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Effect of Compost and Nitrogen Fertilization on Yield and Nutrients Uptake of Rice Crop under Saline Soil

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Abstract

Under high saline conditions, a field experiment was carried out to investigate the role of different rates of compost and N fertilization on yield and nutrients uptake of rice (*Oryza sativa* L. cv. Sakha 101) cultivated in Sahal El-Hossynia Agric. Res. Station Farm in El-Sharkia Governorate, Egypt and irrigated with drainage water from El-Salam canal during summer growing seasons 2014/2015. Compost was added to soil at two rates (5 and 10 ton fed-1) in combination with three rate of N fertilization (35, 50 and 70 Kg N fed^{-1}). The obtained data indicated that increasing N fertilization from 35 to 70 kg N fed^{-1} increased significantly straw, grain and 1000 grain weight of rice. The high yield values (2.88 ton fed^{-1}(straw), 2.11 ton fed^{-1}(grain) and 35.50 g (1000 grain weight) can be obtained under a high level of the N fertilization and compost rate (70 kg N fed^{-1} and 10 ton fed^{-1}, respectively). As well as increasing of N, P, K, Fe, Mn and Zn uptake of straw and rice grain attributed to increasing N fertilization rate especially under high level of compost (10 to fed^{-1}). Nitrogen fertilization rates under two levels of compost didn't affect on most nutrients content, except N and P which increased when N fertilization increased under high level of compost (10 ton fed^{-1}).

Keywords: N fertilization; Compost; Rice; Yield; Nutrients uptake; Saline soil

Introduction

Rice is one of the most cereal crops consumed in the world. Rice is the stable food of more than approximately one-third of the world's population. The primary purpose of the cultivation of rice is used as food for humans as the nutritional value is high because of the rice grain contain a high percentage of carbohydrates. The most important rice-growing areas in Egypt is the northern Delta region where there are special shifts for the cultivation of rice, and there are land reclamation salt, because the rice more crop profitable in such areas to carry rice from other crops. Since the rice bears from other crops, the high proportion of salt and it needed to submerge the ground water for a long period of his life and that water, which is needed for the cultivation of rice works to wash salts in the soil and gradually ease the concentration of salts and thus minimize damage and improve the properties of the soil gradually until the soil reform. Soil salinity is arising from either natural or human-induced causes. Salt affected soils are characterized by very high rates of water soluble salts to a level that impairs food production and environmental health well-being. Sodium chloride is a major salt contaminant in the soil. When this salt oxidized by water, producing Na^+ and Cl^-, which are easily absorbed by root of plants, as well as cause ionic and osmotic stress at cellular rate of plants [1,2]. Compost was added to reclamation saline soils by improving physical, chemical and biological properties as well as the yield of plants were grown in this soil. The treatments contain compost had affected on wheat and maize yield parameters more than control or full mineral fertilizers [3]. Also, bean seed yield was significantly increased at all rates of banana compost compared to control [4,5]. Showed that rice spikelet fertility increased by 79.6% as a result of the use of farm yard manure [6]. Indicated that when were added two types of compost decreased EC, pH, SAR and ESP in saline-sodic soil. The present study aim to effect of different rates of compost and N fertilization on yield and nutrients uptake of rice cultivated in saline soil and irrigated with drainage water from El-Salam canal.

Materials and Methods

A field experiment was conducted in salt-affected clay soil during successive summer growing season of 2014 at Sahl El-Hossynia Agric. Res. Station Farm in El-Sharkia Governorate, Egypt. Some physical and chemical characteristics of the studied soil are presented in Tables 1 and 2. The experiment was carried out during summer seasons 2014 and 2015 on rice (*Oryza sativa* cv. L. Sakha 101). The experimental design was a randomized complete block design with three replications. Compost was added in two rates 5 and 10 to fed^{-1}, these rates of compost combined with three rate of N fertilization (35, 50 and 70 kg N fed^{-1}). Some chemical properties of compost used are presented in Table 3. The targeted area was irrigated from El-Salam canal, which included Nile river water mixed with agriculture drainage water (1:1). Chemical analysis of El-Salam canal water are presented in Table 4. Rice was

Sand %		Silt %	Clay %	Texture
Coarse	Fine			
3.0	8.4	36.5	52.1	Clay

Table 1: Mechanical analysis of used soil.

OM %	pH (1:2.5) suspension	ECe dS/m	Anions				Cations			
			meq/1							
			Cl^-	$CO_3^=$	HCO_3^-	$SO_4^=$	Na^+	K^+	Ca^{++}	Mg^{++}
0.50	8.50	20.5	246	-	10.5	51.0	267.1	0.5	18.2	21.7

Table 2: Some chemical properties of used soil.

C:N ratio	OM %	EC dS m^{-1}	pH 1:2.5	N	P	K	Fe	Zn	Mn
				%			ppm		
1:25	55	5.60	7.20	1.40	0.66	1.22	55	41	20

Table 3: Some chemical properties of used compost.

ECe dS/m	Anions meq/1				Cations meq/1			
	Cl^-	$CO_3^=$	HCO_3^-	$SO_4^=$	Na^+	K^+	Ca^{++}	Mg^{++}
1.83	7.6	nd.	2.5	8.22	10.3	0.36	3.2	4.5

Table 4: Some chemical properties of El-Salam water canal.

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harvested in summer and grain was separated for plant analysis. Both straw and grain were air dried for 10 days and their estimations as yield in ton fed-1. Plant samples were digested with sulfuric acid in the presence of H_2O_2 and digests were analyzed for N, P, K, Fe, Zn and Mn, content. Where, Fe, Mn and Zn were determined by atomic absorption spectroscopy. While, K by flame emission [7] and P by ascorbic acid-reduced molybdo phosphoric blue colorimetric [8]. Total nitrogen in plant was determined by the Kjeldahl method [7].

Results and Discussion

Regarding the effect of compost and N fertilization rates, obtained data Table 5 clearly indicated that increasing N fertilization rates from 35 to 70 kg N fed^{-1} increased significantly straw, grain and 1000 grain weight under two rates of compost (5, 10 ton fed^{-1}). This increasing of yield parameters were highest under high rate of compost (10 ton fed^{-1}). As well as the high yield values (2.88 ton fed^{-1} (straw), 2.11 ton fed^{-1} (grain) and 35.5 g (1000 grain weight)) can be obtained under a high level for each of the N fertilization and compost rate (70 kg N fed^{-1} and 10 ton fed^{-1}, respectively) [9]. indicated that increasing N fertilization level from 100 to 200 kg N fed^{-1} increased straw and grain of corn under the conditions of adding organic compost. As well as, they are showed that the high values of straw and grain (8.23 and 2.87 ton fed^{-1}, respectively) can obtain that under highest rate of N fertilization (200 kg Nfed^{-1}). Under saline conditions, when compost was added, rice yield was increased compared with control (without compost). Rice in the value of each of straw, grain and 1000 grain weight was about 15.7, 29.8 and 33%, respectively [1]. The data representing N, P, K, Fe, Zn and Mn uptake of straw and grain of rice are shown in Table 6 and 7. Data showed that increasing N fertilization rates from 35 to 70 kg N fed^{-1} under two rates of compost increased N, P and K uptake of straw and grain. As well as increasing compost rate from 5 to 10 ton fed^{-1} attributed to increasing nutrients uptake of straw and grain. The treatment (10 ton fed^{-1}+70 g N fed^{-1}) was given high values of N, P and K uptake of rice straw and grain. Increasing N, P and K uptake of rice straw and grain when bio fertilizers and chicken manure were added with N fertilization levels in saline soil, could be due to improve soil properties such as chemical and bio properties [10-12]. The data representing N, P, K, Fe, Zn and Mn content of saline soil are shown in Table 8. Data showed that increasing N fertilization rates under two levels of compost didn't effect on most nutrients content, unless N and P was increased when N fertilization increased under high level of compost (10 ton fed^{-1}) [13]. reported that available nitrogen and potassium in field plots that received organic materials was higher than those treated with chemical fertilizer. The rate of increases in the mean availability of potassium in plots treated with farmyard manure, tomato compost and farmyard manure combined with tomato compost were 23, 36 and 38% as compared with chemical fertilizer treatment, respectively [14] indicated that the addition of compost as soil amendment increased available N in soils compared to control because to available N increased due to mineralization of native nitrogen by soil organisms. Also several organic acids produced during decomposition of organic matter decreased the activity of polyvalent cations through chelation and reduced the phosphorus fixation and increased the availability of phosphorus [1] showed that compost combined with cyanobacteria was improved organic matter content and the available nutrients in saline soil [15]. showed the superiority of compost as a source for nutrients (N, P and K) which values increased after wheat harvest.

Treatments		Straw	Grain	1000 grain weight
Compost ton fed^{-1}	N kg fed^{-1}	ton fed^{-1}		gm
5	35	1.86	1.04	22.40
	50	2.03	1.38	25.90
	70	2.17	1.62	30.30
10	35	2.33	1.72	24.70
	50	2.87	1.79	32.60
	70	2.88	2.11	35.50
LSD5%		0.24	0.17	1.84

Table 5: Effect of compost and N fertilization on rice yield under saline soil.

Treatments		N		P		K	
		mg kg					
Compost ton fed-1	N kg fed-1	Straw	Grain	Straw	Grain	Straw	Grain
5	35	93.60	22.95	9.10	7.65	58.5	93.60
	50	102.90	28.00	10.5	9.60	63.7	102.9
	70	122.31	32.17	12.96	11.7	75.33	122.3
10	35	119.70	26.08	14.82	8.88	72.96	119.7
	50	134.04	32.85	17.01	11.92	81.34	134.0
	70	136.08	37.50	18.48	14.75	89.04	136.1

Table 6: Effect of compost and N fertilization on N, P and K uptake of rice straw and grain under saline soil.

Treatments		Fe		Mn		Zn	
		mg kg					
Compost ton fed-1	N kg fed-1	Straw	Grain	Straw	Grain	Straw	Grain
5	35	4.84	2.10	2.14	0.80	1.40	1.00
	50	5.32	2.56	2.41	1.01	1.68	1.22
	70	6.32	2.97	3.00	1.28	1.09	1.42
10	35	6.00	2.44	3.38	1.06	1.09	1.13
	50	6.70	3.04	3.82	1.29	1.38	1.52
	70	77.34	3.42	2.26	1.55	1.55	1.7

Table 7: Effect of compost and N fertilization on Fe, Mn and Zn uptake of rice straw and grain under saline soil.

Treatments		N	P	K	Fe	Mn	Zn
Compost ton fed-1	N kg fed-1	mg kg-1					
5	35	61	6.40	220	13.3	8.20	**0.44**
	50	65.5	6.50	225	13.4	8.20	**0.45**
	70	68	6.51	230	13.4	8.20	**0.46**
10	35	67	7.20	233	13.5	8.27	**0.48**
	50	71	7.30	235	13.6	8.33	**0.50**
	70	73	7.41	236	13.6	8.33	**0.50**

Table 8: Effect of compost and N fertilization on N, P, K, Fe, Mn and Zn content under saline soil.

Conclusion

It can be concluded that increasing N fertilization rate from 35 to 70 kg N fed^{-1} increased significantly straw, grain and 1000 grain weight of rice. The highest yield was obtained under 70 kg N fed^{-1} and 10 ton compost fed^{-1}. As well as increasing of nutrients uptake of straw and grain attributed to increasing N fertilization rate especially under high level of compost.

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