YIELD PERFORMANCE, ECONOMICS AND SOIL FERTILITY THROUGH DIRECT AND RESIDUAL EFFECTS OF ORGANIC AND INORGANIC SOURCES OF NITROGEN AS SUBSTITUTE TO CHEMICAL FERTILIZER IN RICE-WHEAT CROPPING SYSTEM

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Abstract: *A field experiment was conducted during kharif and rabi seasons of 2006-07 and 2007-08 respectively at Jammu, (J&K) to study the direct and residual effects of organic and inorganic sources of nitrogen in rice-wheat cropping system on yield performance, economics and soil fertility in sandy clay loam soil. Application of 100 % recommended dose of nitrogen from urea significantly influenced the yield and economics of rice in 1st year of experiment. Whereas during the 2nd year of experiment application of 50 % recommended dose of nitrogen from vermicompost and rest through chemical fertilizer (urea) produced significantly highest grain and straw yield of rice. However, gross return, net return and B: C ratio values were significantly highest in the plot which received 25 % N through vermicompost and rest through chemical fertilizer. During wheat season the plots received 100 % recommended dose of fertilizer produced significantly highest yield, gross return net return and B: C ratio which is significantly at par with 75 % of the recommended dose of fertilizer applied to wheat. So, substitution of chemical fertilizers through organic sources likes vermicompost and FYM by 50 % of recommended dose of nitrogen would be better proposition towards reduction in the use of chemical fertilizers in rice and 25 % in wheat. As for as soil fertility is concerned organic sources of nutrients applied to previous crop have edge over chemical fertilization in fertility build up, particularly organic carbon, total and available NPK. The application of 100 per cent nitrogen through vermicompost significantly increased the available N, P, K status of surface soil which was closely followed by that obtained with 100 per cent nitrogen through FYM. There was a buildup of organic carbon and reduction in bulk density in soil where 100 per cent organic sources of nutrients followed by 50 per cent were applied.*

INTRODUCTION

Rice (*Oryza sativa* L.) and wheat (*Triticum aestivum* L.) are world's two most important cereal crops. They contribute about 45% of the digestible energy and 30% of the total protein in the human diet, besides its substantial contribution to feeding live stock (EVANS, 1993). Rice is the predominant crop of the tropics and sub-tropics. Wheat on the other hand, has always been the predominant crop of temperate regions, though it is now grown with moderate success in tropical and subtropical climates (SAUNDERS and HATTEL, 1994). JAMMU and KASHMIR also known for rice cultivation constitute an area of 2.59 lakh hectare under rice and 2.53 lakh hectare under wheat. However, under Jammu province alone, rice and wheat cover an area of about 1.16 and 2.47 lakh hectare, respectively. With a view to reduce the cost and indiscriminate use to chemical fertilizers resulting in losses of fertilizer elements leading to environmental pollution and unsustainable crop production, substitution of part of the chemical fertilizers by locally available organic sources of nutrients viz., manures, compost, green manures, crop residues, biofertilizers etc. is inevitable. In addition to supply of nutrients, organic sources improve the physical condition and biological health of soil, which improves the availability of applied and native nutrients (DICK and GREGORICH, 2004). The integrated use of organic and chemical fertilizers has been reported not only to meet the nutrients needs of the crop but also has been found to sustain large-scale productivity goals. Vermicompost, being a rich source of macro and micro nutrients, vitamins, plant growth regulators and beneficial

microflora, appeared to be the best organic source in maintaining soil fertility on sustainable basis towards an ecofriendly environment (EDWARDS and ARANCON, 2004). Vermicompost application to different field crops has been to reduce the requirement of chemical fertilizer without any reduction in crop yield (GIRADDI, 2000). Although good amount of research work has been done to study the effect of vermicompost and FYM on different vegetable crops (PATIL *et al.*,2004) studying relating to organic (vermicompost and FYM) and inorganic sources of nutrients in *kharif* season rice and their residual effects on *rabi* season wheat are limited. In the present study, therefore effort was made to estimate the quantity of fertilizer nitrogen that can be substituted by organic sources for obtaining comparable yield with 1000 % recommended dose of nitrogen in rice-wheat cropping system.

MATERIALS AND METHODS

The present investigation entitled "Studies on direct and residual effects of organic and inorganic sources of nutrients in rice-wheat cropping system" was conducted at Research Farm of Division of Agronomy, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu at main Campus Chatha, during the year 2006-2008. The soil of the experiment field was sandy loam in texture, slightly alkaline in reaction (pH-8.1), medium in organic carbon (0.55 per cent), low in available nitrogen and medium in available phosphorus and potassium. Rice variety PC-19 sown in nursery @ 40 Kg/ha was transplanted, where as wheat variety PBW-343 was sown after harvest of rice, using 100 Kg seed ha^{-1}. The experiment was laid out in RBD for raising rice crop during 1st crop seasons with 8 treatments of organic and inorganic sources of nutrients. During *rabi* layout of *kharif* crop was utilized for raising wheat crop by dividing the experimental unit in 4 sub-plots and comprised of 32 treatments in wheat. The treatment were randomized and replicated thrice. In rice 8 treatments consisted of control, 100 per cent N through vermicompost and farmyard manure and inorganic fertilizer (NPK) and in combination with 25 -50 per cent N through vermicompost and farmyard manure. While, for wheat in subplot treatments were 0, 50, 75,100 per cent NPK which were superimposed on rice treatments during *rabi* season to study the residual effects of the treatments applied in rice. The soil was sandy loam in texture having medium organic carbon (0.55 per cent), low in available N, K and medium in P. The soil samples were analysed by adopting standard laboratory procedure as described by (JACKSON.1967), OLSEN *et al.* (1954).Total rainfall during crop season was 550.50 mm and 1304 mm in 2006-07 and 2007-08 respectively and distributed uniformly.

Soil fertility

During the period of field experimentation, the treatments showed significant response towards improvement in soil fertility status (viz., organic carbon, available nitrogen, phosphorus and potassium) when compared with their initial values except in control plots (Table).After each rice-wheat cycle pH and electrical conductivity observed no significant effect in all the treatments. Significantly higher values of organic carbon (0.62%) were found in the treatment received 100 % recommended dose of nitrogen through vermicompost followed by 100% FYM. All other treatments received 50 % and 25% N through organic sources have significant effect on organic carbon than control. Bulk density also decreased significantly with the application of organic sources of nutrients (Vermicompost and Farmyard manure) in each rice-wheat cycle. Significantly lower bulk density found in the treatment received 100 % recommended dose of N through FYM followed by 100% vermicompost. Bulk density increased as the quantity of organic sources of nutrients decreased from 50% to 25% respectively in FYM and vermicompost. The treatment received 100% recommended dose of nitrogen through chemical and control plot showed significantly higher values of bulk density.

After each rice wheat cycle significantly higher values of plant nutrients were found in

all the treatments than control plots where no nitrogen was applied. With respect to improvement in soil nutrient status, application of 100 % of recommended dose of N through vermicompost in rice exhibited highest values of N and P followed by 100 % recommended dose of N through FYM in each rice-wheat cycle. Whereas as for as potassium is concerned application of 100% vermicompost exhibited comparable value with 25 % N from vermicompost and rest from chemical fertilizers in 1st year whereas in 2nd year 100 % N through vermicompost and 25 % N through vermicompost +75 % through chemical and 100 % FYM showed significantly at par values.

Economics

Rice cultivation

The treatments under investigation exerted a significant influence on net return and benefit cost ratio in cultivation of wet season rice (Table).The highest gross return, net return and benefit cost ratio Rs. 41064.40, Rs. 26559.40 and 1.83 respectively was achieved from the crop receiving 100 % recommended dose of N through chemical fertilizer which was significantly higher than other treatments except with the application of 25 % recommended dose of N through vermicompost T_8 and rest through chemical fertilizer. However, these two treatments were at par with each other. Whereas during the 2nd year of field experiment highest gross return, net return and B: C ratio found in the plot which received 50 % recommended dose of N through FYM and 50 % through chemical fertilizer (T_5) which was significantly at par with the application of 100 % recommended dose of N through chemical fertilizer (T_4) and 50 % N through vermicompost+50 % through chemical fertilizer (T_7). The lowest gross return, net return and benefit cost ratio found in the control plot during both the year of experimentation. Highest production of grain and straw from these treatments was the main reason for higher gross return, net return and B: C ratio in this crop.

Wheat cultivation

Organic sources of nutrients showed significant residual effect as compared to the inorganic sources of nutrients. The treatment under investigation exerted significant influence on gross return, net return and benefit cost ratio (Table). The highest gross return, net return and B:C ratio (Rs.46613/ha,35451.88 and 3.17) which was significantly higher than other treatments except with the application of 100 % recommended dose of N through FYM (Rs.45378,34216.88 and 3.06). All other treatments exhibited non significant effect due to the residual effect of organic and inorganic sources of nutrients. The lowest gross return, net return and B:C ration was found in the control treatment during both the season of cultivation. Whereas the direct effect of chemical fertilizer applied to the wheat crop showed significant influence on gross return, net return and benefit cost ratio. The gross return, net return and B:C ratio increased significantly with increased in fertilizer level. The maximum B:C ratio (3.26 and 3.35) was observed with 100 % fertilizer application which was significantly at par with the application of 75% recommended dose of fertilizer during both years of cultivation. Highest production of grain and straw from these treatments was the main reason for higher gross return, net return and B:C ratio in this crop.

Table 1

Direct and residual effect of organic and inorganic sources of nutrients on residual fertility status of soil after 1st and 2nd year in rice-wheat cropping system

Treatment	1st year					2nd year				
	OC (%)	Bulk Density ($Mg\ m^{-3}$)	Available Nitrogen ($kg\ ha^{-1}$)	Available Phosphorus ($kg\ ha^{-1}$)	Available Potassium ($kg\ ha^{-1}$)	OC (%)	Bulk Density ($Mg\ m^{-3}$)	Available Nitrogen ($kg\ ha^{-1}$)	Available Phosphorus ($kg\ ha^{-1}$)	Available Potassium ($kg\ ha^{-1}$)
A. Direct effects of organic and inorganic sources										
T_1 Control (No fertilizer)	0.55	1.56	188.10	14.55	108.27	0.55	1.56	179.09	14.08	107.50

Treatment	1st year					2nd year				
	OC (%)	Bulk Density (Mg m^{-3})	Available Nitrogen (kg ha^{-1})	Available Phosphorus (kg ha^{-1})	Available Potassium (kg ha^{-1})	OC (%)	Bulk Density (Mg m^{-3})	Available Nitrogen (kg ha^{-1})	Available Phosphorus (kg ha^{-1})	Available Potassium (kg ha^{-1})
T_2 100% N through FYM	0.60	1.49	222.36	20.55	131.57	0.62	1.48	226.13	21.27	135.29
T_3 100 % N through Vermicompost	0.62	1.47	229.39	22.21	134.38	0.64	1.46	234.72	22.43	137.59
T_4 100 % recommended dose of fertilizer (RDF)	0.56	1.55	210.27	14.95	118.48	0.57	1.55	208.49	15.09	117.71
T_5 50% RDF +50% N through FYM	0.58	1.52	217.81	18.27	129.77	0.59	1.51	220.00	19.40	131.17
T_6 75% RDF +25% N through FYM	0.57	1.53	214.21	17.56	132.26	0.58	1.52	216.57	18.42	135.77
T_7 50% RDF +50% N through Vermicompost	0.59	1.52	220.28	18.82	130.60	0.60	1.51	224.30	19.70	132.04
T_8 75% RDF +25% N through FYM	0.57	1.53	215.17	17.94	134.70	0.58	1.52	218.18	18.76	137.36
C.D. (*p=0.05*)	0.01	0.006	2.28	1.01	1.41	0.01	0.005	1.75	0.81	3.11
B. Residual effect of Inorganic fertilizer										
N_0 (Control)	0.55	1.56	205.44	15.41	108.94	0.55	1.56	203.92	15.60	109.36
N_1 50% recommended dose of fertilizer	0.58	1.55	212.03	16.89	119.94	0.58	1.55	213.88	17.42	121.19
N_2 75% recommended dose of fertilizer	0.59	1.53	217.79	18.93	130.55	0.59	1.53	219.75	19.54	132.76
N_3 100% recommended dose of fertilizer	0.59	1.53	223.53	20.88	138.09	0.59	1.52	226.19	21.62	140.96
C.D. (*p=0.05*)	N.S	N.S	1.33	0.68	2.31	N.S	N.S	1.27	0.40	1.60
Initial status	0.55	1.56	207.43	17.60	128.25					

Table 2

Direct and residual effect of organic and inorganic sources of nutrients on grain straw yield and NPK uptake (Kg ha^{-1}) of rice in rice-wheat cropping system

Treatment	Gross returns (Rs ha^{-1})		Net returns (Rs ha^{-1})		Benefit:cost ratio		Grain yield (q ha^{-1})		Straw yield (q ha^{-1})	
	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08
A. Direct effects of organic and inorganic sources										
T_1 Control (No fertilizer)	21697	21368	9849	9538	0.83	0.80	21.84	21.52	39.17	38.46
T_2 100% N through FYM	28909	34338	15079	20508	1.09	1.48	29.46	35.32	48.36	53.95
T_3 100 % N through Vermicompost	33767	37682	16937	20852	1.00	1.23	34.47	38.86	55.85	58.14
T_4 100 % recommended dose of fertilizer (RDF)	41064	41076	26559	26571	1.83	1.83	42.44	42.42	62.38	62.74
T_5 50% RDF +50% N through FYM	34732	41959	20565	27792	1.45	1.96	35.58	43.50	56.12	62.31
T_6 75% RDF +25% N through FYM	37934	38858	23598	24522	1.64	1.71	39.00	40.04	59.81	60.31
T_7 50% RDF +50% N through Vermicompost	36041	43749	20373	28082	1.30	1.79	36.97	45.47	57.71	63.75
T_8 75% RDF +25% N through FYM	39433	40616	24347	25530	1.61	1.69	40.55	41.92	62.08	62.31
C.D. (*p=0.05*)	2354	2653	2325.40	2040.21	0.25	0.15	1.79	1.57	2.38	2.40
B. Residual effect of Inorganic fertilizer										
N_0 (Control)	--	37622	--	20797	--	1.22	--	37.81	--	57.72
N_1 50% recommended dose of fertilizer	--	37682	--	20852	--	1.23	--	38.00	--	58.30
N_2 75% recommended dose of fertilizer	--	37682	--	20852	--	1.23	--	38.15	--	58.88
N_3 100% recommended dose of fertilizer	--	37682	--	20852	--	1.23	--	38.31	--	59.42
C.D. (*p=0.05*)		N.S		N.S		N.S	--	N.S	--	N.S

Table 3

Direct and residual effect of organic and inorganic sources of nutrients on grain straw yield and economics of wheat in rice-wheat cropping system

Treatment	Gross returns (Rs ha^{-1})		Net returns (Rs ha^{-1})		Benefit:cost ratio		Grain yield (q ha^{-1})		Straw yield (q ha^{-1})	
	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08
A. Residual effects of organic and inorganic sources										
T_1 Control (No fertilizer)	40683	40454	29521	29292	2.64	2.62	38.80	38.60	57.63	57.14
T_2 100% N through FYM	45378	46555	34216	35393	3.06	3.17	43.28	44.40	64.26	65.95
T_3 100 % N through Vermicompost	46613	48150	35451	36988	3.17	3.31	44.50	45.98	65.63	67.68
T_4 100 % recommended dose of fertilizer (RDF)	41465	41864	30303	30702	2.71	2.75	39.55	39.95	58.70	59.09
T_5 50% RDF +50% N through FYM	43635	44864	32473	33702	2.90	3.01	41.62	42.81	61.77	63.35
T_6 75% RDF +25% N through FYM	42164	43046	31002	31884	2.77	2.85	40.19	41.00	59.93	61.46
T_7 50% RDF +50% N through Vermicompost	44047	45383	32885	34221	2.94	3.06	41.92	43.16	63.19	65.39
T_8 75% RDF +25% N through FYM	42406	43318	31244	32156	2.79	2.88	40.42	41.29	60.28	61.57
C.D. (*p=0.05*)	2275	2845	1245	1314	0.15	0.17	0.85	1.16	2.11	1.65
B. Direct effect of Inorganic fertilizer										
N_0 (Control)	30071	30696	20261	20886	2.06	2.12	28.47	29.05	44.48	45.51
N_1 50% recommended dose of fertilizer	42824	43726	31813	32715	2.88	2.97	40.91	41.80	60.05	61.06
N_2 75% recommended dose of fertilizer	48251	49431	36639	37819	3.15	3.25	46.05	47.13	68.06	70.14
N_3 100% recommended dose of fertilizer	52040	53149	39828	40937	3.26	3.35	49.70	50.75	73.10	74.74
C.D. (*p=0.05*)	4652	4652	3451	3236	0.25	0.20	0.75	0.65	1.57	1.06

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