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Effect of Organic, Inorganic and Integrated Nutrient Management Practices on Rice - Wheat Cropping System

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ABSTRACT

The experiment on effect of organic, inorganic and integrated nutrient management practices on performance of rice-wheat crop under irrigated condition was conducted from 2004-05 to 2014-15 under IFS sub-centre Rewa (M.P.). The study reveals that the application of 100 per cent NPK (120 kg N, 60 kg P_2O_5 and 40 kg K_2O/ ha) + 25 kg zinc sulphate / ha based on soil test value for both the crops gave maximum rice yield of 38.86 q per ha and wheat yield of 37.78 q per ha and wheat equivalent yield of 73.49 q per ha with the net profit of Rs. 77291 per ha followed by integrated nutrient management system in which 50 per cent NPK was given through fertilizer + 50 per cent N through FYM. All the organic and inorganic nutrient management systems increased the rice yield by 18.04 per cent to 56.9 per cent as compared to initial conversion period. Similarly, grain yield of wheat crop was increased by 11.02 per cent to 45.39 per cent under different organic and inorganic nutrient management practices over conversion period. The organic carbon and available N status in soil were increased over initial status,while, K status was decreased by 1.58 per cent to 7.93 per cent as compared to initial status under different organic and inorganic nutrient management practices. The response of organic sources of nutrient was more in rice than wheat.

RICE (*Oryza sativa L.)* - wheat (*Triticum aestivum L.)* cropping system is a predominant cropping sequence in India. Approximately, 10.5 million hectare area comes under this cropping system and contributes 25 per cent of total food grain in India. About, 33 per cent of India's rice and 42 per cent of wheat are grown in this rotation. Nearly 63 per cent of total fertilizer used in the country is applied to rice and wheat crop alone (Yadav and Kumar 2009). Rice and wheat are the important crops of Madhya Pradesh which occupy an area of 15.59 lakh hectare and 42.75 lakh hectare, respectively with the production of 14.62 tonnes and 78.47 lakh tonnes, respectively. The average productivity of rice is 989 kg / ha and wheat is 1916 kg / ha.

Integrated nutrient management (INM) aims at efficient and judicious use of all the source of plant nutrients in an integrated manner to attain sustainable crop production with minimum deleterious effect of chemical fertilizers on soil health and least disturbance to the plant soil environment (Pillai, 1996).

There are indication of stagnation or even decline in the productivity of rice and wheat field due to decline in soil organic matter, over mining of nutrient reserve, loss of nutrients and non availability of cost effective fertilizers. The application of inorganic fertilizer even in balance form may not sustain in soil fertility and productivity under continuous rice-wheat cropping. However, integrated use of inorganic and organics including crop residues may improve the soil productivity (Chettry and Bandopadhyay, 2005 and Mankotia, 2007). Farm yard manure is proven source of nutrient in agricultural crops but its availability is quite inadequate (Mishra and Prasad, 2000).

Use of high analysis chemical fertilizers in imbalanced and indiscriminate manner has developed many problems like decline of soil organic matter, increase in salinity and sodicity, deterioration in the quality of crop produce, increase in hazardous pests and diseases and increase in soil pollutants (Chakraboti and Singh, 2004). In view of these facts, supply of all the plant nutrients has been advocated through organic sources only, but organic farming may not be feasible in modern commercial agriculture because it is unable to sustain high level of production to meet the food grain supply for the ever-increasing population (Tarafdar *et al.*, 2008).

Organic farming is a production system that avoids the use of synthetic chemical fertilizers, pesticides and growth regulating hormones and raises the crops with

the use of organic manure, biofertilizers, oilcakes, crop rotation, legumes, green manure and biological pest control in rice and wheat. Continuous use of inorganic fertilizer have not only brought about loss of soil founa and flora but also resulted in loss of secondary and micro nutrients in rice and wheat fields (Kharub and Chander, 2008).

Effect of different organic sources of manure like FYM, vermicompost, non edible oilcakes and biofertilizers in different combination have not been evaluated in scented rice and durum wheat under irrigated condition of Rewa region of Madhya Pradesh. Keeping above facts in view present experiment has been taken.

Material and Methods

The present investigation was made on silty clay loam soil of All India Coordinated Research Project on Farming System, Kuthulia Farm, JNKVV, College of Agriculture, Rewa during *kharif* and *rabi* season of 2004-05 to 2014-15. The experimental field was low in available N (224 kg / ha) and Phosphorous (8.2 kg / ha) and high in available potash (315 kg / ha). The cropping system was rice in *kharif* and wheat in *rabi*. The same treatment and layout were adopted in both the crops for all the years in the same field.

The scented variety of rice PS-5 was transplanted at 20 cm × 15 cm spacing on 2nd weeks of july in different years, in a non replicated randomized block design. The plot size was 20 m × 10 m and year was taken as replication. The treatments were T_1: 50 per cent NPK through fertilizers + 50 per cent N through FYM, T_2 : 1/3 N each through FYM, vermicompost a+nd Neem cake, T_3 : T_2 + intercrop in *Rabi* as mustard with wheat in 4:1, T_4 : T_2 + agronomic practices of weed control to both crop, T_5: 50 per cent N as FYM + PSB + Rock phosphate + Azospirilium, T_6 : T_2 + Azospirilium + PSB, T_7 : Recommended fertilizer dose and T_8 : T_2 + green leaf manuring 10 t / ha. The recommended fertilizer based on soil test value was 120 kg N, 60 kg P_2O_5 and 40 kg K_2O / ha + zinc sulphate 25 kg / ha for both the crops in T_7 and T_1. Wheat variety (durum) was HD 4672 and was sown in last week of November during all the years. All the recommended package of practices were adopted in both the crops.

Results and Discussion

(a) Effect on rice : The grain yield of scented rice variety PS-5 is presented in Table I. After perusal of the result it is evident that grain yield of rice was maximum (38.86 q / ha) in T_7, where, 100 per cent NPK was given through fertilizer followed by 33.49 q per ha in T_1, where, 50 per cent NPK was given through fertilizer and 50 per cent N through FYM. It is due to the fact that inorganic source of nutrient like fertilizer provide the essential element in readily available form as per need of rice crop by which productive tillers per m^2, number of sound grains per panicle and grain yield per panicle were increased in T_1 and T_7. Acharya *et al*. (1998) also reported the positive effect of inorganic fertilizer on yield attributes and yield of rice. Among different organic sources grain yield of rice was maximum (34.49 q per ha) in T_6 in which 1/3 N was given through FYM, 1/3 N through vermicompost and 1/3 N through oil cake + Azatobactor + PSB. The first three years period were considered as conversion period and response of different organic and inorganic sources of nutrient management was calculated (Table I). It is evident from the result that the maximum increase in grain yield of rice was observed in T_3, where, grain yield of rice was 57.69 per cent higher than the conversion period followed by 56.9 per cent in T_7, where, 100 per cent NPK was given through fertilizer. All the organic, inorganic and integrated nutrient management systems gave 18.04 to 57.69 per cent higher grain yield of rice as compared to base year period. The increase in grain yield under integrated nutrient management system in T_1 and 100 per cent NPK given through fertilizer in T_7 were due to supply of nutrients in balanced form for better growth of rice. Apart from above different organic sources improve the physical condition and microbial activity in soil after 3 year of experimentation. Adhikari and Mishra (2002), Khanda (2005) and Singh *et al.* (2000) also reported the positive effect of organic sources of nutrient on physical and chemical properties of soil.

(b) Effect on wheat : The data pertaining to grain yield of durum wheat is presented in Table II. It reveals that grain yield of wheat was maximum (37.78 q / ha) in T_7, where, 100 per cent NPK was given through fertilizer followed by 33.13 q per ha in T_1, where, 50 per cent NPK was given through fertilizer

TABLE I

Effect of different organic, inorganic and integrated sources of nutrients on grain yield (q per ha) of rice (PS-5) in different years

Treatments	Grain Yield (q per ha)												% Increase over Base year
	2004-05	2005-06	2006-07	Mean	2007-08	2008-9	2009-10	2010-11	2011-12	2012-13	2013-14	Mean	
T_1: 50 per cent NPK through fertilizers + 50 per cent N through FYM to both crops	24.52	36.09	24.52	28.37	30.68	36.6	45.45	40.77	39	35.93	39.25	33.49	18.04
T_2 : 1/3 N through FYM Vermicompost and Neem cake to both the crops	21.31	22.76	20.63	21.56	20.44	23.31	39.56	28.14	27.62	32.49	31.89	29.06	34.8
T_3: T_2 + intercropping of mustard in wheat	21.55	22.85	20.17	21.52	20.26	31.4	40.77	30.38	30.37	32.91	37.56	31.95	57.69
T_4: T_2 + Agronomic practices of weed control of both crops	21.29	22.12	21.05	21.48	20.17	31.4	39.98	28.08	30.65	34.16	37.75	31.74	47.77
T_5 : 50 per cent N as FYM + PSB + Rockphosphate + Azotobactor	20.5	24.14	21.34	21.99	21.56	24.76	42.12	34.12	32.94	33.94	30.92	31.48	43.15
T_6 : T_2 + Azotobactor + PSB	23.09	25.69	22.67	23.81	27.63	30.8	42.67	33.7	33.86	35	37.81	34.49	44.48
T_7 : 100 per cent NPK + 25 kg $ZnSo_4$ based on soil test value	27.62	23.97	22.74	24.77	31.4	37.02	44.45	41.97	41	36.24	39.98	38.86	56.9
T_8 : T_2 + green Manure in Rice	20.82	22.03	20.38	21.07	20.47	25.12	39.35	29.71	29.89	36.84	38.65	31.43	49.18

TABLE II

Effect of different organic, inorganic and integrated sources of nutrients on wheat (HD 4672) grain yield (q per ha) in different years

Treatments	Grain Yield (q per ha)												% Increase over Base year
	2004-05	2005 -06	2006-07	Mean	2007-08	2008-9	2009-10	2010-11	2011-12	2012-13	2013-14	Mean	
T_1 : 50 per cent NPK through fertilizers + 50 per cent N through FYM to both crops	22.85	24.85	20.67	22.79	21.71	35.03	35.97	35.03	36.7	37.92	29.59	33.13	45.39
T_2 : 1/3 N through FYM Vermicompost and Neem cake to both the crops	17.79	14.55	13.96	15.43	12.99	24.16	16.97	20.59	19.2	25.36	15.16	19.2	24.46
T_3 : T2 + intercropping of mustard in wheat	12.78W	12.9	11.05	12.24	11.08	15.73	17.81	16.3	22.6	19.97	10.26	16.25W	32.76
	0.82M	0.73	0.87	0.8	0.8	1.67	2.56	3.68	1.9	4.86	1.87	2.47M	
T_4 : T2 + Agronomic practices of weed control of both crops	17.38	15.62	12.56	15.18	13.59	17.03	18.81	24.16	21.2	25.52	16.42	19.52	28.67
T_5 : 50 per cent N as FYM + PSB + Rockphosphate + Azotobactor	17.48	12.52	12.78	14.26	15.38	23.98	16.48	17.5	19	19.95	18.24	18.64	30.76
T_6 : T2 + Azotobactor + PSB	20.13	16.02	14.35	16.83	16.88	24.76	15.22	19.32	18.4	26.05	15.76	19.48	15.77
T_7 : 100 per cent NPK + 25 kg Znso4 based on soil test value	39.41	36.85	25.83	34.03	26.88	36.84	43.79	35.63	39	44.89	37.44	37.78	11.82
T_8 : T2 + green Manure in Rice	18.03	14.04	13.39	15.15	14.41	19.33	18.24	22.34	21.9	20.01	15.7	18.84	24.4

TABLE III

Effect of different organic, inorganic and integrated sources of nutrients on Yield and NMR

Treatments	Rice (q per ha)		Wheat (q per ha)		Wheat Equivalent (q per ha)	Net Profit (Rs. / ha.)
	Base 3 years Average	Average 7 years	Base 3 years Average	Average 7 years		
T_1 : 50 per cent NPK through fertilizers + 50 per cent N through FYM to both crops	28.37	33.49 (18.04%)	22.79	33.13 (45.39%)	67.52	67156
T_2 : 1/3 N through FYM Vermicompost and Neem cake to both the crops	21.50	29.06 (34.80%)	15.43	19.20 (24.46%)	47.08	30178
T_3 : T_2 + intercropping of mustard in wheat	21.52	31.95 (57.69%)	12.24 0.80M	16.25W (32.76%)	52.49	40601
T_4 : T_2 + Agronomic practices of weed control of both crops	21.48	31.74 (47.70%)	15.18	19.52 (28.62%)	49.74	35044
T_5 : 50 per cent N as FYM + PSB + Rockphosphate + Azotobactor	21.99	31.48 (43.15%)	14.26	18.64 (30.76%)	48.5	57048
T_6 : T_2 + Azotobactor + PSB	23.81	34.49 (44.48%)	16.83	19.48 (15.77%)	52.04	39752
T_7 : 100 per cent NPK + 25 kg Znso4 based on soil test value	24.77	38.86 (56.90%)	34.03	37.78 (11.02%)	73.49	77291
T_8 : T_2 + green Manure in Rice	21.07	31.43 (49.18%)	15.15	18.84 (24.40%)	47.41	33574

Figures in parentheses are per cent over initial status.

TABLE IV

Effect of different organic, inorganic and integrated sources of nutrients on Chemical properties of soil after 10 years of field experimentation

Treatments	Soil pH	Ecds / m	OC g / kg	Available nutrients kg / ha		
				N	P	K
T_1 : 50 per cent NPK through fertilizers + 50 per cent N through FYM to both crops	7.29	0.49	5.9 (5.33%)	225 (0.44%)	8.45 (3.04%)	290 (-7.93%)
T_2 :1/3 N through FYM Vermicompost and Neem cake to both the crops	7.27	0.44	6.2 (10.7%)	238 (6.25%)	8.6 (4.87%)	295 (-6.34%)
T_3 : T_2 + intercropping of mustard in wheat	7.27	0.45	6.1 (8.92%)	235 (49.5%)	8.5(3.65%)	290 (-7.93%)
T_4 : T_2 + Agronomic practices of weed control of both crops	7.29	0.46	6 (7.14%)	230 (2.67%)	8.5 (3.65%)	295 (-6.34%)
T_5 : 50 per cent N as FYM + PSB + Rockphosphate + Azotobactor	7.29	0.45	6.3 (12.5%)	240 (7.14%)	8.65 (5.48%)	300 (-4.76%)
T_6 : T_2 + Azotobactor + PSB	7.27	0.46	6.1 (8.92%)	238 (6.25%)	8.6 (4.87%)	298 (-5.39%)
T_7 : 100 per cent NPK + 25 kg Znso4 based on soil test value	7.3	0.5	5.8 (3.57%)	240 (7.14%)	8.7 (6.09%)	310 (-1.58%)
T_8 : T_2 + green Manure in Rice	7.26	0.43	6 (7.14%)	232 (4.01%)	8.56(4.26%)	290 (-7.93%)
Initial status	7.25	0.46	5.6	224	8.2	315

Figures in parentheses are per cent over initial status

and 50 per cent N through FYM. It may be due to supply the nutrient in available form as per need of the wheat crop. The similar finding was also reported by Maurya *et al.* (2010).

Different organic sources of nutrients were not found as much as effective as 100 per cent NPK given through fertilizer in T_7. The grain yield of wheat crop was increased by 45.39 per cent in T_1 as compared to base year period after seven years of field experimentation. The increase in grain yield of wheat was minimum (11.82%) in T_7, where, 100 per cent NPK was given through fertilizer as compared to base year period. The grain yield of wheat was increased under different organic sources of nutrient management as compared to base year period by 15.77 to 32.76 per cent which was also higher than 100 per cent NPK given through fertilizer. It may be due to increase in organic carbon and available N as compared to initial fertility status given in Table IV. Positive effect of organic carbon and available N on growth and yield of wheat crop were also reported by Maurya *et al.* (2010) and Anonymous (2013).

(c) Effect on rice-wheat system : The wheat equivalent yield and net return of rice-wheat cropping system under the influence of different organic, inorganic and integrated nutrient management system have been given in Table III. It reveals that wheat equivalent yield was maximum (73.49 q / ha) in T_7, where, 100 per cent NPK was given through fertilizer followed by 67.52 q per ha in T_1, where, 50 per cent NPK was given through fertilizer and 50 per cent N through FYM in both the crops. Similarly, these treatments gave higher net return than different organic sources of nutrient management. Among different organic sources, T_5 in which 50 per cent N was given through FYM + PSB + Azatobactor + rock phosphate gave more wheat equivalent yield and net profit than rest of the organic sources of nutrient management given in rice and wheat crop in sequence. It may be

due to higher yield of rice and wheat in these systems as compared to different organic sources. The similar finding was also reported by Maurya *et al.,* (2010).

(d) Effect on soil : The chemical properties of the soil after completion of ten crops cycle have been given in Table IV. It is clear from the results that soil pH and electrical conductivity of soil were not affected as compared to initial status under different organic and inorganic nutrient management system. The organic carbon content in soil was increased by 3.57 to 12.5 per cent and maximum (12.5%) organic carbon was increased in T_5 where 50 per cent N was given through FYM + PSB + Azatobactor + rock phosphate. It is due to more addition of organic matter through FYM, phosphorus solublizing bacteria and Azatobactor after mineralization. The findings are inconformity with the findings of Gaur (1990). The N content in soil was increased by one to 49.5 per cent under different organic and inorganic nutrient management system and maximum (49.5 %) was increased in T_3 in which T_2 + trap crop of mustard in wheat was taken. It may be due to addition of more organic matter by mustard residues in soil after mineralization of mustard residues the N content was increased in soil. The available phosphorous in soil was increased by 3 to 6 per cent under different organic and inorganic nutrient management system and maximum (6.09 %) was increased in T_7 where 100 per cent NPK was given through fertilizer. The available potash status was decreased by 1.58 to 7.93 per cent under different organic and inorganic nutrient management system as compared to initial soil status.

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