Effect of Integrated Nutrient Management on Productivity and Soil Fertility in Wheat-based Cropping System

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***Abstract*— Six year field experimentation with ten treatments consisted of FYM, vermicompost, green manure, nadep compost, azospirillum, azotobacter, rice residue, haulms (green gram/black gram) incorporation and NPK fertilizers at Kalai (Aligarh) research station of C.S. Azad University of Agriculture & Technology, Kanpur, indicated that higher value of grain yield of wheat (4286kg ha^{-1}) was recorded when wheat was grown after rice with residual effect of FYM (10t ha^{-1}) followed by vermicompost (5t ha^{-1}) and nadep compost (5t ha^{-1}) alongwith three-fourth quantity of N (90kg ha^{-1}) as compared to the yield (4018 Kg ha^{-1}) obtained with recommended dose of N(120kg ha^{-1}). The experimental results also indicated that one-fourth quantity of N (30 Kg ha^{-1}) could be reduced with the application of azotobacter alone or in combination with residual effect of biodynamic compost or incorporation of haulms (green gram/black gram) or green manuring of *sesbania in-situ* with rice residue incorporation without any significant decrease in the yield of wheat. Cultivation of rice and wheat on recommended dose of NPK fertilizers alone decreased the organic carbon, available P and K contents of the soil. Application of FYM, vermicompost, nadep compost, biofertilizers alone or along with biodynamic compost, green manuring, residue / haulms incorporation supplemented by NPK fertilizers improved the soil fertility.**

Keywords— Nitrogen, Productivity, Wheat, Soil fertility, Cropping system.

1. INTRODUCTION

Continuous use of chemical fertilizers, increased the crop yield during initial stage, but adversely affected the sustainability at a later stage. Indiscriminate use of chemical fertilizers especially, urea resulted in deficiency of nutrients other than the applied and caused decline in soil organic carbon singh et al; [1] Cereal crops generally require a good supply of major nutrients especially nitrogen during most of their crop growth period. The availability of N in the soil has been known to be prime factor in determining over all growth and yield. Thus N in the soil plays a dominant role in the nutrition of crops. Incorporation of organic material not only supply nutrients but also improve soil health. Hence, judicious application of chemical fertilizers along with manures (organic matter) would help in arresting decline in soil fertility besides reducing gap between the potential and actual yields to a larger extent. Keeping this in view the present investigation was undertaken to study the effect of nutrient management on yield and changes in soil fertility in wheat based cropping system under semi-arid conditions of Uttar Pradesh.

2. MATERIALS AND METHODS

A field experiment was conducted at Kalai ,Aligarh research station of C.S. Azad University of Agriculture and Technology Kanpur (U.P.) for six consecutive years beginning in Kharif 2004. Experimental soil was sandy loam in texture having P^H (1 : 1.25) 7.5, EC (1 : 1.25) 0.59 dsm^{-1}, organic carbon 0.47% and available P_2O_5 and K_2O as 13.5 and 112.5 Kgha^{-1} respectively. Crops grown were rice (Pant-12), green gram (HUM-2), black gram (PU-35) and wheat (PBW-343). Details of ten treatment comprised of FYM (0.6% N, 0.3%P, 0.5%K), vermicompost (1.3%, 0.6%P, 0.9%K), Nadep Compost (0.9%N, 0.5%P, 0.7%K), biodynamic compost, green manuring, azospirillum, azotobacter, crop residue/ haulms incorporation and NPK fertilizers are given in table-1. Biodynamic compost used was cow pat pit (CPP) manure (1.3%N, 0.4%P, 0.5%K and 249x10^{6}g^{-1} total microbial count) prepared using biodynamic compost preparations (BD 502-507) with cow dung and was applied as root treatment (5kgha^{-1}) in rice. Manurial treatments were applied in kharif each year. In rice and wheat half dose of nitrogen and full dose of phosphate (DAP) and potash (MOP) were applied as basal and rest half N was top dressed, In green and black gram full doses of N and P were applied as basal. The amount of nitrogen applied through DAP was adjusted in the amount applied through urea. The experiment was laid out in completely randomized block design with four replications. The statistical analyses were carried

Table-1 Details of treatments during Kharif and Rabi each year

Treatments	Crop-rotation	Kharif	Rabi
T_1	Rice- wheat	NPK(120:60:60)*	NPK(120:60:60)*
T_2	Rice- wheat	F+NPK(90:60:60)	NPK(90:60:60)
T_3	Rice- wheat	VC+NPK(90:60:60)	NPK(90:60:60)
T_4	Rice- wheat	NC+NPK(90:60:60)	NPK(90:60:60)
T_5	Rice- wheat	BC+Azos+NPK(90:60:60)	Azot+NPK(90:60:60)
T_6	Rice- wheat	Azos +NPK(90:60:60)	Azot+NPK(90:60:60)
T_7	GM-Rice- wheat	NPK(90:60:60)	RRI+NPK(90:60:60)
T_8	Green gram-wheat	NPK(20:40:0)	GHI+NPK(90:60:60)
T_9	Black gram- wheat	NPK(20:40:0)	BHI+NPK(90:60:60)
T_{10}	Rice- wheat	NPK(0:0:0)	NPK(0:0:0)

*RDF = Recommended dose of fertilizer F = FYM (Farm yard manure (10t ha^{-1}) VC = Vermicompost (5t ha^{-1}) NC = Nadep compost (5t ha^{-1}) BC = Biodynamic compost (5kg ha^{-1}) Azos = Azospirillum Azot = Azotobacter GM = Green manuring of sesbania in-situ (@15t ha^{-1} fresh weight) RRI = Rice residue incorporation GHI = Green gram haulms incorporation BHI = Black gram haulms incorporation

out according to standard method. Soil samples collected at harvest of wheat crop were air dried, ground, passed through 2 mm sieve analyzed for organic carbon, available P and K using standard procedure.

3. RESULTS AND DISCUSSION

Grain yield of wheat

The different treatments influenced the grain yield of wheat (Table-2). The residual effect of organic manures applied in kharif (Once a year) was observed on yield of succeeding rabi crop (wheat). The higher grain yield of wheat (4286, 4203, 4193 $kgha^{-1}$) for consecutive six years was recorded when wheat was grown after rice with residual effect of FYM (10t ha^{-1}), vermicompost (5t ha^{-1}) and Nadep compost (5t ha^{-1}) along with three-fourth quantity of nitrogen (90Kg ha^{-1}) as compared to the grain yield (4018 $kgha^{-1}$) obtained with recommended dose of N (120 kg ha^{-1}). Wheat yield obtained from the plots after green manuring of *sesbania in situ* in kharif coupled with rice residue incorporation or application of biodynamic compost + azotobacter or azotobacter alone or haulms incorporation along with similar quantity of nitrogen (90 $kgha^{-1}$) was at par with the yield recorded in recommended dose of nitrogen.. The experimental results indicated that application of FYM (10t ha^{-1}) or vermicompost (5t ha^{-1}) or Nadep compost (5t ha^{-1}) during kharif not only reduced the N fertilizer requirement by 30 $kgha^{-1}$ but also increased the wheat yield. Similar reduction to the tune of 30 $KgNha^{-1}$ in the recommended dose of N could be made with green manuring + rice residue incorporation or application of biodynamic compost+azotobacter or azotobacter alone or through haulms (green gram / black gram) incorporation, without any adverse effect on grain yield of wheat. Higher yield of wheat with FYM or vermicompost or nadep compost may be attributed to the fact that applied quantity of these organic manures not only effectively supplemented the reduced quantity of N (30 $kgha^{-1}$) but supplied additional amount of nutrients too. The effect of biodynamic compost + biofertilizers or biofertilizers alone or green manuring + rice residue incorporation or haulms incorporation failed to supply additional amount, resulting in yield at par with 120 $kgNha^{-1}$. Beneficial effects of integrated use of manures, biofertilizers along with chemical fertilizers were also reported by Singh and Chauhan [2]; Singh et al. [3].

Table-2 Grain yield of wheat (kg ha⁻¹) as influenced by different treatments

Treat Ments	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	Average
T_1	3858	4002	4013	3945	4253	4035	4018
T_2	3927	4222	4282	4375	4595	4318	4286
T_3	3917	4135	4145	4256	4506	4257	4203
T_4	3929	4124	4175	4267	4538	4130	4193
T_5	3828	4135	4010	4015	4344	4070	4067
T_6	3826	3827	3924	4070	4334	4095	4012
T_7	3852	4028	4035	4240	4315	4190	4110
T_8	3860	4012	4021	4127	4346	4167	4089
T_9	3863	4025	4032	4138	4355	4105	4086
T_{10}	1213	1413	1362	1375	1538	1019	1320
CD(P=0.05)	250	221	260	81	113	91	-

Table-3 Effect of treatments on grain yield of Kharif crops (kg ha⁻¹)

Treat ments	2004	2005	2006	2007	2008	2009	Average
T_1	4112	4011	4005	4000	4325	4168	4104
T_2	4225	4327	4386	4422	4505	4423	4381
T_3	4265	4320	4367	4484	4485	4356	4380
T_4	4213	4312	4353	4382	4415	4356	4339
T_5	4300	4300	4203	4217	4335	4305	4276
T_6	4110	4015	4000	4012	4270	4210	4102
T_7	4735	4637	4558	4577	4780	4588	4646
T_8	1118	1104	1025	1100	1405	1245	1166
T_9	1022	1012	1108	1112	1250	1335	1140
T_{10}	1727	1510	1536	1510	1345	1200	1471

Table-4 Effect of treatments on fertility status of soil (After and 2nd, 4th and 6th year)

Treat ments	Organic carbon (%)			Available P_2O_5 (kg ha^{-1})			Available K_2O (kg ha^{-1})		
	II year	IV year	VI year	II year	IV year	VI year	II year	IV year	VI year
T_1	0.46	0.43	0.40	12.75	11.65	10.95	110.30	100.45	100.00
T_2	0.61	0.67	0.70	18.10	21.95	24.00	142.15	207.10	219.15
T_3	0.55	0.63	0.68	16.61	19.78	21.85	138.15	200.77	215.00
T_4	0.58	0.62	0.64	18.20	20.90	22.15	141.40	202.70	213.20
T_5	0.51	0.59	0.63	14.10	15.10	15.68	120.15	124.40	127.10
T_6	0.49	0.51	0.55	14.10	15.60	16.65	121.20	128.10	135.00
T_7	0.54	0.60	0.66	15.05	15.75	16.00	130.27	158.10	168.00
T_8	0.52	0.63	0.65	14.70	16.25	17.35	126.60	152.55	158.05
T_9	0.52	0.62	0.64	14.80	16.75	17.70	127.00	152.45	159.05
T_{10}	0.39	0.30	0.26	10.65	8.10	7.25	102.00	100.70	95.00

Grain yield of Kharif crops (rice, green gram, black gram)

The highest grain yield of rice (4646 $Kgha^{-1}$) was recorded when rice was grown after green manuring of *sesbania in situ* along with three- fourth quantity of recommended dose of N (Table-3). Application of FYM or vermicompost or nadep compost or biodynamic compost+azospirillum along with reduced quantity of N (90 $Kgha^{-1}$) yielded higher as compared to the yield recorded with recommended dose of N (120 $Kgha^{-1}$). The response of azospirillum alone was found at par with the recommended dose of nitrogen. Early decomposition of succulant legume like *sesbania* might have caused early release and availability of plant nutrients and in turn might have resulted in higher yield of rice. Increase in yield of rice with green manuring was also reported by Singh et. al. [3]. The differences in the yield of green gram and black gram were negligible.

Organic Carbon

Organic carbon content of surface soil (Table-4) increased with the application of manures along with chemical fertilizers. The increase in the organic carbon content in manurial treatment combinations is attributed to direct incorporation of organic matter in the soil. The subsequent decomposition of these materials could have resulted in enhanced organic carbon content of the soil. Application of biofertilizers (azospirillum / azotobacter) also enhanced organic carbon content but to a lesser extent as compared to manures. Residue incorporation also improved organic carbon content considerably and found to be equivalent to the application of manures. Application of NPK fertilizers alone and absolute control showed negative impact and reduced organic carbon by 0.07% and 0.21% respectively. Increase in organic carbon status with combined use of organic manures or residue incorporation with fertilizers was also reported by Singh et. al [4]

Available Phosphorus

Available phosphorus content of the surface soil (Table-4) increased appreciably with the application of manures along with chemical fertilizers as compared to sole application of NPK fertilizers which registered negative impact and reduced by 18.9%. Highest available phosphorus was observed with the application of FYM followed by nadep and vermicompost. The increased available P of soil might be due to release of CO_2 and organic acids during decomposition, which helps in solubilizing the native P. Addition of organic manure like FYM, with inorganic fertilizers had the beneficial effect in increasing phosphate availability Singh and Singh [5].

Available Potassium

Available Potassium content of surface soil [Table-4] increased appreciably with the application ofmanures, biofertilizers and residue incorporation along with chemical fertilizers.Higher availability could be ascribed to direct addition of potassium to the potassium pool of soil besides reduction in potassium fixation and release of potassium due to interaction of organic matter with clay. Beneficial effects of manure on K availability were also reported by Das et. al. [6].

4. CONCLUSION

One-fourth quantity (30 $Kgha^{-1}$) of recommended dose of nitrogen could be reduced with the application of FYM (10t ha^{-1}) or vermicompost (5t ha^{-1}) or Nadep compost (5t ha^{-1}) once a year during kharif to obtain higher yield of wheat. It was also concluded that green manuring in kharif coupled with rice residue incorporation or application of azotobacter alone or in combination with biodynamic compost or haulms (green or black gram) incorporation contributed 30 kg N ha^{-1} and sustained yield level of wheat, which were at par with the application of recommended dose of N(120 $kgha^{-1}$). Cultivation of rice and wheat on recommended dose of fertilizers reduced organic carbon, available P and K content of soil.

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