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Effect of integrated nutrient management on physical and chemical properties of soil under South Gujarat condition

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Abstract
An investigation entitled, Effect of integrated nutrient management in rice crop under South Gujarat condition was conducted during *kharif* season of 2012 and 2013 at the Instructional Farm, Department of Agronomy, N.M. College of Agriculture, Navsari Agricultural University, Navsari (Gujarat). The soil of the experimental field was clayey in texture, low in organic carbon (0.45%) and available nitrogen (220.80 kg/ha), medium in available phosphorus (40.60 kg/ha) and high in available potash (321.12 kg/ha). The soil was slightly alkaline in reaction (pH 8.0).The experiment was laid out in randomized block design with five treatments replicated four times *viz*., General RDF (RDF + FYM @ 10 t/ha), 75% RDN through chemical fertilizer + 25% RDN through biocompost, 75% RDN through chemical fertilizer + 25% RDN through vermicompost, 75% RDN through chemical fertilizer + 25% RDN through FYM and control.Significantly higher organic carbon, available nutrient status (NPK) and least bulk density of soil after harvest of the crop were observed through application of general RDF (RDF + FYM @ 10 t/ha) during both the years of experimentation and in pooled results over the years and over control. On the basis of experimental results, it can be concluded that for maintaining good soil health, *kharif* rice crop should be nourished with general RDF (RDF: 100-30-00 kg N-P-K/ha + FYM @ 10 t/ha).

Keywords: Nutrient management, rice, soil property

Introduction
Rice (*Oryza sativa* L.) is one of the most important cereal crops. In country like India, rice is the most important food crop, it is not only an integral part of daily diet but also it is an integral part of spiritual religious ceremonies and holy festivals. Globally, India ranks first in rice area and second in rice production after China. Within the country, rice occupies one-quarter of the total cropped area, contributes about 40 to 43% of total food grain production and continues to play a vital role in the national food and livelihood security system. Area under rice cultivation in India was 42.75 million hectares with production of 105.24 million tonnes and the productivity of 2462 kg per hectare. Area under rice cultivation in Gujarat was 7.01 lakh hectares, production of 15.41 lakh tonnes and the productivity of 2198 kg per hectare (Anon., 2013) [1].

Keeping in view the average annual population growth rate of 1.5% and per capita consumption estimate of about 400 g of rice per day, demand for rice in India expected to be 140 million tonnes by 2025 (Mishra, 2003) [11]. For satisfying the growing demand of increasing population, 38 per cent more rice has to be produced by 2030 (Khush, 2007) [8].

Continuous cultivation of rice for longer periods and often under poor soil and crop management practices, resulted in the loss of soil fertility as indicated by the emergence of multi-nutrient deficiencies (Fujisaka *et al.* 1994, Singh and Singh 1995, Dwivedi *et al*. 2001) [4, 16, 3] and deterioration of soil physical properties (Tripathi, 1992) [19]. This decline in soil quality resulted in a decrease in factor productivity and overall crop productivity (Yadav, 1998) [20]. Olk and Cassman (1995) [13] proposed that the relatively low response to nitrogen (N) fertilizers in continuously flooded rice systems was associated with sequestration of N as recalcitrant N compounds that have slow mineralization rates; these N complexes are formed as a result of slow and incomplete decomposition of retained rice crop residues. Intensive agriculture involving exhaustive high yielding varieties of rice has led to heavy withdrawal of nutrients from the soil, imbalanced and indiscriminate use of chemical fertilizers has resulted in deterioration of soil health (John *et al.* 2001) [7].

The basic concept of integrated nutrient management (INM) is the maintenance or adjustment of soil fertility and supply plant nutrients to an optimum level for sustaining the desired crop productivity through optimization of benefits from all possible sources of plant nutrients in an integrated manner (Tondon, 1992) [18]. The appropriate combination of mineral fertilizers, organic manures and crop residues varies according to the system, land use, ecological, social and economic conditions. Inspite of increased use of fertilizer nutrients, there is a gap between the nutrients applied and nutrients harvested, which is likely to widen further with the achievement of targets, leading to mining of soil. Over use of certain potential areas and sub-optional use of larger areas are crucial issues. Experiences from long term fertilizer experiments revealed that integrated use of farm yard manures, vermicompost, biocompost, *etc.* with graded levels of chemical fertilizers is promising not only in maintaining higher productivity but also in providing maximum stability in crop production. The response of N as chemical fertilizer generally increases when it is used in combination with FYM, vermicompost, *etc.* and saves N fertilizer (Nambiar and Abrol, 1989) [12].

Although a good deal of information is available on fertilizer application for higher production of rice as well as green gram and so far FYM is the organic source, which has been used predominantly but meagre work has been done on vermicompost and biocompost as organic source as far as rice–green gram sequence is concerned. The information on INM in rice–green gram cropping sequence is lacking. Hence, the present investigation was therefore, undertaken to find out the effect of integrated nutrient management in Rice - Green Gram cropping sequence under South Gujarat condition.

Material and Methods

Study site and Treatment details

An experiment was conducted during *kharif* season of 2012 and 2013 on transplanted rice under rice-green gram cropping sequence at Instructional Farm, Navsari Agricultural University, Navsari (Gujarat). The soil of the experimental site was clayey in texture belonging to *Inceptisols*. As regards chemical composition, it was low in organic carbon (0.45%) and available nitrogen (220.80 kg/ha), medium in available phosphorus (40.60 kg/ha) and high in available potassium (321.12 kg/ha). The soil was slightly alkaline in reaction (pH 8.0). The experiment was laid in randomized block design with four replications. Experiment comprised of five treatments replicated four times in randomized block design, involving T1 - general RDF (RDF:100-30-00 kg N-P-K/ha + FYM @ 10 t/ha), T2 - 75% Recommended dose of nitrogen (RDN) through chemical fertilizer + 25% RDN through biocompost, T3 - 75% RDN through chemical fertilizer + 25% RDN through vermicompost, T4 - 75% RDN through chemical fertilizer + 25% RDN through FYM and T5 – control (no fertilizer/manure). The fertilizers were applied as per treatments through ammonium sulphate and single super phosphate for nitrogen and phosphorus, respectively. The 40% dose of nitrogen and full dose of phosphorus were applied at the time of transplanting, 40% dose of nitrogen at maximum tillering stage and remaining 20% dose of nitrogen at panicle initiation stage. All the calculated quantity of organic manures was applied before 15 days of transplanting.

Sowing and Harvesting

Rice crop (Cv. Jaya) was transplanted at 20 x 15 cm spacing on 12th and 22nd of July during 2012 and 2013, respectively. Recommended seed rate was used and plant protection measures were applied as and when necessary. The rice crop was harvested close to the ground with the help of sickle at maturity. The border lines were harvested first and removed from the experimental area. The net plot area was harvested and the produce was allowed to sun dry in respective plots for three days. Then the produce was tied into bundles and weighed for recording total quantity of produce separately for each plot. The plot wise threshing and cleaning operations were carried out. Subsequently, the grain/seed yields were recorded and straw/stover yields were computed by subtracting the grain/seed yields from the total biological yield for each net plot.

Soil analysis

Plotwise composite soil samples drawn from 0-22.5 cm depth before starting of experimentation and after harvest of crop during both the years. The soil samples were dried under shade, ground and then sieved through 2 mm size sieve. The initial soil samples were analysed for different physico-chemical properties. The soil samples collected after harvest of rice were used to determine available nitrogen, phosphorus, potassium, organic carbon and bulk density by using standard methods.

Statistical analysis

The data on various variables and pooled analysis of two years data were carried out by using statistical procedures as described by Panse and Sukhatme (1967) [14].

Results and Discussion

Physical properties of soil

Bulk density (g/cc)

Data presented in Table 1 indicated that bulk density decreased slightly due to manurial application as compared to control (T_5) during both the years of study and also in pooled results. However, these values observed in various manurial treatments did not achieve the level of significance. The relative reduction in bulk density of soil was found more pronounced with the treatment of general RDF (RDF + FYM 10 t/ha) (T_1).

The integration of inorganic fertilizer and organic manure helped in maintaining the bulk density value same as that of control. Lower values of bulk density were observed under FYM application than initial status during both the year study and pooled analysis. It might be the result of higher organic matter content, more pore space and better aggregation of soil particles. These findings are in close conformity with those of Gaud (2004) [5].

Chemical properties of soil

Organic carbon (%)

The data on per cent soil organic carbon content after harvest of rice as influenced by different treatments are presented in Table 1 indicated that organic carbon content in the soil was improved significantly due to use of organic manures *viz.*, FYM, vermicompost and biocompost over control (T_5) during both the years of investigation and in pooled data. Almost all the treatments which received organic manure with full or reduced dose of RDN (T_1 to T_4) increased the organic carbon content of the soil in between the range of 0.52 to 0.62% against initial status of 0.45% during both the years of study and also in pooled analysis. Whereas, control (T_5) treatment did not show any changes in organic carbon content of soil during both the years of study and in pooled analysis.

The soil organic carbon was increased by integrated nutrient management than initial status. All the integrated nutrient management treatments recorded significantly highest organic carbon over control, however integration of inorganic fertilizer with FYM recorded higher values of organic carbon during individual year and pooled. Its enhancement is attributed to direct application of large quantity of organic matter in the soil. The increase in organic carbon content of the soil with the application of fertilizers and FYM had also been reported by Singh *et al.* (2001) [17], Gaud (2004) [5], Kumar *et al.* (2012) [9] and Chesti *et al.* (2013) [2].

Available nitrogen (kg/ha)

The data on soil available nitrogen (kg/ha) at 0-22.5 cm profile depth after harvest of rice as influenced by various treatments are presented in Table 2 during both the years of experimentation and in pooled analysis. The mean available nitrogen content of soil after harvest of rice were 222.84, 223.43 and 223.14 kg/ha during 2012, 2013 and pooled, respectively, indicating improvement in available nitrogen during both the years of experimentation and pooled as compared to initial nitrogen status (220.80 kg/ha).

The soil available nitrogen (236.25, 238.78 and 237.51 kg/ha) registered after harvest of rice was significantly higher due to application of general RDF (RDF + FYM @ 10 t/ha) (T_1) over control and remained at par with 75% RDN through chemical fertilizer + 25% RDN through vermicompost (T_3) during both the years of experimentation as well as in pooled results. Further results indicated that, application of 75% RDN through chemical fertilizer + 25% RDN through vermicompost (T_3), 75% RDN through chemical fertilizer + 25% RDN through biocompost (T_2) and 75% RDN through chemical fertilizer + 25% RDN through FYM (T_4) found at par with each other during both the years of study and pooled. Control (T_5) treatment showed reduction in available nitrogen status (210.72, 204.95 and 207.83 kg/ha) than initial status (220.80 kg/ha) of soil during 2012, 2013 and pooled, respectively.

The available nitrogen content in soil after harvest of rice was influenced significantly due to integration of inorganics and organics and recorded increased in available nitrogen content over initial status during both year and pooled at 0-22.5 cm profile depth, while depletion of soil available nitrogen content was noticed under control plot as compared to initial status. Significantly maximum available nitrogen content was observed with the application of general RDF (RDF + FYM @ 10 t/ha) during individual year and pooled analysis. This may be due to application of higher quantity of nutrients and their complementary effects. The buildup in available nitrogen content in soil due to integration of inorganics and FYM had been observed by Singh *et al.* (2001) [17], Laxminarayana and Patiram (2006) [10], Chesti *et al.* (2013) [2] and Paul *et al.* (2013) [15].

Available phosphorus (kg/ha)

The data pertaining to soil available phosphorus (kg/ha) at 0-22.5 cm profile depth after harvest of rice as affected by different treatments are presented in Table 2 during both the years of experimentation and in pooled analysis. The mean available phosphorus during 2012, 2013 and pooled were 42.80, 42.96 and 42.88 kg/ha respectively, indicating improvement in available phosphorus as compared to initial status of 40.60 kg/ha during both the year study and pooled analysis.

The differences among the treatments were non significant during year 2012, 2013 and pooled analysis. Maximum available phosphorus (44.27, 44.52 and 44.39 kg/ha) was registered under the application of general RDF (RDF + FYM @ 10 t/ha) (T_1) during individual year and pooled analysis. Lowest available phosphorus content (40.55, 40.50 and 40.52 kg/ha) was exhibited by control (T_5) treatment during 2012, 2013 and pooled data.

The available phosphorus content of the soil increased due to integration of inorganics and organics than initial status at 0-22.5 cm after harvest of rice. The increase in available phosphorus content in soil was maximum under application of general RDF (RDF + FYM @ 10 t/ha) during individual year and pooled analysis. It may be attributed due to the mineralization of organic phosphorus, production of organic acids making soil phosphorus more available, also the organic anions retard the fixation of soil phosphorus attributed to formation of soluble complexes between humic/fulvic acids and phosphate. Several workers have reported similar results Singh *et al.* (2001) [17], Laxminarayana and Patiram (2006) [10], Chesti *et al.* (2013) [2] as well as Paul *et al.* (2013) [15]. No significant difference observed between available phosphate remaining in the soil after harvest of rice and that remaining after green gram harvest. This shows that phosphate fixation in *kharif* rice was nearly of the same magnitude as that of *rabi* (Gupta *et al.*, 1999) [6].

Available potassium (kg/ha)

The available potassium status of soil (Table 2) at 0-22.5 cm soil depth after harvest of rice did not explicit the level of significance during both the years and pooled. It is evident from the data that there was a build up of soil available potassium during successive years as compared to initial level (321.12 kg/ha). The mean values of available potassium content of soil were 327.00, 330.98 and 328.99 kg/ha during 2012, 2013 and pooled, respectively.

The highest available potassium content of soil was observed in treatment (T_1) general RDF (RDF + FYM @ 10 t/ha) during both the years of experimentation and pooled, the values recorded due to this treatment were 331.53, 336.81 and 334.17 kg/ha during first year, second year and pooled, respectively. Lowest value of available potassium content (322.38, 323.93 and 323.16 kg/ha) of soil was observed in control (T_5) treatment during both the years of experimentation.

The build up of soil available potassium due to addition of inorganics in combination with organics after harvest of rice at soil depth 0-22.5 cm than initial status of soil. The application of general RDF (RDF + FYM @ 10 t/ha) recorded maximum build up of available potassium content during individual year and pooled analysis. It might be due to additional potassium applied through FYM, the solubilisation action of certain organic acids produced during FYM decomposition and its greater capacity to hold K_2O in the available form. Similar results were also reported by Laxminarayana and Patiram (2006) [10] and Chesti *et al.* (2013) [2].

Table 1: Bulk density (g/cc) and organic carbon (%) of soil as influenced by different treatment after harvest of rice

Treatments	Bulk density (g/cc)			Organic carbon (%)		
	2012	2013	Pooled	2012	2013	Pooled
T_1 : General RDF (RDF + FYM @ 10 t/ha)	1.46	1.44	1.45	0.59	0.62	0.61
T_2 : 75% RDN through chemical fertilizer + 25% RDN through biocompost	1.50	1.49	1.50	0.52	0.53	0.52
T_3 : 75% RDN through chemical fertilizer + 25% RDN through vermicompost	1.51	1.51	1.51	0.53	0.55	0.54
T_4 : 75% RDN through chemical fertilizer + 25% RDN through FYM	1.48	1.47	1.48	0.56	0.58	0.57
T_5 : Control	1.52	1.53	1.52	0.44	0.45	0.45
SE m±	0.024	0.034	0.021	0.013	0.017	0.011
C.D. at 5%	NS	NS	NS	0.04	0.05	0.03
C.V. %	3.21	4.59	3.96	5.05	6.04	5.58
General mean	1.49	1.49	1.49	0.53	0.55	0.54
Initial status	1.38			0.45		

Table 2: Available nutrient (N, P_2O_5 and K_2O) status (kg/ha) of soil as influenced by different treatment after harvest of rice

Treatments	Available N (kg/ha)			Available P_2O_5 (kg/ha)			Available K_2O (kg/ha)		
	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled
T_1 : General RDF (RDF + FYM @ 10 t/ha)	236.25	238.78	237.51	44.27	44.52	44.39	331.53	336.81	334.17
T_2 : 75% RDN through chemical fertilizer + 25% RDN through biocompost	220.60	222.42	221.51	42.88	43.05	42.97	326.86	330.28	328.57
T_3 : 75% RDN through chemical fertilizer + 25% RDN through vermicompost	227.28	229.58	228.43	43.79	44.01	43.90	327.77	332.65	330.21
T_4 : 75% RDN through chemical fertilizer + 25% RDN through FYM	219.36	221.45	220.40	42.51	42.70	42.60	326.45	331.22	328.83
T_5 : Control	210.72	204.95	207.83	40.55	40.50	40.52	322.38	323.93	323.16
SE m±	4.894	5.256	3.591	1.101	1.707	1.016	8.579	12.156	7.439
C.D. at 5%	15.08	16.20	10.48	NS	NS	NS	NS	NS	NS
C.V. %	4.39	4.70	4.55	5.15	7.95	6.70	5.25	7.35	6.40
General mean	222.84	223.43	223.14	42.80	42.96	42.88	327.00	330.98	328.99
Initial status	220.80			40.60			321.12		

Conclusion

On the basis of experimental results, it can be concluded that for getting higher returns and maintenance of soil health, *kharif* rice crop should be nourished with general RDF (RDF:100-30-00 kg N-P-K/ha + FYM @ 10 t/ha) under south Gujarat conditions.

References

1. Anonymous. Directorate of Economics and Statistics, Department of Agriculture and Cooperation, 2013.
2. Chesti MH, Ali T, Bhat MA. Effect of organic and inorganic phosphrous sources on quality of greengram (*Vigna radiate* L.) under temperature conditions of Jammu and Kashmir. Legume Research. 2013; 35(1):47-49.
3. Dwivedi BS, Shukla AK, Singh VK, Yadav RL. Results of participatory diagnosis of constraints and opportunities (PDCO) based trials from the state of Uttar Pradesh. In: Subba, R.A., Srivastava, S. editors. Development of farmers' resource-based integrated plant nutrient supply systems: experience of a FAO–ICAR–IFFCO Collaborative Project and AICRP on Soil Test Crop Response Correlation. Bhopal (India): IISS, 2001, 50-75.
4. Fujisaka S, Harrington L, Hobbs P. Rice–wheat in South Asia: systems and long-term priorities established through diagnostic research. Agriculture System. 1994; 46:169–187.
5. Gaud VV. Production potential and economic feasibility of rice based cropping system under integrated nutrient management. Ph.D. thesis submitted to Navsari Agricultural University, Navsari, 2004.
6. Gupta JP, Khanna YP, Surishta Devi. Effect phosphorus and farmyard manure on changes in phosphorus fractions in a rice soil. Madras Agricultural Journal. 1999; 86(7-9):359-362.
7. John PS, George M, Jacob R. Nutrient mining in agro – climatic zones of Kerala. Fertilizer News. 2001; 46:45-52, 55–57.
8. Khush GS. Rice breeding for 21st century. Book on Science, Technology and Trade for Peace & Prosperity, 2007, p64-65.
9. Kumar M, Yaduvanshi NPS, Singh YV. Effects of Integrated Nutrient Management on Rice Yield, Nutrient Uptake and Soil Fertility Status in Reclaimed Sodic Soils. Journal of the Indian Society of Soil Science. 2012; 60(2):132-137.
10. Laxminarayana K, Patiram. Effect of integrated use of inorganic, biological and organic manures on rice productivity and soil fertility in ultisols of mizoram. Journal of Indian Society of Soil Science. 2006; 54(2):213-220.
11. Mishra B. Rice research in India-Major achievements and future thrust. Paper presented in winter school on 'Advances in Hybrid Rice Technology' held at DRR Hyderabad, 2003, p48-59.
12. Nambiar KKM, Abrol IP. Long term fertilizer experiments in India – An overview. Fertilizer News. 1989; 34(4):11-20.
13. Olk DC, Cassman KG. Characterization of two chemically extracted humic acid fractions in relation to nutrient availability. ACIAR Proceedings No. 56. Canberra (Australia): ACIAR, 1995, p131–134.
14. Panse VG, Sukhatme PV. Statistical methods for Agricultural Workers. ICAR, New Delhi, 1967, p199-200.
15. Paul T, Bisht PS, Pandey PC, Singh DK, Roy S. Rice productivity and soil fertility as influenced by nutrient management in rice-wheat cropping system. Indian Journal of Agronomy. 2013; 58(4):495-499.
16. Singh J, Singh JP. Land degradation and economic sustainability. Ecological Economics. 1995; 15:77–86.
17. Singh SK, Varma SC, Singh RP. Effect of integrated nutrient management on yield, nutrient uptake and changes in soil fertility under rice-lentil cropping system. Indian Journal of Agronomy. 2001; 46(2):191-197.

18. Tondon HLS (Ed.). Fertilizers, organic manures, recyclable wastes and biofertilizers. Fertilizer Development and Consultation, New Delhi, 1992, 148.
19. Tripathi RP. Physical properties and tillage of rice soils in rice–wheat system. In: Pandey RK, Dwivedi BS, Sharma AK, editors. Rice-wheat cropping system. Modipuram (India): PDCSR, 1992, 53-67.
20. Yadav RL. Factor productivity trends in a rice–wheat cropping system under long-term use of chemical fertilizers. Experimental Agriculture. 1998; 34:1-18.