractable ($mgkg^{-1}$)			
Chicken manure	7.27	6.34	24.89	1.77	0.85	1.96	34.0	72.0	41	3.8

RESULTS AND DISCUSSION

Yield and yield compound:

The results obtained revealed that soil chemical properties and fertility statuses are reflected on plants growth, and in turn their yields of straw and grains. Directly effects of the used different fertilizers sources during successive two growth seasons on rice yields are shown in Table (4). It showed the results show that the effect of three treatments (N- mineral fertilizer levels, Bio- fertilizer *Azospirillum brasilense NO 40* Salt Tolerant PGPR and organic manure (chicken manure) on yield and yield attributes of rice cultivar (sakha 101). In both seasons the three treatments significantly increased straw and grain (g) / plant, as well as grain and straw yield ton fed^{-1} and weight of 1000 grain (g). The beneficial effect of bio- fertilizer and chicken manure application were an increasing rice yield ton fed^{-1} and its compounds may be attributed to increase the available nutrients in the soil as a result of organic matter mineralization added through the organic fertilization. These data are in harmony with those reported by Zayed *et al*. (2005). The data obtained showed that the values of dry matter yields of both studied crops increased with application bio-fertilizer and chicken manure combination with mineral N- rates, due to more reduction in soil salinity and sodicity. These increases for both rice straw and grain yields are noticed in all the studied experimental pilot units these data are in harmony with those reported by Shaban and Helmy (2006).

Data in Table (4) obviously declared that the incremental addition of mineral, bio-fertilizer and chicken manure or combination of nitrogen with mineral fertilizer as endingly augmented the straw and grain yield of both seasons. Wherever the increased rate of mineral fertilizer from 25 to 100 kg N/fed enhanced the straw and grain yield by 1.17 % and 65 % in the first seasons and 21.76 % and 49.11 % in the second season respectively, compared to the received 25 kg N /fed. The corresponding values were 8.90% in 1^{st} and 9.48 % in 2^{nd} seasons for straw however it were 12.12 % in 1^{st} and 4.00 % in 2^{nd} seasons for grain yield as affected with the combination between the highest dose of mineral and bio-fertilizers compared with 25 kg N/ fed. On the other hand, the relative increases in straw and grains yield (ton /fed) as affected with application of chicken manure plus the third levels N –mineral were 12.00 % in 1^{st} and 9.58 % in 2^{nd} seasons for straw, where the values of grain yield were 5.84 in 1^{st} and 14.1 % in 2^{nd} as affect chicken manure plus N rates of 100 kg N/ fed than treatment chicken manure plus 25 kg N/fed.

Table (4):

These results may be ascribed to the enhancing effect of mineral and organic fertilizers on increasing the availability of micro and micronutrients in the experimental soil consequently, its uptake by plants, so its yield productivity.

These data are in consonance with those reported by Irshad *et al*. (2002) who found that the application of composted manure and urea fertilizer enhanced plant growth and nutrient uptake as compared with the non-treated control. Maize growth was better under urea fertilizer than under composted manure. The uptake of nutrient was also affected by the salinity and form of fertilizer applied.

N, P and K concentration in rice crop:

Data present in Table (5) showed that the effect of all treatments on concentration of N, P and K in straw and grain of rice was significant in both seasons. Also data displayed that N, P and K concentrations in grains and straw of rice crop tended to increase with increasing of nitrogen rate addition with chicken manure however it with bio-fertilizer respectively. Data showed that the applied tribal combination treatments (mineral -N+ bio-fertilizer + Chicken manure fertilizer) resulted in a significant effect on the concentration of N, P and K in grain and straw. The highest values of N, P and K concentration for rice straw and grain were 3.26, 0.46 and 2.14 % and 1.52, 0.61 and 0.93% respectively as affected with Ch M application in both seasons. The data obtained previously displayed that the sequence of N, P and K in both straw and grains could be arranged according to their concentrations in the following order:

Chicken manure > Bio- fertilizer > mineral -N for all experimental pilot units. The relative increase percentages in the concentration of N, P and K for bio-fertilizer and chicken manure means were 7.87 – 9.25 % in 1^{st} and 7.10 – 8.42 % in 2^{nd} for straw and 7.87 – 4.32 % in 1^{st} and 2.87 – 4.96 % in 2^{nd} for grain of N ; 29.63 - 48.15% in 1^{st} and 15.16 – 30.30 % in 2^{nd} and 10.64 – 6.38 % in 1^{st} and 18.00 – 14.00 % in 2^{nd} for grain of P and 3.29 – 9.89 % in 1^{st} and 3.26 – 9.78 % in 2^{nd} for straw and 2.63 – 6.57% in 1^{st} and 6.41 – 12.82 % in 2^{nd} for grain of K compared with N-mineral fertilizer .

These data are in harmony with those reported by Mahmoud *et al*. (2004) and El-Meneasy *et al*. (2005). In general the increase of concentration of N, P and K in straw and grain in the rice crop in soil treated with bio-fertilizer and compost combination with N – rates may be refer to the change of some soil chemical properties, microbial population, and biochemical and soil enzymes activities in saline soil cultivation under semi- arid condition. These results are in agreement with those obtained by Haum *et al* (2007). Irshad (2002) reported that N, P, and K uptake of rice plant were higher in urea and urea + manure treatments as compared with manure and control. The poor response of composted manure may be due to its short-term application or impeded N mineralization under saline conditions.

Table (5):

Trace element concentrations in straw and grain of rice plants:

Effects of different fertilizer sources on the concentrations of some micronutrients (Fe, Mn and Zn), in rice are presented in Table (6) The data obtained elucidated that application of the bio-fertilizer and chicken manure alone and combination with N- rates caused an increases in the concentrations of Fe, Mn and Zn, in rice plant, with a more pronounced increase in the 2nd seasons. These results are in harmony with those obtained by Ashmaye *et al*. (2008) found that the application of the organic farm yard manure and bio-fertilizer in combination with N-levels caused an increases in the concentrations of Fe, Mn and Zn for straw and grains. The relative increases of the studied micronutrients (Fe, Mn and Zn) in rice crop (straw and grains) are mainly dependent on the used different fertilization sources, as it could be arranged as follows: Chicken manure > bio-fertlizer > mineral nitrogen.

Finally, it is concluded that the concentrations promotion of micronutrients in rice plant, generally, reflect their availability enhancement in soil, during the both seasons as a result of the beneficial affect of the added fertilizers. These results are in consonance with those obtained by El-Maghraby *et al*. (1997) and Ashmaye *et al*. (2008).

Effect of different fertilization sources on available macronutrients in soil:

Data in Table (7) showed the amounts of some available macronutrients N, P and K (mg/kg soil) in studied soil as affected by different fertilization sources in the successive two seasons. Table (7) revealed that the soils treated with chicken manure and bio-fertilizer combination with mineral N-rates gave higher values of available N, P and K than that treated with mineral nitrogen (100kg N fed^{-1}) alone. This may be attributed to that chicken manure combination with N- rates which is more richer in organic materials as well as in N, P and K, likewise the bio-fertilizer that led to increase of N, P and K, according to its important role in improving of soil nutrients status because of the N fixed in soil and microorganisms activity and (PGPR). Bio-fertilizers especially, N- fixing bacteria were suggested to reduce the amount of mineral fertilizer added into the soil and produce clean and healthy crops (Mantri pukhri, 2006). The obtained data are in agreement with those reported by Kavitha and Subramanian (2007) and Shaban and Omar (2006). Data showed that the applied mineral N- rates, chicken manure and bio-fertilization alone or combination with resulted in a significant effect on increasing the available N, P and K in soil.

Table (6):

Table (7):

Effect of different fertilization sources on available micronutrients in the studied soil:

Data presented in Table (7) appeared a slightly influence for the applied fertilizer on availability of micronutrients determined in the soil. Wherever no significant effect for different source of applied fertilizer were observed. This is more related to the residual effect of organic compounds in the chicken manure and bio-fertilizer. These results were according either in the fertilizer the second seasons of growth. These results are in agreement with those obtained by Abou El-Roos *et al*. (1996) and Shaban (2005).

All the different applied treatments showed significant increases with Fe, Mn and Zn available in soil. It is recommended to use bio-fertilizer NO40 in combination with 50 % dose of mineral N- fertilizer to reduce expenses and to improve soil and rice growth and productivity.

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تأثير المخصبات الحيوية والعضوية على صفات الأرض الملحية حديثة الاستصلاح وإنتاجية محصول الأرز

عواطف عبد المجيد محمود – خالد عبده حسن احمد شعبان –
منى جمال عبد القادر
معهد بحوث الأراضي والمياه والبيئة – مركز البحوث الزراعية – الجيزة – مصر

الملخص العربي

أقيمت تجربتان حقليتان في مزرعة خاصة بقرية خالد بن الوليد بمنطقة جنوب سهل الحسينية بمحافظة الشرقية وهذه المنطقة تروى بمياه ترعة السلام (مياه مخلوطة بنسبة ١ : ١ مياه نيل + مياه صرف زراعي) وكان الهدف من الدراسة هو تحسين صفات التربة وإنتاجية محصول الأرز صنف ١٧٨ جيزة باستخدام مخصبات حيوية متحملة للملوحة مثل NO40 سلالة بكترية مثبتة للنتروجين ومتحملة للملوحة وتفرز هرمونات منظمة للنمو والتسميد العضوي (سماد مخلفات المزارع الداجنة) ومعدلات التسميد النتروجيني المعدني (يوريا ٤٦ %) وتأثيرهم على مدى تيسر العناصر نتروجين – فوسفور – بوتاسيوم – حديد – منجنيز – زنك في التربة وتركيزها في القش والحبوب لمحصول الأرز تحت ظروف الاراضى الملحية حديثة الاستصلاح.

وقد أظهرت النتائج المتحصل عليها الاتى :

- **أظهرت الأسمدة المستخدمة تأثيرا معنويا على زيادة إنتاجية محصول القش والحبوب (طن\ فدان) حيث تراوح إنتاجية الفدان في الموسم الأول والثاني لمحصول القش من ١.٩٩ إلى ٢.٣٥ للمعاملة التسميد المعدني كذالك من ٢.٧٧ إلى ٢.٨٧ للمعاملة بالتسميد الحيوي + ٥٠ % تسميد نتروجينى معدني وكذالك من ٢.٨٧ إلى ٢.٨٨ في المعاملة مخلفات الدواجن + ٥٠ % تسميد نتروجينى معدني وكذالك زيادة في وزن الألف حبة ووزن الحبوب والقش للنبات الواحد (جرام) أدى استخدام الأسمدة الثلاثة إلى زيادة معنوية في تركيز العناصر نتروجين – فوسفور – بوتاسيوم – حديد – منجنيز – زنك بالحد المسموح بة في الحبوب والقش .**
- **كان لاستخدام التسميد العضوي والحيوي مع معدلات من التسميد النتروجينى المعدني لموسمين متتالين زيادة معنوية في زيادة العناصر الميسرة النتروجين والفوسفور والبوتاسيوم والحديد والمنجنيز والزنك زيادة معنوية بالمقارنة بالتسميد الحيوي والعضوي المعدني كلا على حدة.**

Table (4): Yield component and yield productivity as affected by application of bio, organic and mineral nitrogen fertilizer:

Treatment	N-kg/fed	Weight (ton/fed)				Weight (g/plant)				Weight (1000 grains) (g)	
		Straw		Grain		Straw		Grain			
		1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Mineral –N	25	1.79	1.93	0.95	1.12	32	33	15	19	21.59	23.21
	50	1.88	2.17	1.38	1.39	34	36	18	22	23.31	28.58
	100	1.99	2.35	1.57	1.67	40	41	21	24	28.28	32.41
	Mean	1.89	2.15	1.30	1.39	35	37	18	22	24.39	28.10
Bio-fertilizer	25	2.25	2.32	1.65	1.75	38	40	19	23	25.37	31.24
	50	2.77	2.87	1.74	1.79	42	45	23	26	30.16	34.85
	100	2.45	2.54	1.67	1.82	44	40	20	22	26.25	30.49
	Mean	2.49	2.58	1.69	1.78	41	42	21	24	27.26	32.19
Ch – manure	25	2.26	2.40	1.54	1.91	37	39	17	20	24.21	25.12
	50	2.87	2.88	1.61	1.97	41	42	22	23	29.42	35.68
	100	2.53	2.63	1.63	2.58	40	44	24	26	32.88	38.12
	Mean	2.55	2.64	1.60	2.15	39	42	21	23	28.84	33.17
LSD 5%Fert		0.26		0.18		6.76		1.55		2.00	
LSD 5%rateN		0.23		0.16		6.77		1.95		1.78	
LSD 5% season		0.55		0.28		5.52		4.69		3.04	

Table (5): Macronutrients concentration in straw and grains of rice crop as affected by application different fertilizers used:

Treatment	N- kg/fed	N (%)				P (%)				K (%)			
		Straw		Grain		Straw		Grain		Straw		Grain	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Mineral –N	25	2.85	2.91	1.35	1.36	0.25	0.31	0.44	0.47	1.78	1.82	0.72	0.75
	50	2.93	2.96	1.39	1.42	0.27	0.33	0.47	0.49	1.82	1.83	0.76	0.78
	100	2.99	3.05	1.42	1.45	0.29	0.35	0.51	0.53	1.86	1.87	0.79	0.81
	Mean	2.92	2.97	1.39	1.41	0.27	0.33	0.47	0.50	1.82	1.84	0.76	0.78
Bio-fertilizer	25	3.12	3.15	1.37	1.39	0.31	0.36	0.48	0.50	1.84	1.86	0.75	0.79
	50	3.18	3.20	1.44	1.46	0.36	0.38	0.52	0.55	1.89	1.91	0.78	0.83
	100	3.16	3.19	1.48	1.49	0.37	0.39	0.55	0.58	1.92	1.93	0.81	0.86
	Mean	3.15	3.18	1.43	1.45	0.35	0.38	0.52	0.54	1.88	1.90	0.78	0.83
Ch – manure	25	3.14	3.16	1.40	1.43	0.38	0.41	0.43	0.53	1.90	1.94	0.77	0.84
	50	3.20	3.26	1.45	1.48	0.40	0.43	0.49	0.58	1.96	1.97	0.82	0.88
	100	3.23	3.25	1.49	1.52	0.43	0.46	0.58	0.61	2.11	2.14	0.84	0.93
	Mean	3.19	3.22	1.45	1.48	0.40	0.43	0.50	0.57	2..00	2.02	0.81	0.88
LSD 5%Fert		0.67		0.025		0.035		0.032		0.160		0.011	
LSD 5%rateN		0.68		0.028		0.039		0.036		0.180		0.013	
LSD 5% season		0.55		0.043		0.140		0.055		0.820		0.019	

Table (6): Micronutrients concentration in straw and grains of rice crop as affected by application different fertilizers used:

Treatment	N- kg/fed	Fe (mg/kg)				Mn (mg/kg)				Zn (mg/kg)			
		Straw		Grain		Straw		Grain		Straw		Grain	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Mineral –N	25	148	150	122	124	66	67	47	51	42	44	57	61
	50	152	153	127	129	68	70	52	57	47	49	59	63
	100	155	157	130	134	72	74	55	59	52	53	61	65
	Mean	152	153	126	129	69	70	51	56	47	49	59	63
Bio-fertilizer	25	153	155	125	128	79	81	50	52	45	48	58	62
	50	156	158	129	132	82	83	54	58	55	59	62	64
	100	159	162	133	136	86	87	58	61	62	63	64	66
	Mean	156	158	138	132	82	84	54	57	54	57	61	64
Ch – manure	25	157	160	130	134	88	90	56	59	51	54	60	63
	50	160	163	134	137	90	94	58	61	59	64	65	68
	100	168	169	136	138	92	96	60	64	63	66	66	70
	Mean	162	164	133	136	90	93	58	61	58	61	64	67
LSD 5%Fert		3.56		1.52		3.24		4.17		6.80		4.59	
LSD 5%rateN		3.97		1.01		3.62		4.33		6.76		6.27	
LSD 5% season		3.04		Ns		5.52		Ns		5.52		Ns	

Table (7): Available macro – micronutrients contents in soil after rice harvest as affected by application different fertilizers used:

Treatment	N-kg/fed	N (mg/ kg)		P (mg/kg)		K (mg /kg)		Fe (mg/kg)		Mn (mg/ kg)		Zn (mg/kg)	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd		
Mineral –N	25	58	63	6.24	6.52	215	227	13.21	13.48	8.10	8.24	0.41	0.47
	50	64	67	6.38	6.55	219	233	13.23	13.52	8.12	8.27	0.45	0.49
	100	66	71	6.43	6.59	224	237	13.25	13.55	8.14	8.28	0.47	0.53
	Mean	63m	67	6.35	6.55	219	232	13.23	13.51	8.12	8.26	0.44	0.50
Bio-fertilizer	25	65	70	7.12	7.22	226	229	13.34	13.54	8.22	8.27	0.44	0.48
	50	68	72	7.15	7.31	228	238	13.42	13.59	8.26	8.34	0.46	0.54
	100	70	74	7.16	7.37	234	243	13.44	13.62	8.31	8.36	0.48	0.57
	Mean	68	72	7.14	7.30	229	237	13.40	13.58	8.26	8.32	0.46	0.53
Ch – manure	25	65	69	7.25	7.35	228	237	13.47	13.58	8.24	8.30	0.45	0.51
	50	68	73	7.34	7.42	235	244	13.53	13.65	8.27	8.38	0.49	0.58
	100	71	75	7.36	7.47	237	248	13.55	13.68	8.33	8.42	0.52	0.61
	Mean	68	72	7.32	7.41	233	243	13.52	13.64	8.28	8.37	0.49	0.57
LSD 5%Fert		3.24		0.67		0.84		0.32		0.49		0.36	
LSD 5%rateN		3.62		0.68		0.94		0.36		0.65		0.04	
LSD 5% season		5.52		0.55		1.43		0.55		0.38		0.03	