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Effect of Integrated Nitrogen Management on Yield of Rice and Chemical Properties of Sodic Soil

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A B S T R A C T

A field experiment on "Effect of integrated nitrogen management on yield of rice and chemical properties of sodic soil" was conducted at the Agronomy Farm, College of Agriculture, Anand Agricultural University, Vaso during *kharif* season 2017. The experiment was laid out in a randomized block design with ten integrated nitrogen management (INM) treatments and four replications. Experimental result revealed that the treatment receiving 50% RDN through castor cake + 50% RDN through inorganic fertilizer (T_7) recorded significantly higher grain yield (4461 kg ha^{-1}) as compared to application of 100% RDN through inorganic, FYM and vermicompost but it was at par with rest of the treatments. However, straw yield (7974 kg ha^{-1}) was observed to be significantly higher with the treatment receiving application of 100% RDN through castor cake (T_4) than other treatments except treatment receiving 100% RDN through FYM (T_2) as well as 50% RDN through castor cake and 50% RDN through inorganic fertilizer (T_7). The organic carbon content of soil as well as available status of nitrogen, phosphorus, potassium were remarkably improved and also significantly reduced the ESP after harvest of rice crop due to the application of treatment receiving organic manures alone or in combination with inorganic fertilizers.

Introduction

The expected increase in world's population (9.6 billion by 2050) needs food productivity to step up within few decades (Pitaman and Lauchili, 2002). Unfortunate's extensive areas of irrigated lands are unproductive, due to the accumulation of salts in the soil profile occupied by the root systems. Salt affected soils are mostly unproductive unless excess salts are reduced or removed. These soils occur mostly in arid and semiarid climate and also found in coastal areas where soils are inundated by ocean or sea water. Salt affected soil has been estimated about 67 lakh ha of land in India (Anonymous, 2017), in which the highest area of salt affected soils reported in Gujarat (22 lakh ha). Maintaining and restoring the quality of soil is one of the great challenges of our time. Soil fertility is one of the vital features controlling yields of the crops. Fertility status of salt affected soils is generally poor because of high pH, excess amount of exchangeable sodium and low organic matter and nitrogen content, which restrict the growth and yield of many crops. Therefore, salt affected soil must be reclaimed to maintain satisfactory fertility levels and improve the soil health.

Integrated nutrient supply involving combined use of organic and chemical fertilizer as nutrient sources has been developed. The use of adequate dose of organic source coupled with chemical fertilizers is expected to ensure optimum growth condition under intensive agriculture using rice hybrid. Singh *et al.,* (2004) from Hissar reported that 100 per cent recommended NPK through chemical fertilizer, 50 per cent NPK through chemical fertilizer + 50 per cent N through FYM and 75 per cent NPK through chemical fertilizer + 25 per cent N through FYM in rice-wheat cropping system gave 39.21, 17.5 and 23.1 per cent higher returns over farmers' practice. It has been well established that the applied organic sources not only increase soil fertility but also improve soil physical conditions, which help in proper growth of plant and increased water holding capacity, aeration, permeability, soil aggregation and nutrient holding capacity and decreased bulk density and soil crusting due to the continuous use of organic manure (Das, 2011). Keeping these in view, the present investigation was aimed to study the effect of integrated nitrogen management of rice yield and chemical properties of sodic soil.

Materials and Methods

A field experiment was conducted on sodic soil at Agronomy Farm of College of Agriculture, Vaso, Gujarat which is situated at 22^0-35'N latitude, 72^0 - 55' E longitude at an altitude of about 37 meters above the mean sea level during the *Kharif* season of year 2017 to study the effect of integrated nitrogen management (INM) on rice (*Oryza sativa* L.) in sodic soil. The mean annual rainfall is 865 mm. The soil of experimental field (0-15 cm) had loamy sand in texture, pH (1:2.5)- 8.75, EC- 0.76 dS m^{-1} at 25^oC, organic carbon- 0.24%, available N- 204 kg ha^{-1}, available P_2O_5- 32.25 kg ha^{-1} and available K_2O- 206 kg ha^{-1}, bulk density- 1.51 g cc^{-1} and water holding capacity- 38.05%. The experiment comprising of total ten treatment involving: T_1- Control (RDN: 100 kg N ha^{-1} through inorganic fertilizer), T_2- 100% RDN through FYM, T_3- 100% RDN through vermicompost, T_4- 100% RDN through castor cake, T_5- 50% RDN through FYM + 50% RDN through inorganic fertilizer, T_6- 50% RDN through vermicompost + 50% RDN through inorganic fertilizer, T_7- 50% RDN through castor cake + 50% RDN through inorganic fertilizer, T_8- 25% RDN through FYM + 75% RDN through inorganic fertilizer, T_9- 25% RDN through vermicompost + 75% RDN through inorganic fertilizer, T_{10}- 25% RDN through castor cake + 75% RDN through inorganic fertilizer. The experiment was laid out in a Randomized Block Design with four replications. Seed of rice was sown @ 25 kg ha^{-1}. Rice variety Gurjari was selected for cultivation in *kharif* season. Farm yard manure, vermicompost and castor cake were incorporated according to the treatments at the time of field preparation and mixed thoroughly. Half of inorganic nitrogen and full dose of phosphorus were applied as per treatments at the time of transplanting and remaining dose of nitrogen was applied in two equal splits at tillering and panicle initiation stages through urea. Recommended dose of fertilizers was applied @ 100 kg N and 25 kg P_2O_5 ha^{-1} for rice. All recommended agronomic and cultural practices are followed for good rice crop in a sequence (Table 1).

The crop was harvested at maturity, dried in the sun, threshing manually, grain and fodder yield were recorded net plot wise and converted on hectare basis. The soil samples were collected after completion of the experiment, were air-dried and pulverized to pass through 2 mm sieve. Soil samples were analyzed by using standard procedures as described for pH (Jackson, 1973), organic carbon (Jackson, 1973), available nitrogen (Subbiah and Asija, 1956), available phosphorus (Olsen *et al.*, 1954) and available potassium (Jackson, 1973).

Results and Discussion

Grain and straw yield of rice

The data on yield attributes *viz.*, grain and straw yield of rice influenced by different treatments is presented in Table 2. From this data it was revealed that treatment receiving application of 50% RDN through castor cake + 50% RDN through inorganic fertilizer (T_7) produced significantly higher grain yield of rice (4461 kg ha^{-1}) as compared to application of 100% RDN through inorganic fertilizer, FYM and vermicompost but was found to be at par with treatments T_4, T_5, T_6, T_8, T_9 and T_{10}. The grain yield of rice under treatment T_7 was 44.38% higher as compared to control (100% RDN through inorganic fertilizer). While treatment receiving application of N through 100% RDN through castor cake (T_4) was recorded significantly maximum value for straw yield (7974 kg ha^{-1}) than rest of the treatments but was found to be at par with treatment receiving application of 100% RDN through FYM (T_2) as well as 50% RDN through castor cake + 50% RDN through inorganic fertilizer (T_7). The straw yield of rice under treatment T_4 was 38.58% higher over use of 100% RDN through inorganic fertilizers (control).

The higher grain yield associated with higher level of organic manures in combination with inorganic fertilizer may be due to its greater availability and uptake of macro and micro-nutrients and active participation in carbon assimilation, photosynthesis, starch formation, translocation of protein and sugar, entry of water into plants root and development *etc*. Similar findings have also been reported by Kumar *et al.*, (2012) and Bahadur *et al.*, (2013). This increment in grain and straw yield of rice might be due to the increased nutrient availability from the castor cake application and might have increased the various endogenous hormonal levels in plant tissues, which might be responsible for enhanced yield and yield attributes. These results are in line with those reported by Kumar and Yadav (2008) and Bafna *et al.*, (2010).

Post-harvest soil properties

Soil pH, Electrical conductivity (EC) and organic carbon (OC)

The data on pH and EC of soil as well as organic carbon (OC) in soil after harvest of rice as influenced by integrated nitrogen management is presented in Table 3. The data indicated that pH in both the soil depths did not differ significantly due to the application of different treatments but the soil pH values were decreased in all the treatments as compared to control after harvest of rice. Application of organic sources with inorganic fertilizer significantly decreased the soil EC over the application of full RDN dose through inorganic fertilizer, but differences were not up to the levels of significance for the depth of 0-15 cm. The maximum reduction was noticed under the treatment T_4 (100% RDN through castor cake) and treatment T_7 (50% RDN through castor cake and 50% RDN through inorganic fertilizer) in the 0-15 cm and 15-30 cm soil depth, respectively. The treatment T_7 significantly reduced the EC of soil in 15-30 cm soil depth than other treatments except treatments T_4, T_5, T_6, T_8

and T_{10}. This might be due to production of organic acid from the organic manure decomposition resulting lowering of EC. The reduction of EC of the soil with application of organic manures may be ascribed to salt leaching facilitated by improve permeability of soil and formation of weak salts which result the reduction in EC. Similar findings have been observed by Mishra and Sharma (1997) and Koushal *et al.,* (2011).

Among the different treatments, treatment T_2 (100% RDN through FYM) recorded significantly maximum value of organic carbon (0.43%) in 0-15 cm soil depth as compared to treatments $T_{1,}$ T_3 and T_8 but it was par with rest of the treatments. Former significant treatment was also recorded significantly maximum organic carbon (0.55%) in 15-30 cm soil depth as compared to rest of the treatments but it was par with treatments $T_{4,}$ T_6 and T_8. This is might be due to build- up of organic matter through application of organic manures. The soil organic matter increases with the fertility of soil by improving its properties. The result is in line with those reported by Gupta and Sharma (2010), Sepehya *et al.,* (2012) and Kumar *et al.,* (2012). The increase in soil organic carbon with application of organic residues like wheat residue, FYM and green manure in rice-wheat system has also been reported previously by Kumar and Yadav (2008).

Available nutrients in soil

Application of organic manures alone or in combination with inorganic fertilizer significantly increased the available nitrogen, phosphorus and potassium in 0-15 cm and 15-30 cm depth of soil over 100% RDN applied through inorganic fertilizer after harvest of rice crop (Table 3). Among the different treatments, treatment T_2 (application of 100% RDN through FYM) was recorded significantly maximum values of available N (244.6 kg N ha^{-1} and 251.0 kg N ha^{-1} in 0-15 cm and 15-30 cm soil depth, respectively) as compared to other treatments but it was at par with treatments T_3, T_4, T_5, T_6 and T_7 in both the depths of soil. The available nitrogen after harvest of rice under treatment T_2 was 62.76% and 42.99% higher at 0-15 cm and 15-30 cm depth, respectively as compared to 100% RDN through inorganic fertilizer. The increase in available N with incorporation of organic sources may attribute to N mineralization from organic manures. The suitable soil condition under organic sources might have helped the mineralization of soil N leading to build up of higher available N (Kumar *et al.,* 2012).

Among the different treatments, treatment T_4 (100% RDN through castor cake) was recorded maximum value of available phosphorus (42.23 kg P_2O_5 ha^{-1}) in 0-15 cm depth and treatment T_2 (100% RDN through FYM) was recorded maximum value (45.10 kg ha^{-1}) in 15-30 cm depth of soil after harvest of rice, which was significantly higher as compared to rest of the treatments except treatments T_2, T_3, T_6 and T_{10} in 0-15 cm and treatments T_3, T_4, T_8, T_9 and T_{10} in 15-30 cm soil depth. The available phosphorus after harvest of rice under T_4 was 45.72 % and T_2 was 40.84 % higher as compared to 100% RDN through inorganic fertilizer in 0-15 and 15-30 cm, respectively. This might be due to increasing in available P_2O_5 content of soil with FYM application may be due to greater mineralization of organic P, production of organic acids making soil-P more available. Similar findings are observed by Yaduvanshi (2001).

Effect of integrated nitrogen management on available potassium in 0-15 cm depth of soil was found to be non-significant whereas in 15-30 cm depth of soil it was found significant. Among the different treatments, treatment T_4 (100% RDN castor cake) was recorded significantly higher available potassium (272.2 kg K_2O ha^{-1}) after harvest of rice in 15-30 cm depth of soil as compared to treatments T_1, T_8, T_9 and T_{10} but was remained statistically at par with treatments T_2, T_3, T_5, T_6 and T_7. The application of organic manure might also be attributed to direct addition of potash in available K pool of the soil which ultimately improved the availability of potash at harvest. Similar findings were also observed by Singh *et al.,* (2005) and Singh and Singh (2007).

Table.1 Chemical composition of FYM, vermicompost and castor cake

Parameters	FYM	Vermi-compost	Castor cake	Method followed
Total nitrogen content (%)	0.45	0.72	4.2	Kjeldahl digestion method (Jackson, 1973)
Total phosphorus content (%)	0.40	1.39	1.8	Vanadomolybdo phosphoric acid yellow colour method (Jackson, 1973)
Total potassium content (%)	0.50	0.60	1.3	Flame photometry (Jackson,1973)

Table.2 Effect of integrated nitrogen management on grain and straw yield of rice

Sr.No.	Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
T_1	Control (RDN: 100 kg N ha^{-1} through inorganic fertilizer)	3084	5755
T_2	100% RDN through FYM	3379	7060
T_3	100% RDN through vermicompost	3289	6637
T_4	100% RDN through castor cake	4016	7974
T_5	50% RDN through FYM + 50% RDN through inorganic fertilizer	4346	6892
T_6	50% RDN through vermicompost + 50% RDN through inorganic fertilizer	4039	6004
T_7	50% RDN through castor cake + 50% RDN through inorganic fertilizer	4461	7129
T_8	25% RDN through FYM +75% RDN through inorganic fertilizer	3894	6765
T_9	25% RDN through vermicompost + 75% RDN through inorganic fertilizer	3969	6339
T_{10}	25% RDN through castor cake + 75% RDN through inorganic fertilizer	4331	6820
	S. Em. ±	**243**	**318**
	CD at 5%	**706**	**925**
	CV %	**12.54**	**9.47**

Table.3 Effect of integrated nitrogen management on chemical properties of soil after harvest of rice

Sr. No.	Treatments	pH		E C (dS m^{-1})		Organic Carbon (%)		Available N (kg ha^{-1})		Available P_2O_5 (kg ha^{-1})		Available K_2O (kg ha^{-1})		ESP (%)	
		0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 Cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
T_1	Control (RDN: 100 kg N ha^{-1} through inorganic fertilizer)	8.59	8.34	0.71	0.63	0.20	0.24	150.3	175.5	28.98	32.02	226.5	233.9	17.80	17.61
T_2	100% RDN through FYM	8.47	8.27	0.62	0.59	0.43	0.55	244.6	251.0	41.45	45.10	245.3	264.8	13.38	13.71
T_3	100% RDN through vermicompost	8.44	8.04	0.61	0.59	0.35	0.47	228.9	247.8	40.96	43.53	245.8	255.4	14.55	14.80
T_4	100% RDN through castor cake	8.38	8.25	0.60	0.54	0.42	0.54	243.7	244.6	42.23	41.35	262.8	272.2	14.38	14.92
T_5	50% RDN through FYM + 50% RDN through inorganic fertilizer	8.52	8.15	0.63	0.55	0.38	0.46	232.3	228.9	34.55	31.12	239.3	271.5	15.53	15.90
T_6	50% RDN through vermicompost + 50% RDN through inorganic fertilizer	8.49	8.28	0.63	0.55	0.42	0.52	225.8	225.8	36.33	37.23	233.2	266.8	15.62	15.99
T_7	50% RDN through castor cake + 50% RDN through inorganic fertilizer	8.37	8.30	0.62	0.52	0.36	0.46	232.1	228.9	34.55	36.85	235.9	259.4	15.37	15.61
T_8	25% RDN through FYM +75% RDN through inorganic fertilizer	8.58	8.19	0.63	0.53	0.33	0.48	207.0	207.0	33.03	40.17	237.9	235.2	15.63	16.14
T_9	25% RDN through vermicompost + 75% RDN through inorganic fertilizer	8.52	8.31	0.65	0.57	0.37	0.45	207.0	205.4	34.03	39.06	232.5	242.6	15.35	15.71
T_{10}	25% RDN through castor cake + 75% RDN through inorganic fertilizer	8.46	8.31	0.64	0.53	0.39	0.45	203.7	213.3	36.08	42.21	233.2	247.3	15.15	15.85
	S. Em. ±	**0.15**	**0.13**	**0.03**	**0.01**	**0.03**	**0.02**	**11.17**	**10.82**	**2.34**	**2.09**	**8.22**	**8.45**	**0.65**	**0.59**
	CD at 5%	**NS**	**NS**	**NS**	**0.03**	**0.07**	**0.07**	**32.40**	**31.39**	**6.79**	**6.06**	**NS**	**24.52**	**1.89**	**1.70**
	CV %	**3.54**	**3.20**	**8.91**	**3.71**	**13.87**	**10.06**	**10.27**	**9.71**	**12.94**	**10.75**	**6.87**	**6.63**	**8.54**	**7.50**

Exchangeable Sodium Percentage (ESP)

The data on exchangeable sodium percentage after harvest of rice influenced by integrated nitrogen management is presented in Table 3. The effect of different treatments of INM was found significant on ESP of both the soil depths after harvest of rice. The significantly minimum ESP values, 13.38% and 13.71% were recorded under the treatment receiving 100% RDN through FYM (T_2) in 0-15 cm and 15-30 cm soil depth, respectively, but it was at par with treatments T_3, T_4 and T_{10} in 0-15 cm depth and with treatments T_3 and T_4 in 15-30 cm soil depth. With different sources of organic manure under study, the resulted reductions of ESP were 24.83%, 18.25% and 19.15% and 22.14%, 15.95% and 15.27% with application of 100% RDN through FYM, vermicompost and castor cake over application of 100 % of inorganic fertilizer in 0-15 cm and 15-30 cm depths, respectively. Similarly, Sarwar *et al.*, (2008) and Virdia and Mehta (2009) also reported that application of organic manure alone or in combination of inorganic fertilizer reduced the ESP. The application of organic matter to salt-affected soil promotes flocculation of clay minerals, which is an essential condition for the aggregation of soil particles. It also plays an important role in increasing bio pores spaces, which increase Na^+ leaching and consequently decreased the exchangeable sodium percentage (Lakhdar *et al.*, 2010).

It can be concluded that integrated use of organic manure (FYM, vermicompost and castor cake) with inorganic fertilizers could be beneficial to maintain sustainable rice yield as well as to improve the soil chemical properties and reclamation of sodic soil as compared to inorganic fertilizer alone.

References

Anonymous (2017). Annual Report. Central Soil Salinity Research Institute, Karnal.

Bafna, A. M., Arvadia, M. K., Gami, R. C., Patel, K. G., Patel, Z. N. and Patel, K. P. (2010). Integrated nutrient management on paddy-sugarcane cropping sequence. State Level Seminar on "*Organic Farming*"-2010, Navsari, Gujarat, pp: 134-135.

Bahadur, L., Tiwari, D. D., Mishra, J., Gupta, B. R. (2013). Evaluation of integrated nutrient management options in rice-wheat (*Triticum aestivum*) cropping system in reclaimed sodic land. *Indian Journal of Agronomy*, 58(2): 137-145.

Das, D.K, (2011). Introductory Soil Science, Kalyani Publishers, Ludhiana, Haryana. 3rd Edn. pp. 335-336.

Gupta, V. and Sharma, R. S. (2010). Effect of integrated nutrient management on yield and nutrient uptake based cropping, conducted at Jabalpur. *Research on Crops*, 11: 239-243.

Jackson, M. L. (1973). Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd., New Delhi.

Koushal, S., Sharma, A.K. and Singh, A. (2011). Yield performance, economics and soil fertility through direct and residual effects of organic and inorganic sources of nitrogen as substitute to chemical fertilizer in rice-wheat cropping system. *Research Journal of Agricultural Science*, 43(3): 189-193.

Kumar, J. and Yadav, M. P. (2008). Effect of conjunctive use of organic, inorganic and bio-fertilizers on growth and yield attributes, yield and nutrient uptake in hybrid rice. *Research on Crops*, 9(3): 511-513.

Kumar, M., Yaduvanshi, N. P. S., Singh, Y. V. (2012). Effect of integrated nutrient management of rice yield, nutrient uptake and soil fertility status in reclaimed sodic soil. *Journal of Indian Society of Soil Science*, 60(2): 132-137.

Lakhdar, A., Scelza, R., Scotti, M., Rao, N., Jedidi, L., Gianfreda, C. Abdelly.

(2010). The effect of compost and sewage sludge on soil biologic activities in salt affected soil. *R.C. Suelo Nutr. Veg*., 10(1): 40-47.

Mishra, V. K. and Sharma, R. B. (1997). Effect of fertilizers alone and in combination with manure on physical properties and productivity of entisol under rice-based cropping system. *Journal of the Indian Society of Soil Science*, 45: 84-88.

Olsen, S. R., Cole, V. C., Watenable, P. S. and Dean, L. A. (1954). Estimation of available phosphorus in soil by extraction with sodium bicarbonates. *Chemical Abstract*, 48(16): pp.1598.

Pitaman, M. G., and Lauchili, A. (2002). Global impact of salinity and agricultural ecosystem. *In* Salinity: Environment-plants-Molecules; Lauchili, A., Luttge, U., Eds.; Kluwer Academic Publisher: Dodrech, *The Netherlands*, pp. 3-20.

Sarwar, G., Hussain, N., Schmeisky, H., Muhammad, S. (2008). Use of compost an environment friendly technology for enhancing rice-wheat production in Pakistan. *Pakistan Journal of Botany*, 39(5): 1553-1558.

Sepehya, S., Subehia, S. K., Rana, S. S., and Negi, S.C. (2012). Effect of integrated nutrient management on rice-wheat yield and soil properties in a north western Himalayan region. *Indian Journal of Soil Conservation*, 40: 135-140.

Singh, B. and Singh, R. V. (2007). Comparative performance of rice hybrid sat different fertility levels under irrigated transplanted condition. *International Journal of Agricultural Science*, 4(2): 485-488.

Singh, K., Singh, R. K., Herojit, A., Zoliana, S. and Gopimohon, N. (2005). The economy in fertilizer use, sustaining soil health and yield of crops could be achieved only by conjunctive use of fertilizer, organic and biofertizers. *Journal of the Indian Society of Soil* Science, 53: 107-115.

Singh, Yadvinder, Singh, Bijay, Ladha, J. K., Khind, C. S., Gupta, R. K., Meelu, O. P., Pasuquin, E. (2004). Long-term effects of organic inputs on yield and soil fertility in the rice-wheat rotation. *Soil Sci. Soc. America J.* 68(3): 845-853.

Subbiah, B. V and Asija, G. L. (1956). A rapid procedure for the estimation of available nitrogen in soils. *Curr. Sci.*, 25: 259-260.

Virdia, H. M. and Mehta, H. D. (2009). Integrated nutrient management in transplanted rice (*Orayza sativa* L.). *Journal of Rice Research*, 2(2): 99-104.

Yaduvanshi, N. P. S. (2001). Effect of five years of rice-wheat cropping and NPK fertilizer use with and without organic and green manures on soil properties and crop yields in a reclaimed sodic soil. *Journal of the Indian Society of Soil* Science, 49(4): 714-719.

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