Integrated Nutrient Management in Rice –Pea Cropping System For Sustainable Productivity

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Abstract - **Integrated nutrient management module for rice-pea cropping system was developed through field experimentation for twelve consecutive crop seasons (2006-2012). The treatments consisted of farm yard manure (FYM), vermi-compost (VC), green manure (GM), Azospirillum , blue green algae (BGA), rhizobium , phosphorus solublizing bacteria (PSB), and NPK fertilizers. Highest yield of rice (4494 kgha^{-1}) was obtained with the application of recommended dose of NPK (120,26.4,49.8 kgha^{-1}) , which was at par with the rice grown after green manuring with fifty per cent of NPK (60,13.2,24.9 kgha^{-1}) accompanied by microbial cultures (Azospirillum, BGA and PSB). Reduction to the tune of seventy five per cent in recommended dose of N P fertilizers (22.5, 19.8 kgha^{-1}) could be made with the application of FYM or vermi-compost in kharif alongwith rhizobium and PSB without decrease in the yield of pea. Cultivation of rice and pea on recommended dose of fertilizers alone reduced organic carbon, available phosphorus and potassium content of the soil. Application of FYM, VC, and green manure alone or in combination with bio-fertilizers supplemented by chemical fertilizers improved the soil fertility.**

Keywords— Integrated nutrient management, FYM, vermi-compost, green manure, bio-fertilizers, and cropping system

1. INTRODUCTION

Use of imbalanced and inadequate fertilizers has made the soil not only deficient in nutrients but also deteriorated soil health resulting in decline crop response to recommended dose of N-fertilizers. In addition the chemical fertilizers becoming expensive over the years. Therefore, the importance of organic manures and bio-fertilizers is gaining prominence. Under such a situation, integrated plant nutrient system (IPNS) has vital significance for maintenance of soil productivity. Therefore, suitable combination of chemical fertilizers, organic manures and microbial cultures need to be developed for particular cropping system and soil. Present investigation was under taken to develop integrated nutrient module for rice-pea cropping system for sustainable production.

2. MATERIALS AND METHODS

A field experiment was conducted at Kalai (Aligarh), Research station of C.S. Azad university of Agriculture and Technology, Kanpur for Twelve crop seasons beginning with rice (kharif-2006). The experimental soil was sandy loam in texture, having pH (1:2.5)7.5, Ec (1:2.5) 0.48 dSm^{-1}, organic carbon 0.36% and available P and K contents 7.75 and 114.71 kg ha^{-1} respectively. Crops grown were rice (Pant-12)and pea (KPMR-400). Details of nine treatments comprising FYM (0.65%N, 0.2% P and 0.42% K), VC (1.5% N, 0.5% P and 0.9% K), green manure, *Azospirillum,* BGA, *Rhizobium* and NPK fertilizers are given in table -1.Manurial treatments were repeated each year during kharif season. In rice half dose of N, full dose of phosphate (DAP) and potassium (MOP) were applied as basal and rest half was top dressed.In pea full dose of N, P was applied as basal. The experiment was laid out in completely randomized block design with four replications. The statistical analyses were carried out following standard method. Soil samples collected at the harvest of pea crop after second, fourth and sixth year were air dried, ground, passed through a 2 mm sieve and analyzed for organic carbon, available P and K using standard procedures.

3. RESULTS AND DISCUSSION

Grain Yield

The highest grain yield (4474 kg ha^{-1}) of rice was obtained with the application of recommended dose of NPK fertilizers (120, 26.4 and 49.8 kg ha^{-1}). Rice grown after green manuring of *sesbania* in- situ along with half quantity of recommended dose of NPK fertilizers (60,13.2 and 24.9 kg ha^{-1}) accompanied by microbial cultures (*Azospirillum*, PSB and BGA) yielded 4453 kg ha^{-1}(Table-2).The results indicated that fifty percent of recommended dose of NPK fertilizers can be substituted with the use of green manuring along with bio-fertilizers. The grain yield 1365 kg ha^{-1} was lowest under the treatment where no manure,or fertilizer was applied. Application of FYM or vermi-compost along with green manuring and bio-fertilizers (*Azospirillum*, PSB, BGA) supplemented by one-fourth quantity of NPK (T_5, T_6) recorded significantly higher yield in comparison to application of

TABLE-1 DETAIL OF TREATMENTS DURING KHARIF AND RABI EACH YEAR

Treatments	Kharif	Rabi
T_1	100% RDF NPK (120,26.4,49.8 kg ha^{-1})	100% RDF NP (30,26.4 kg ha^{-1})
T_2	50% RDF NPK+GM+Azos+PSB+BGA	50% RDF NP+Rhizo +PSB
T_3	25% RDF NPK+FYM@20t ha^{-1}+Azos+PSB+BGA	25% RDF NP+Rhizo +PSB
T_4	25% RDF NPK+VC@10t ha^{-1}+Azos+PSB+BGA	25% RDF NP+Rhizo +PSB
T_5	25% RDF NPK+GM+FYM@10t ha^{-1} +Azos+PSB+BGA	25% RDF NP+Rhizo +PSB
T_6	25% RDF NPK+GM+VC@5t ha^{-1}+Azos+PSB+BGA	25% RDF NP+Rhizo +PSB
T_7	Zero RDF+GM+FYM@20t ha^{-1} +Azos+PSB+BGA	Zero RDF+Rhizo +PSB
T_8	Zero RDF+GM+VC@10t ha^{-1}+Azos+PSB+BGA	Zero RDF+Rhizo +PSB
T_9	Absolute control	Absolute control

RDF=Recommended dose of fertilizer,GM=Green manuring(15t ha^{-1} freshweight),Azos=Azospirillum, PSB=Phosphate solubilizing bacteria , BGA=Blue green algae (Applied in rice field 7 DAT), Rhizo=Rhizobium

Table-2 Effect of Treatments on Grain Yield of Rice (Kg ha^{-1})

Treatments	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**Average**
T_1	4689	4665	4585	4235	4305	4363	4474
T_2	4481	4555	4600	4350	4260	4475	4453
T_3	3223	3315	3605	3700	3380	4250	3579
T_4	3338	3450	3575	3645	3395	4275	3613
T_5	3812	3905	4105	3885	3675	4363	3958
T_6	3915	4028	4210	3950	3715	4481	4050
T_7	3526	3633	3870	3650	3600	3569	36.41
T_8	3629	3740	3800	3688	3630	3794	3714
T_9	1495	1505	1405	1275	1235	1275	1365
CD(P=0.05)	**130**	**42**	**64**	**86**	**80**	**170**	**-**

Table-3 Effect of Treatments on Grain Yield of Pea (Kg ha^{-1})

Treatments	**2006-07**	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**2011-12**	**Average**
T_1	3289	3045	3035	2564	3153	2473	2927
T_2	2486	2305	2709	2333	2810	2238	2480
T_3	3266	3015	3028	2615	3320	2482	2954
T_4	3255	2920	3005	2550	3170	2402	2884
T_5	3022	2980	2982	2407	3040	2377	2801
T_6	2993	2825	2866	2335	3055	2375	2742
T_7	3082	2695	2884	2160	2935	2082	2640
T_8	3058	2700	2833	2158	2925	2047	2620
T_9	1011	800	780	706	851	880	838
CD(P=0.05)	**55**	**146**	**128**	**79**	**71**	**101**	**-**

Table-4 Effect of Treatments on Fertility Status of Soil

Treatments	**After second year**			**After fourth year**			**After sixth year**		
	Organic C (%)	Available P (kgha^{-1})	Available K (kgha^{-1})	Organic C (%)	Available P (kgha^{-1})	Available K (kg ha^{-1})	Organic C (%)	Available P (kg ha^{-1})	Available K (kg ha^{-1})
T_1	0.35	7.70	113.00	0.34	7.39	112.05	0.33	6.82	107.90
T_2	0.46	7.94	114.13	0.48	7.99	115.20	0.50	8.03	116.70
T_3	0.56	9.28	130.31	0.58	10.52	134.46	0.61	10.91	146.50
T_4	0.53	9.15	126.99	0.57	9.68	133.34	0.58	10.38	142.10
T_5	0.49	8.43	124.96	0.51	9.33	129.07	0.53	9.81	139.77
T_6	0.43	8.36	122.12	0.48	8.67	127.57	0.51	9.55	134.71
T_7	0.55	9.11	129.36	0.59	10.65	137.20	0.60	10.78	146.91
T_8	0.54	8.91	128.03	0.57	10.25	133.38	0.59	10.55	144.70
T_9	0.32	6.68	108.07	0.29	6.60	102.13	0.27	6.21	99.60

FYM or vermi-compost and bio-fertilizers along with similar quantity of NPK(T_3, T_4) . Early decomposition of succulent legume such as *sesbaia* might have caused early release and availability of plant nutrients and these in turn might have resulted higher yield of rice. Application of one-fourth quantity of NPK dose of fertilizers along with manures and bio-fertilizers improved the yield in comparison to application of manures and bio-fertilizers alone. Beneficial effects of integrated use of manures and biofertilizers along with chemical fertilizers were also reported by Singh et.al.[1].

The different treatments influenced the grain yield of pea (Table-3). Among three organic manures applied during kharif (once a year), FYM (20t ha^{-1}) along with one-fourth quantity of NPK in conjunction with bio-fertilizers recorded highest grain yield of pea (2954 kg ha^{-1}) followed by application of recommended dose of NP fertilizers (30, 26.4 kg ha^{-1}) which was at par with the vermi-compost (10t ha^{-1}) when supplemented with one-fourth quantity of recommended dose of N, P along with bio-fertilizers (T_4). The residual effect of organic manures was found to be in the order FYM>VC>GM. Application of *rhizobium* and PSB supplemented by one-forth quantity of NP fertilizers along with manurial treatments in kharif recorded higher grain yield of pea as compared to green manuring(residual effect) and half dose of N P along with rhizo+PSB (T_2) and proved better than application of FYM (20t ha^{-1}) or vermi-compost (10t ha^{-1}) combined with biofertilizers (*Rhizobium* + PSB) in rabi without NP fertilizers (T_7, T_8).

The present experimental results suggests that reduction in half quantity of recommended dose of NPK fertilizers (60, 13.2 and 24.9) could be made with the application of green manuring along with bio-fertilizers *(Azospirillum*, PSB and BGA) without any decrease in the yield of rice, whereas in pea three-fourth quantity may be saved with the application of FYM (20t ha^{-1}) or vermi-compost (10t ha^{-1}) along with bio-fertilizers (rhizobium and PSB).

Organic Carbon

Organic carbon content of the surface soil (Table-4) increased with the application of manures along with fertilizers. Application of NPK fertilizers and absolute control showed negative impact and reduced organic carbon content by 0.03% and 0.08% respectively in six years. Highest organic content was observed with the application of FYM followed by vermi-compost and green manuring. The increase in organic carbon content in manurial treatment combinations is attributed to direct incorporation of organic matter in the soil. The subsequent decomposition of these materials might have resulted in enhanced organic carbon content of the soil. The increase in organic carbon status occurred on combined use of organic manure and fertilizers, and enhanced further by the application of bio-fertilizers. Basker[2]; Singh and Pathak[3];Tolanur and Badanur[4]; Singh, *et* al.[1].

Available Phosphorous

Available phosphorus content of the surface soil (Table-4) increased appreciably with the application of manures along with fertilizers as compared to sole application of NPK fertilizers, which registered a negative impact. Highest available phosphorus was observed with the application of FYM followed by vermi-compost and green manuring. The increased available P content of soil might be due to release of $CO_2$and organic acids during decomposition, which helps in solubility of the native soil P and in turn enhanced the availability of P. Addition of organic manures like FYM, vermi-compost and green manure with inorganic fertilizers had the beneficial effect in increasing the phosphate availability. Application of PSB also contributed towards phosphate nutrition of both rice and pea as is evident from the results. Increase in available phosphorus with the application of PSB was also reported by Singh et.al.[5].

Available Potassium

Available potassium content of surface soil increased considerably due to combined application of manures, bio-fertilizers and inorganic fertilizers as compared to the sole application of inorganic fertilizers. The beneficial effect of FYM, vermin-compost, green manuring and bio-fertilizers on available potassium may be ascribed to the reduction of K-fixation, solublization and release of K due to interaction of organic matter with clay, besides direct potassium addition to potassium pool of soil.

4. CONCLUSION

Green manuring in-situ alongwith bio-fertilizers(*Azospirillum*, PSB, and BGA) were equivalent to 60 kg N,13.2 kg P and 24.9 kg K fertilizers ha^{-1} $year^{-1}$ for rice cultivatation.Integrated use of bio-fertilizers like *rhizobium* and PSB combined with residual effect of organic manures reduced NP fertilizers requirement for pea by seventy five per cent.

5. REFERENCES

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