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Response of Organic Nitrogen Nutrition on Productivity and Quality of Produce in Rice-Tablepea-Onion Cropping Sequence

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Abstract

A field experiment was conducted during 2003-04 and 2004-05 to study the effect of various sources (farm yard manure, vermicompost and poultry manure) and rates of organic manures (100%, 125% and 150% RND) on yield, quality of produce, soil quality and economics of rice-tablepea-onion cropping sequence. Poultry manure at 150% RND gave higher grain (57.96 q/ha) and straw yield (91.27 q/ha) in rice, green pod yield (70.72 q/ha) and straw yield (70.03 q/ha) of tablepea and bulb (270.84 q/ha) and haulm yield (35.13 q/ha) of onion. On an average, application of poultry manure resulted improved values on soil organic carbon, uptake of available NPK and soil biological properties compared to varying doses of vermicompost, FYM and over the control treatment. Physical properties of soil viz. bulk density and water stable aggregates were not affected due to nitrogen management through organic sources. Economic analysis revealed that the highest rice-grain equivalent yield and maximum net profit (Rs 130,799/ha) from rice-tablepea-onion sequence were recorded with the application of 150% RND through poultry manure.

Key words : Rice, Tablepea, Onion, Cropping sequence, Organic farming.

Green revolution of India has undoubtedly changed the scenario of food grain production which has been more than doubled during post-green revolution period without any change in the cultivated area. This has resulted not only self-sufficiency in food grains production but also made the country food surplus. This increased level of production could be achieved only due to increased use of external agro-inputs mainly fertilizers. Use of these high analysis chemical fertilizers in imbalanced and indiscriminate manner had developed many problems like decline of soil organic matter, increase in salinity, sodicity, soil pollutant and hazards of pests and diseases (1). Continuous use of inorganic fertilizers has not only brought loss of vital soil fauna and flora but also resulted in loss of secondary and micronutrients. In organic production systems, the soil health is maintained and improved through stimulating the activity of soil organisms and organic manures are also helpful in alleviating the increasing incidence or deficiency of secondary and micronutrients and is capable of sustaining crop productivity. Organic manures modifies the soil physical behavior and increases the efficiency of applied nutrients (2). Regular application of organics in amounts sufficient to meet the requirements of crops not only results in increasing crop yield but also improve soil fertility and organic matter content (3). Use of organic manures to meet the nutrient requirement of crops would be an inevitable practice in the years to come for sustainable agriculture hence, organic matter should be replenished by adding organic manures. Therefore, the present study was conducted to find out the effect of various organic manures on yield, quality and nutrient uptake by rice-tablepea-onion cropping sequence and to explore the possibility of improving the productivity, profitability and sustainability of the above sequence by supply of nutrients through organic source.

Methods

A field experiment was conducted during 2003-04 and 2004-05 at Varanasi, Uttar Pradesh with rice-tablepea-onion cropping sequence during rainy, winter and summer seasons.The soil was sandy clay loam in texture with pH 7.12, 0.45% organic carbon and 180.5, 18.2 and 202.4 kg/ha available nitrogen, phos-

Table 1. Effect of organic nitrogen nutrition on the productivity of rice-tablepea-onion cropping sequence (q/ha). RND, recommended nitrogen dose; FYM, farmyard manure; VM, vermicompost; PM, poultry manure. Charges of input used (Rs/kg) : Urea 5.00, FYM 0.50, VM 3.00, PM 3.00.Selling price (Rs/kg) of organic produce : Rice grain 6.50, tablepea pod 8.00, onion bulb 4.00, rice and tablepea straw 1.00, Selling price (Rs/kg) of inorganic produce : Rice grain 5.00, tablepea pod 5.00, onion bulb 3.00, rice and tablepea straw 0.50.

	Rice						Table pea					
	Grain			Straw			Green pod			Straw		
Treatment	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1–100% RND as FYM	46.79	40.86	43.83	64.23	71.79	68.27	40.51	51.92	46.21	59.95	53.2	56.57
T_2–125% RND as FYM	47.44	41.51	44.47	64.59	77.89	71.06	40.98	54.8	47.89	60.21	60.89	60.55
T_3–150% RND as FYM	48.72	44.89	46.8	64.74	78.84	71.72	43.58	58.33	50.95	61.89	61.21	61.55
T_4–100% RND as VM	49.56	45.43	47.49	68.2	81.09	74.64	49.99	59.3	54.65	62.67	61.53	62.1
T_5–125% RND as VM	50.32	50.96	50.8	69.23	81.72	75.48	59.31	60.3	59.81	63.11	62.07	62.59
T_6–150% RND as VM	50.64	51.12	52	72.43	85.9	79.16	62.99	64.42	63.71	64.82	62.82	63.83
T_7–100% RND as PM	52.88	54.07	52.19	74.51	90.7	82.61	63.69	65.69	64.69	66.44	63.14	64.77
T_8–125% RND as PM	53.52	54.55	54.04	74.68	99.42	87.05	64.54	68.59	66.56	66.75	65.06	65.9
T_9–150% RND as PM	57.37	58.55	57.96	76.12	106.41	91.27	67.09	74.36	70.72	68.91	71.15	70.03
T_{10}–100% RND through urea	43.91	38.62	41.27	61.48	64.94	63.21	39.44	34.62	37.03	57.44	47.76	52.6
CD (P=0.05)	5.80	4.79	3.63	25.4	16.92	14.74	4.79	11.19	5.88	NS	14.07	8.78

Table 1. Continued.

	Onion					
	Bulb			Haulm		
Treatment	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1–100% RND as FYM	238.94	239.68	239.31	13.78	13.74	13.76
T_2–125% RND as FYM	245.94	244.76	245.35	21.87	14.68	18.27
T_3–150% RND as FYM	249.81	251.47	250.64	22.95	16.24	19.6
T_4–100% RND as VM	250.46	258.8	254.63	23.29	17.47	20.36
T_5–125% RND as VM	257.46	261.03	259.24	24.87	24.44	24.65
T_6–150% RND as VM	262.42	262.02	262.22	27.54	26.12	26.83
T_7–100% RND as PM	264.54	265.55	265.05	31.23	26.44	28.83
T_8–125% RND as PM	266.3	266.12	266.21	32.31	29.35	30.83
T_9–150% RND as PM	270.54	271.14	270.84	35.82	34.43	35.13
T_{10}–100% RND through urea	234.54	238.05	236.3	10.27	12.26	11.27
CD (P=0.05)	14	19.72	11.7	8.87	8.18	5.81

phorus and potassium, respectively. The experiment was carried out in randomized block design in fixed plots lay out replicated thrice consisting a set of 10 treatment combinations involving 3 sources of organic manures viz. farm yard manure (FYM), vermicompost (VM) and poultry manure (PM) adopting three different rates i.e. 100, 125 and 150% of recommended nitrogen dose (RND) and 100% RND through urea (control). The organic manures were applied as per their nutrient content on oven dry weight basis. The FYM, vermicompost and poultry manure contained 0.50, 2.30 and 2.80% N, 0.20, 0.75 and 2.20% P_2O_5 and 0.50, 1.23 and 1.30% K_2O respectively. Organic manures were applied as per treatment at sowing and mixed thoroughly in 15 cm top soil layer. In control treatment, recommended dose of nitrogen through urea was drilled 10 cm deep and 5 cm away from the seed or seedling. The cultivars of rice (Pusa Sugandha-3), tablepea (Early Apoorva) and onion (Pusa Red) were transplanted/sown at 20 × 10 cm, 30 × 10 cm and 20 × 10 cm, respectively. Protein content in rice and tablepea grain was estimated through NIR by taking whole grain under near infrared waves. Pungency (%) in onion was computed by allyl-propyl-disulphide content in onion bulb determined as pyruvic acid and using formula suggested by Hort and Fisher (4). The yield data were recorded and converted into rice-grain equivalent and system

Table 2. Total uptake of nitrogen, phosphorus and potassium (kg/ha) in rice - tablepea - onion sequence (mean data of 2 years).

Treatment	Rice			Tablepea			Onion			Total uptake of system (kg/ha)		
	N	P	K	N	P	K	N	P	K	N	P	K
T_1–100% RND as FYM	64.28	12.56	100.45	82.07	9.42	53.83	37.14	37.3	68.25	183.49	59.28	222.53
T_2–125% RND as FYM	66.52	13.22	105.19	83.355	10.59	54.37	38.08	37.88	69.97	187.96	61.69	229.53
T_3–150% RND as FYM	70.04	13.81	106.45	86.135	10.94	53.78	38.9	38.7	71.48	195.08	63.45	231.71
T_4–100% RND as VM	72.17	14.4	110.72	87.01	11.19	55.31	39.52	39.31	72.62	198.70	64.90	238.65
T_5–125% RND as VM	76.97	15.32	113.92	88.465	11.75	56.96	40.23	40.03	73.93	205.67	67.10	244.81
T_6–150% RND as VM	79.37	16.06	120	89.455	12.24	57.22	40.7	40.49	74.79	209.53	68.79	252.01
T_7–100% RND as PM	85.47	17.11	127.58	90.825	12.84	57.46	41.13	40.92	75.59	217.43	70.87	260.63
T_8–125% RND as PM	88.27	17.93	136.95	92.48	13.42	58.12	41.32	41.1	75.92	222.07	72.45	270.99
T_9–150% RND as PM	94.62	19.14	146.57	94.625	14.02	63	42.03	41.82	77.24	231.28	74.98	286.81
T_{10}–100% RND through urea	59.84	11.48	92.81	78.03	9.19	49.35	36.67	36.48	67.39	174.54	57.15	209.55
CD (*P*=0.05)	1.00	0.92	0.53	1.15	0.78	1.11	1.04	0.83	0.79	4.50	1.14	12.04

productivity was calculated on the basis of prevailing market prices of rice, tablepea and onion. Economics of treatments were calculated on prevailing market price of yield and inputs during investigation period.

Results and Discussion

Yield of Rice, Tablepea and Onion

An increase in grain and straw yields of rice were recorded during both the years with increase in level of nitrogen from 100% recommended dose to 150% under all the three sources of organic manures (Table 1). Among the different sources of manures used, PM proved significantly superior followed by CV and FYM. Pooled analysis revealed that the maximum grain and straw yields i.e. 40.4 and 44.4% higher than control were recorded with PM applied at 150% RND (T_9) which produced significantly greater yield response than other sources at all the levels of nitrogen application. However, during first year differences in straw yield were found non-significant. Grain and straw yield of rice behaved in similar manner and these might be attributed to better physical conditions of soil which provided congenial growing environment. Maximum reduction in rice yield was found when the crop was fertilized with 100% RND through urea.

The green pod yield level of tablepea improved considerably with successive increment in rate of organic nitrogen nutrition through FYM levels remained statistically at par. Incorporation of 150% RND as PM produced significantly higher green pod yield compared to other sources and their application rates and the increase was found to the extent of 70.1 and 114.8% higher over control treatment during first and second year, respectively. However, pooled data reflects that application of PM and VM at 150% RND produced significantly higher green pod yield over their 100% RND only and were at part with 125% RND. Similarly superior values of tablepea straw yields were recorded at higher levels of different sources for nitrogen nutrition. Poultry manure at 150% RND was best in enhancing straw yield and had 33.1% higher straw yield compared with control in pooled analysis.

Bulb and haulm yield of onion were affected significantly (Table 1). Use of FYM, VM and PM gave better bulb yield than the control (T_{10}). Increased application of organic manure alone, from 100 to 150% of the recommended dose of N, also increased bulb and haulm yield. Application of PM and VM brought significant improvement in bulb and haulm yield of onion over 100% RND through urea (control) irrespective of levels of manures. Application of 150% RND as PM recorded the maximum bulb and haulm yield of onion. However, superior values of bulb and haulm yield were recorded in order of PM>VM>FYM>control.

It may thus be inferred that sustainability of rice-tablepea-onion sequence production was not influenced by organic nitrogen nutrition and poultry manure among all organic sources used was proved most

Table 3. Effect of organic nitrogen nutrition on quality of rice-tablepea-onion cropping sequence.

	Rice							
	Hulling (%)		Milling (%)		Head rice recovery (%)		Protein content in grain (%)	
Treatment	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05
T_1–100% RND as FYM	71.51	71.61	59.81	59.89	57.44	57.48	5.90	5.87
T_2–125% RND as FYM	71.69	71.79	59.86	59.94	57.54	57.60	5.96	5.89
T_3–150% RND as FYM	71.76	71.84	60.26	60.34	57.92	57.99	5.99	5.99
T_4–100% RND as VM	71.94	72.01	60.28	60.36	57.94	58.01	6.06	6.16
T_5–125% RND as VM	72.10	72.16	60.36	60.44	58.03	58.08	6.15	6.24
T_6–150% RND as VM	72.19	72.25	60.45	60.53	58.10	58.14	6.21	6.31
T_7–100% RND as PM	72.22	72.31	60.60	60.68	58.25	58.33	6.44	6.54
T_8–125% RND as PM	72.58	72.68	60.69	60.77	58.59	58.67	6.48	6.57
T_9–150% RND as PM	72.61	72.73	61.20	61.28	58.82	58.91	6.54	6.74
T_{10}–100% RND through urea	70.94	71.06	59.69	59.77	57.37	57.45	5.89	5.84
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS

Table 3. Continued.

	Tablepea						Onion			
	Protein content (%)		Protein yield (kg/ha)		Carbohydrate content (%)		Pungency (%)		Carbohydrate (%)	
Treatment	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05
T_1–100% RND as FYM	16.20	16.27	270.86	315.96	56.50	56.75	0.0039	0.0021	10.37	10.30
T_2–125% RND as FYM	16.33	17.94	302.11	351.27	56.60	56.90	0.0044	0.0035	10.57	10.33
T_3–150% RND as FYM	17.20	18.00	329.55	365.94	57.30	57.55	0.0048	0.0039	10.83	10.50
T_4–100% RND as VM	17.29	18.08	335.77	372.09	57.60	57.85	0.0049	0.0045	10.90	10.80
T_5–125% RND as VM	17.75	18.11	360.86	384.84	57.90	58.15	0.0059	0.0058	10.97	10.87
T_6–150% RND as VM	17.81	18.52	368.13	415.22	58.25	58.50	0.0061	0.0066	11.03	10.93
T_7–100% RND as PM	18.11	19.01	406.03	429.06	58.69	58.94	0.0062	0.0072	11.07	11.03
T_8–125% RND as PM	18.66	19.02	432.35	451.67	59.25	59.50	0.0071	0.0076	11.60	11.20
T_9–150% RND as PM	19.10	19.22	452.10	458.01	59.93	60.18	0.0076	0.0078	11.80	11.97
T_{10}–100% RND through urea	15.30	16.05	247.40	296.93	56.26	56.51	0.0017	0.0014	10.20	10.10
CD (P=0.05)	2.44	2.92	20.88	8.45	1.15	1.12	NS	NS	NS	NS

effective. It might be due to the fact that mineralized nutrient from these sources could sufficiently meet the nutritional requirement of the crops. Thus higher rates over recommended nitrogen dose favorably influenced plant growth and development characters which ultimately resulted in higher yields.

Quality of Produce

There were no significant differences in parameters judged for quality of rice grain due to different treatments during both the years (Tables 2 and 3). Protein content, protein yield and carbohydrate content in tablepea grain differed significantly due to various treatments and the highest values of these were noticed with PM treatments followed by VC, FYM and 100% RND through urea, respectively. Poultry manure applied at 150% RND produced maximum protein content which was significantly superior over control, 100 and 125% RND as FYM during first year and to the control and 100% RND as FYM during second year of study. Rest all the treatments were found at par. Protein yield (452.10 and 458.01 kg/ha) and carbohydrate content (59.93 and 60.18%) during both years were observed significantly higher than other treatments when PM applied at 150% RND which was at par with PM at 125% RND. Pungency percentage in onion was significantly higher with PM application and followed the order of PM>VM> FYM>control (T_{10}). Each successive increase in the level of organic nitrogen nutrition through different sources showed significant improvement in pungency

Table 4. Parameters as influenced by organic nitrogen nutrition at the end of 2 years cycle of rice-tablepea-onion sequence.

Treatment	Soil physical parameters			Soil chemical parameters				Soil biological parameters		
	Bulk density (g/cc)	Porosity (%)	Water stable aggregates (%)	Organic carbon (%)	Available nutrient (kg/ha) N	P	K	Bacteria ($\times 10^3$)	Fungi ($\times 10^3$)	Actinomycetes ($\times 10^3$)
T_1–100% RND as FYM	1.36	40.32	18.01	0.44	184.34	24.43	154.41	62.82	22.5	33.73
T_2–125% RND as FYM	1.37	40.38	18.18	0.45	185.46	24.61	154.87	63.63	23.03	34.74
T_3–150% RND as FYM	1.39	41.34	18.2	0.46	186.72	25.44	155.44	66.92	24.00	35.43
T_4–100% RND as VM	1.38	40.3	18.01	0.47	187.73	26.52	157.42	72.34	25.31	36.25
T_5–125% RND as VM	1.4	40.36	18.2	0.48	189.44	27.82	158.84	77.94	27.94	37.44
T_6–150% RND as VM	1.41	41.18	18.5	0.49	189.95	28	160.42	78.65	28.63	43.18
T_7–100% RND as PM	1.39	40.2	18.04	0.5	190.44	28.42	161.72	79.54	29.45	46.94
T_8–125% RND as PM	1.41	40.22	18.32	0.52	191.43	28.84	162.43	80.44	32.11	54.46
T_9–150% RND as PM	1.42	40.95	18.65	0.54	192.98	29.43	164.12	82.45	37.82	58.23
T_{10}–100% RND through urea	1.35	40.02	18.00	0.4	178.95	22.44	152.44	41.85	11.49	33.44
Initial	1.35	40.00	18.00	0.38	178.43	22.41	151.24	41.45	11.25	32.41
CD (P=0.05)	NS	0.86	NS	0.12	9.78	0.56	8.94	–	–	–

per cent. The superior performance exhibited by PM in comparison to other sources and also better results obtained at higher RND may be explained with the fact it might have helped in improving the nutrients availability for a prolonged period and improved physical condition of soil allowed better utilization of nutrients and root penetration of crops.

Soil Quality

Soil physical parameters viz. bulk density and water stable aggregates did not showed any profound effect due to addition of organic materials (Table 4). The values of chemical properties of soil like organic carbon, available N, P and K increased significantly from initial stage and over control treatment on the completion of 2-years cycle of rice-tablepea-onion sequence. The maximum organic carbon build up was accured (0.54%) when 150% RND was supplied through PM (T_4) while the least value (0.40%) was noticed with the 100% RND through urea (T_{10}). The organic carbon of the soil increased over its initial status (0.38%) under nitrogen supply through organic sources. The nutrient status of the experimental site was also affected significantly by the application of different organic manures alongwith their varying rates. Results clearly indicated improved fertility status of soil due to increased values of available N, P and K in all organic treatments over its initial value as well as control. Application of organic manures with increased rate enhanced soil fertility over their lower doses. At the end of 2-year sequence, 150% RND applied as PM maintained higher values of organic carbon and available N, P and K. Next best treatments in this respect were also found when PM applied with reduced rates of 125% and 100% RND, respectively. Continuous application of organic manures in sufficient quantities have been reported to improve the soil organic carbon and available N, P and K in soil there by sustaining the soil health (5). Soil biological properties showed improvement in the soil microbial counts over its initial values at the end of 2-years cropping sequence due to supplementation of organic sources. Poultry manure applied at 150% RND was best which lead into higher counts of bacteria (82.45×10^3), fungi (37.82×10^3) and actinomycetes (58.23×10^3) closely followed by the treatments where PM was applied with reduced rates (T_8 and T_7), respectively. The control treatment (T_{10}) had relatively lower values of soil microbial count than the organic treatments. The favorable effect of organics on soil biological properties is a proven fact which helped in providing ideal conditions and presumably increased the microbial activity because of the available high organic matter. Hati et al. (6) also reported favorable effect of organic manures on soil physical and biological properties.

System Productivity and Economics

Pooled data of 2-years revealed that the system productivity of rice-tablepea-onion sequence in terms

Table 5. Effect of organic nitrogen nutrition on rice grain equivalent yield (RGEY) and economics of rice-tablepea-onion sequence (mean data of 2 years).

Treatment	System			Net return (Rs/ha) from componeny crops in sequence		
	Rice grain equivalent yield (RGEY)	Net return (Rs/ha)	Benefit : cost ratio	Rice	Tablepea	Onion
T_1—100% RND as FYM	24797	97749	1.29	4009	29804	63936
T_2—125% RND as FYM	25439	96602	1.18	1704	31046	63852
T_3—150% RND as FYM	26375	96846	1.10	284	33094	63468
T_4—100% RND as VM	27145	114198	1.50	7025	37108	70065
T_5—125% RND as VM	28394	116451	1.42	6260	40784	69407
T_6—150% RND as VM	29178	116038	1.32	4408	43530	68100
T_7—100% RND as PM	29492	130517	1.72	10877	45407	74233
T_8—125% RND as PM	29978	128233	1.56	9523	46515	72195
T_9—150% RND as PM	31167	130799	1.49	9493	49758	71548
T_{10}—100% RND through urea	22008	49494	0.91	3183	10109	36202

of rice-grain equivalent yield was highest with the application of PM at 150% RND than other treatments. In general the production of grain, pod and bulb of rice, tablepea and onion were higher with application of organic manures, respectively. Higher application rate of each manure augmented system productivity of which PM was best closely followed by VM. Pooled economic evaluation in terms of monetary return showed that all the organic nitrogen nutrition treatments gave higher net returns and benefit : cost ratio than control (Table 5), indicating that organic nitrogen management is a productive and remunerative practice while 100% RND through urea was not found to be economical. Onion gave maximum net profit followed by tablepea while rice cultivation in sequence was less profitable. In case of rice-tablepea-onion system, maximum net return of Rs 130,799/ha with 1.49 benefit : cost ratio was obtained when crops were fertilized with 150% RND through PM. It was followed by (Rs 1,30,517/ha and 1.72 benefit : cost ratio) 100% RND applied as PM. The benefit : cost ratio reduced with increase in the rate of manure application is an indicative of the fact that additional productivity obtained due to increased manurial dose over RND and the value of additional product/ha were not proportionately increased.

It was concluded that growing of rice-tablepea-onion sequence with organic nitrogen nutrition applied as 150% RND through PM could be beneficial for enhancing soil fertility and sustaining the system productivity.

References

1. Chakraborti M. and N. P. Singh. 2004. Bio-compost : a novel input to organic farming. *Agrobios News Let.* 2 : 14—15.
2. Pandey N., A. K. Verma, Anurag and R. S. Tripathi. 2007. Integrated nutrient management in transplanted hybrid rice (*Oryza sativa* L.). *Ind. J. Agron.* 52 : 40—42.
3. Ramesh P., N. R. Panwar, A. B. Singh and S. Ramana. 2008. Effect of organic manures on productivity, nutrient uptake and soil fertility of maize–Linseed cropping system. *Ind. J. Agric. Sci.* 78 : 351—354.
4. Hort F. L. and H. J. Fisher. 1970. Determination of Pyruvic acid in dehydrated onion. Pp. 433—434. *In Modern food analysis.* Springer Verlog, New York, USA.
5. Tiwari A., A. K. Dwivedi and P. R. Dikshit. 2002. Long term influence of organic and inorganic fertilization on soil fertility and productivity of soybean–wheat system in a vertisols. *J. Ind. Soc. Soil Sci.* 50 : 472—475.
6. Hati K. M., K. G. Mandal, A. K. Mishra, P. K. Ghosh and C. L. Acharya. 2001. Effect of irrigation regimes and nutrient management on soil water dynamics, evapo-transpiration and yield of wheat in vertisols. *Ind. J. Agric. Sci.* 71 : 581—587.