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Relative Economics of Organic Resource Utilization in Rice-Wheat Cropping System under Temperate Condition

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ABSTRACT

An field experiments was conducted at Division of Agronomy, SKUAST-K from 2006 to 2009 to compare FYM, Bio fertilizers and Crop residue alone and their integration with chemical fertilizers in rice-wheat cropping system under temperate Kashmir valley conditions. The treatments comprised of two standard controls *i.e.* (1) recommended fertilizer dose (120:60:30 kg/ha of N:P_2O_5:K_2O) and (2) no manuring along with 8 eight organic resources. Among the nutrient sources, grain yield of rice, wheat, rice equivalent wheat and rice equivalent system yield were recorded statistically higher with 100% RDF followed by FYM @ 25 t/ha + biofertilizers and FYM @ 20 t/ha + biofertilizers which were at par with each other. Lowest yield was recorded in no manuring treated plots. All the yield attributes registered increasing trend but Net return and benefit cost ratio was reduced with application of FYM and crop residue due to high input cost.

Keywords **:** Crop residue, Biofertilizer, B:C ratio, net photosynthesis rate.

INTRODUCTION

Agriculture in the modern chemical era concentrates on maximum output but overlooks input efficiency as a result of which it has not been sustainable. The declining trend in the productivity of crop has become the major concern for the farmers which is mainly due to decline in soil health (Singh and Kumar, 2009). The loss of nutrients in the soil is mainly due to exhaustive cropping systems like rice-wheat or rice-oats or rice-brown sarson being followed in the valley. Recommended dose of NPK fertilizers alone does not sustain soil productivity under continuous intensive cropping (Kumar *et al.*, 2007 and Singh and Kumar, 2009) whereas inclusion of organic resources improve soil fertility and crop yields (Diwedi and Diwedi, 2007), physical properties (Kumar and Tripathi, 1990) and biological status of soil (Batra, 2004). However integrated use of organics and inorganics may improve the soil productivity and can sustain the desired yields of important exhaustive system like rice-wheat. The use of organic sources like FYM is important source of nutrition to the agricultural crops but its availability is quite inadequate due to its alternative use as a fuel (Misra and Prasad, 2000). As other alternatives, biofertilizers and crop residue have advantage and proven ability to enhance the productivity of major cropping systems with continues incorporation (Singh and Kumar, 2009). However, initially immobilization process occurs with crop residue incorporation due to low temperature in temperate condition decomposition process is slow and desired period for proper decomposition in the valley conditions is not possible as the time span between the harvests of *rabi* crops like wheat, brown sarson and oats and transplanting of succeeding rice crop and vice-versa is limited. With the continuous adoption of the exhaustive cropping systems, nutrient management has become a major issue being addressed by the agricultural scientists working in Kashmir valley. In this context the use of locally available organic materials can be a good option for supplementing the scarce chemical fertilizers. In view of the above facts, an experiment was taken up to evaluate organic resources alone and in combination in rice-wheat cropping system.

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MATERIALS AND METHODS

An experiment was conducted using rice variety *Jhelum* during rainy (*kharif*) seasons and wheat variety VL-738 during winter (*rabi*) seasons of 2006 to 2009 at main campus Shalimar Srinagar (34^0 5'N longitude and 74^0 8' E latitude and 1605 m mean sea level). The soil was silty clay loam, with pH 6.7, available N 380, P_2O_5 14 and K_2O 122 kg/ha, respectively. The organic carbon in the soil was 1.1 %. The treatments comprised of two standard controls of recommended fertilizer dose (120:60:30 kg/ha of $N:P_2O_5:K_2O$, respectively) and no nutrients, three organic resources (FYM @ 25 & 20 t/ha, biofertilizers and crop residue respectively), biofertilizers and crop residue combined with both rates of FYM, individually and in combination, respectively. Twelve treatments which were tested in a fixed layout for three cropping years in a randomized block design with three replications. The plot size was 6 x 3.5 m. Fertilizers were applied through urea, DAP and MOP as per package of practices only in recommended dose of fertilizers (RDF) treatment plot.

The organic sources were incorporated at the time of puddling in rice and at the time of sowing in wheat, because there is no sufficient gap between harvesting of previous crops and transplanting/ sowing of next crop under temperate condition. The rice crop was transplanted 30 days old seedling at a spacing 15 x 15 cm and wheat was sown with 23 cm row distance. All the agronomic measures were adopted for raising and maintaining a healthy crop. Ten randomly selected hills in rice and earmarked 1 meter row length in wheat from each replication were studied for growth and yield attributes. The yield parameters and yields were recorded and economics was worked out. The collected data were analysed statistically by using analysis of variance technique (ANOVA). The net photosynthesis rate of both crop were recorded with the help of portable photosynthesis analyzer (TPS-1) at booting stage.

Table 1 : Effect of FYM, Bio fertilizers and Crop residue alone and its combinations on Plant height, Tillers/hill, Grains/panicle, 1000-grain weight of rice in rice-wheat cropping system.

	Plant height (cm)			Tillers/hill			Grains/panicle			1000-grain wt. (g)		
	2006	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**
T_1 = No manuring	85.02	84.35	82.85	9.07	8.93	8.60	65.50	64.17	63.30	24.08	23.67	23.33
T_2 = 100% RDF (NPK)	96.60	97.10	96.60	13.65	13.25	12.75	91.80	90.80	90.13	25.67	25.50	25.25
T_3 = FYM @ 25 t./ha	93.40	95.40	96.85	12.20	12.90	13.30	73.27	73.63	74.97	24.75	25.00	25.33
T_4 = Crop residue	84.25	85.75	87.10	8.80	9.13	9.45	65.27	65.37	67.03	24.00	24.25	24.50
T_5 = Bio-fertilizers	86.23	87.90	88.45	9.85	10.05	10.35	66.87	67.20	68.20	24.00	24.35	24.65
T_6 = FYM @ 20 t./ha	90.90	91.90	92.40	12.00	12.30	12.60	72.87	73.53	74.53	24.75	25.20	25.40
T_7 = FYM @ 25 t./ha + Crop residue	91.23	91.55	92.05	10.70	11.05	11.45	68.47	69.13	70.17	24.25	24.55	24.70
T_8 = FYM @ 25 t./ha + Bio-fertilizers	95.55	96.55	97.15	12.80	13.30	13.80	77.47	78.47	79.40	25.67	25.95	26.15
T_9 = FYM @ 20 t./ha + Crop residue	88.85	89.85	90.85	10.53	11.00	11.38	67.70	69.03	70.00	24.42	24.65	24.87
T_{10} = FYM @ 20 t./ha + Bio-fertilizers	94.55	95.65	97.05	12.50	12.85	13.35	73.37	74.37	75.27	24.92	25.20	25.50
T_{11} = FYM @ 25 t./ha + Crop residue + Bio-fertilizers	90.15	90.85	91.75	11.90	12.30	12.80	70.27	71.50	72.40	24.50	24.85	25.05
T_{12} = FYM @ 20 t./ha + Crop residue + Bio-fertilizers	90.05	90.55	91.40	11.80	12.10	12.50	69.57	71.13	62.03	24.50	24.85	25.00
SEm +	2.52	1.72	1.81	1.04	0.97	0.89	2.71	1.29	3.09	0.43	0.38	0.43
LSD 0.05	7.38	5.05	5.30	NS	2.83	2.61	7.94	3.78	9.06	NS	1.12	1.27

RESULTS AND DISCUSION

Plant Height

Significantly highest plant height of rice were recorded with the treatment of 100% RDF applied with fertilizers in all the years which were at par with treatments FYM @ 25 t/ha + biofertilizers followed by FYM @ 20 t/ha + biofertilizers, FYM @ 25 t/ha, FYM @ 20 t/ha in all the years and FYM @ 25 t/ha + crop residue + biofertilizers and FYM @ 20 t/ha + crop residue + biofertilizers in first year 2006 (Table 1). However the no manuring (control) treatment was recorded lowest plant height of rice (Table 1). This might be due to instant supply of nutrient (NPK) boosting the growth of plant, while incorporation of crop residue may decrease the supply of nutrient during decomposition due to immobilization. In case of wheat crop in first year 100% RDF recorded significantly higher plant height than all other treatments, except FYM @ 25 t/ha + biofertilizers, FYM @ 20 t/ha + biofertilizers, FYM @ 25 t/ha, FYM @ 20 t/ha, FYM @ 25 t/ha + crop residue + biofertilizers, FYM @ 20 t/ha + crop residue + biofertilizers and FYM @ 25 t/ha + crop residue in second and third year and FYM @ 20 t/ha + crop residue in third year which were at par to each other. The height of both crop shows increasing trend year after year with application of all the organic resources alone and in combination (Table1& 2). However, it was almost stagnated with 100% RDF application and continue decline in no manuring treatment. Similar findings also recorded by Kumar, 2008.

Effective Tillers

In case of rice first year observed no significant difference in effective tillers/hill (Table 1& 2). However, second and third year of experiment significantly highest number of tillers/hill was recorded with application of FYM @ 25 t/ha + biofertilizers than alone application of biofertilizers, crop residue and no manuring while rest of the treatments were at par with this treatment. In case of wheat crop significantly higher number of effective tillers/m^2 was recorded

Table 2 : Effect of FYM, Bio fertilizers and Crop residue alone and its combinations on plant height, effective tillers/m^2, grains/spike, 1000-grain weight of wheat yield in rice-wheat cropping system.

Treatment	Plant height (cm)			Effective tillers/m^2			Grains/spike			1000-grain wt. (g)		
	2006-07	2007-08	2008-09	2006-07	2007-08	2008-09	2006-07	2007-08	2008-09	2006-07	2007-08	2008-09
T_1 = No manuring	87.27	86.47	84.18	220	218.7	216.3	45.73	45.07	43.74	43.88	43.55	41.88
T_2 = 100% RDF (NPK)	104.07	105.47	105.16	374	407.3	405.3	61.33	60.67	59.62	44.06	43.73	43.06
T_3 = FYM @ 25 t./ha	90.60	100.07	102.26	303	349.3	375.3	54.27	54.93	57.52	43.24	43.57	43.91
T_4 = Crop residue	88.13	91.80	92.15	224.7	252.3	269.5	47.20	48.20	49.53	43.31	43.54	43.54
T_5 = Bio-fertilizers	88.93	92.33	92.95	233.0	253.3	277.4	47.67	48.67	49.73	43.63	43.83	44.17
T_6 = FYM @ 20 t./ha	90.60	100.60	101.95	301.3	332.0	351.7	53.57	54.47	55.13	41.82	42.02	42.35
T_7 = FYM @ 25 t./ha + Crop residue	90.20	98.00	99.48	239.3	284.0	312.3	51.30	52.00	52.83	43.45	43.65	43.99
T_8 = FYM @ 25 t./ha + Bio-fertilizers	94.93	101.33	103.03	321.7	372.7	385.8	57.00	57.67	58.02	41.82	41.96	42.29
T_9 = FYM @ 20 t./ha + Crop residue	89.4	96.93	98.29	234.7	272.3	301.4	50.37	50.93	51.23	43.21	43.35	43.68
T_{10} = FYM @ 20 t./ha + Bio-fertilizers	92.77	100.93	101.93	316.0	365.3	375.2	54.33	55.67	56.12	42.57	42.72	42.70
T_{11} = FYM @ 25 t./ha + Crop residue + Bio-fertilizers	90.33	99.20	102.13	298.7	302.7	332.6	53.27	53.93	56.82	41.66	41.76	42.09
T_{12} = FYM @ 20 t./ha + Crop residue + Bio-fertilizers	90.27	100.80	101.93	286.7	300.0	327.5	53.27	53.93	56.62	41.77	41.90	42.24
SEm +	2.67	2.64	3.72	16.80	20.45	15.1	2.05	2.26	2.12	0.71	0.61	0.84
LSD 0.05	7.82	7.74	10.92	49.3	60.0	44.2	6.03	6.62	6.22	NS	NS	NS

with 100% RDF application in all the years than all other treatments, except application of FYM @ 25 t/ha + biofertilizers and FYM @ 25 t/ha alone in second and third year and FYM @ 20 t/ha + biofertilizers in third year (Table 2). This trend was found might be due to year after year increment in nutritional supply capacity of soil due to incorporation of organic resources. These results are also confirmed by Kumar, 2008.

Yield and Yield Attributes

Significantly higher number of grains/panicle was counted in rice with application of 100% RDF than all other treatments in all the years. However, the increasing trend was observed year after year with application of all the organic FYM @ 25 t/ha + biofertilizers which were at par with 100% RDF, FYM @ 20 t/ha + biofertilizers, FYM @ 25 t/ha + crop residue + biofertilizers, FYM @ 20 t/ha + crop residue + biofertilizers. While during first year in rice and during all the years in wheat, statistically similar 1000-grain weights were recorded with all the treatments (Table 1). The higher grain yield of rice was recorded with 100% RDF during first year and with FYM @ 25 t/ha + biofertilizers during second and third years of experiments, while straw yield was higher with 100% RDF in all the years, but they were statistically equal to each other and also similar to FYM @ 25 t/ha + biofertilizers, FYM @ 25 t/ha and FYM @ 20 t/ha + biofertilizers in all the years(Table 2).In case of wheat yield it was

Table 3 : Effect of FYM, Bio fertilizers and Crop residue alone and its combinations on rice and wheat yield in rice-wheat cropping system.

Treatment	Rice grain yield (q/ha)			Rice straw yield (q/ha)			Wheat grain yield (q/ha)			Wheat straw yield (q/ha)		
	2006-07	2007-08	2008-09	2006-07	2007-08	2008-09	2006-07	2007-08	2008-09	2006-07	2007-08	2008-09
T_1 = No manuring	51.40	46.34	44.34	61.27	56.46	53.86	28.78	27.55	25.12	49.42	40.70	40.12
T_2 = 100% RDF (NPK)	66.21	67.01	67.68	81.85	82.81	83.67	36.87	37.81	37.82	47.62	48.39	48.34
T_3 = FYM @ 25 t./ha	63.68	63.82	65.16	72.48	73.27	75.45	32.67	33.21	34.93	44.40	42.49	45.08
T_4 = Crop residue	48.45	48.78	50.78	60.54	60.57	62.95	28.65	29.76	30.50	39.10	40.81	42.42
T_5 = Bio-fertilizers	52.97	53.98	55.31	66.33	67.88	69.64	29.50	30.22	32.04	39.55	41.12	42.71
T_6 = FYM @ 20 t./ha	63.51	63.28	64.95	70.27	72.52	74.30	32.64	32.82	33.51	41.81	42.46	44.60
T_7 = FYM @ 25 t./ha + Crop residue	56.35	59.36	60.36	71.13	69.47	73.63	29.75	30.91	32.49	40.21	41.35	43.16
T_8 = FYM @ 25 t./ha + Bio-fertilizers	65.08	67.02	69.02	77.34	79.51	82.15	35.42	36.85	39.01	47.17	49.22	50.93
T_9 = FYM @ 20 t./ha + Crop residue	56.22	56.97	58.30	65.22	65.91	67.70	29.54	30.68	32.24	39.65	41.28	43.01
T_{10} = FYM @ 20 t./ha + Bio-fertilizers	64.09	65.37	68.04	75.48	77.95	81.17	34.65	35.42	37.59	46.40	48.08	50.08
T_{11} = FYM @ 25 t./ha + Crop residue + Bio-fertilizers	62.92	62.47	64.14	67.60	71.39	73.32	30.70	31.78	33.18	40.71	42.37	43.61
T_{12} = FYM @ 20 t./ha + Crop residue + Bio-fertilizers	59.92	60.08	63.08	67.45	69.79	72.46	29.80	31.39	32.79	40.32	41.75	43.30
SEm +	2.66	2.22	2.41	2.45	2.81	5.15	1.13	1.78	1.30	1.77	1.96	1.96
LSD 0.05	7.8	6.50	7.07	7.18	8.24	15.09	3.32	5.22	3.80	5.18	5.74	5.74

resource application alone and in combination, but stagnation with 100% RDF and decline trend with no manuring were seen(Table 1 & 3). The same trend was also found in case of wheat grains/spike (Table Table 2 &3). 1000-grain weight were recorded significantly higher in rice during second and third year with application of statistically higher with 100% RDF during first and second year of grain yield and in first year of straw yield. However, application of FYM @ 25 t/ha + biofertilizers recorded significantly higher grain yield in third year and straw yield in second and third year, but they are at par with each other, and followed by FYM @ 20 t/ha + biofertilizers, both

grain and straw yield in all the year and FYM @ 25 t/ha in grain yield during second and third year. However, the year after year trend of both grain and straw yield were observed increasing with organic application while it was stagnated with 100% RDF and decline with no manuring (Table 3).

Three year mean grain yield of rice, wheat, rice equivalent wheat and rice equivalent system yield (Table 4) were recorded significantly high with 100% RDF followed by FYM @ 25 t/ha + biofertilizers and FYM @ 20 t/ha + biofertilizers whith were at par with each other in all the component of system and also at par with FYM @ 25 t/ha, FYM @ 20 t/ha and FYM @ 25 t/ha + crop residue + biofertilizers in rice grain yield. Statistically lover yield was recorded with no manuring treatment in all the components. This might be due to the instant supply of nutrient in crop residue incorporation enhance the immobilization rate and reduce the nutrient supply initially during decomposition, but year after year soil health was improved by crop residue and FYM decomposition and increases nutrient supply rate was responsible for increasing trend in yield, however stagnation was observed with 100% RDF and decline trend in no manuring treatment (Table 3). Similar findings also observed by Mankotia *et al.*, 2008.

Net Photosynthesis Rate

The three year mean net photosynthesis rate at booting stage of both crop were recorded and measured statistically higher rate with application of FYM @ 25 t/ha + biofertilizers (6.63), in rice crop followed by 100% RDF (6.57), FYM @ 20 t/ha + biofertilizers (6.53), FYM @ 25 t/ha (6.10), FYM @ 20 t/ha (5.87), FYM @ 25 t/ha + crop residue + biofertilizers (5.63) and FYM @ 25 t/ha + crop residue (5.37), and they were at par with

Table 4 : Effect of FYM, Bio fertilizers and Crop residue alone and its combinations on 3 year mean grain yield of rice, wheat, rice equivalent wheat, rice equivalent system yield and net photosynthesis (PS) rate in rice-wheat system

Treatments	Rice grain yield (q/ha)	Wheat grain yield (q/ha)	Rice equivalent wheat grain yield (q/ha)	Rice equivalent system yield (q/ha)	Net PS rate of rice in flag leaf (µmol/cm²/Sec)	Net PS rate of wheat in flag leaf (µmol/cm²/Sec)	Production efficiency (kg/ha/day RESY)
T_1 = No manuring	47.36	27.15	28.86	76.22	4.47	5.97	20.88
T_2 = 100% RDF (NPK)	66.97	37.50	39.84	106.81	6.57	8.81	29.26
T_3 = FYM @ 25 t./ha	64.22	33.60	35.70	99.92	6.10	8.24	27.38
T_4 = Crop residue	49.34	29.64	31.49	80.83	4.63	6.24	22.15
T_5 = Bio-fertilizers	54.09	30.59	32.50	86.58	4.77	6.39	23.72
T_6 = FYM @ 20 t./ha	63.91	32.99	35.06	98.97	5.87	8.18	27.12
T_7 = FYM @ 25 t./ha + Crop residue	58.69	31.05	32.99	91.68	5.37	6.73	25.12
T_8 = FYM @ 25 t./ha + Bio-fertilizers	67.04	37.09	39.41	106.45	6.63	8.66	29.16
T_9 = FYM @ 20 t./ha + Crop residue	57.16	30.82	32.75	89.91	4.93	6.48	24.63
T_{10} = FYM @ 20 t./ha + Bio-fertilizers	65.83	35.88	38.13	103.97	6.53	8.31	28.48
T_{11} = FYM @ 25 t./ha + Crop residue + Bio-fertilizers	63.18	31.88	33.88	97.06	5.63	7.54	26.59
T_{12} = FYM @ 20 t./ha + Crop residue + Bio-fertilizers	61.03	31.33	33.29	94.31	5.03	7.33	25.84
SEm +	2.02	0.92	0.98	2.09	0.50	0.48	-
LSD 0.05	5.91	2.69	2.86	6.14	1.46	1.42	-

each other. However, in wheat crop statistically higher net photosynthesis rate was recorded with 100% RDF (8.81), followed by FYM @ 25 t/ha + biofertilizers (8.66), FYM @ 20 t/ha + biofertilizers (8.31), FYM @ 25 t/ha (8.24), FYM @ 20 t/ha (8.18), FYM @ 25 t/ha + crop residue + biofertilizers (7.54). The lowest net photosynthesis rate was recorded with no manuring in both crop rice (4.47) and wheat (5.97) (Table 4). This might be due to variable rate of nutrient availability in variable treatments.

influenced by two components one is input cost and second is out puts. The benefits of crop production is proportionally related to out puts of the crop and inversely related to input cost. The total amount of input cost was higher in treatment those consists FYM and crop residue due to its hues amount applied as compare to NPK fertilizer and biofertilizers. Due to high cost of FYM and crop residue the net return and benefit: cost ratio of crop were reduced in those treatment which consists FYM and crop residue because its hues

Table 5: Cost of cultivation, net return and net benefit: cost ratio of rice-wheat cultivation system.

Treatment	2006-07			2007-08			2008-09		
	Cost	Net return	B:C Ratio	Cost	Net return	B:C Ratio	Cost	Net return	B:C Ratio
T_1 = No manuring	42892	30283.5	0.71	47212	24891.4	0.53	51532	20185.3	0.39
T_2 = 100% RDF (NPK)	48764	45379.8	0.93	53144	48452.0	0.91	57524	50236.7	0.87
T_3 = FYM @ 25 t./ha	80392	7004.3	0.09	89712	3558.9	0.04	101532	50.9	0.00
T_4 = Crop residue	54370	16367.8	0.30	59471	17014.0	0.29	64696	18767.3	0.29
T_5 = Bio-fertilizers	43592	31979.7	0.73	47912	34098.7	0.71	52232	37367.5	0.72
T_6 = FYM @ 20 t./ha	72892	13818.4	0.19	81212	11198.4	0.14	91532	8398.0	0.09
T_7 = FYM @ 25 t./ha + Crop residue	93179	-14206.2	-0.15	103085	-15948.5	-0.15	116220	-21353.8	-0.18
T_8 = FYM @ 25 t./ha + Bio-fertilizers	81092	10442.0	0.13	90412	10031.3	0.11	101882	8172.8	0.08
T_9 = FYM @ 20 t./ha + Crop residue	85010	-7091.9	-0.08	94114	-9556.5	-0.10	105403	-13302.7	-0.13
T_{10} = FYM @ 20 t./ha + Bio-fertilizers	73592	16264.9	0.22	81912	15678.8	0.19	92232	15494.9	0.17
T_{11} = FYM @ 25 t./ha + Crop residue + Bio-fertilizers	93613	-9344.2	-0.10	104142	-13423.2	-0.13	116577	-17863.5	-0.15
T_{12} = FYM @ 20 t./ha + Crop residue + Bio-fertilizers	86057	-4810.6	-0.06	95369	-7164.3	-0.08	106777	-9465.6	-0.09

Production Efficiency

Production efficiency was calculated on the basis of rice equivalent system yield and presented in Table 4. The greater production efficiency (kg/ha/day) was recorded with 100% RDF (29.26) followed by FYM @ 25 t/ha + biofertilizers (29.16) and FYM @ 20 t/ha + biofertilizers (28.48), FYM @ 25 t/ha (27.38), FYM @ 20 t/ha (27.12) and FYM @ 25 t/ha + crop residue + biofertilizers (26.59) as like grain yield. However, lover production efficiency (kg/ha/day) was recorded with no manuring treatment (20.88). It was totally depends on rice equivalent system yield. The findings are in close conformity with those of Jamwal (2005).

Relative Economics

The economics of crop production is manly

quantity application. This is might be due to immobilization of nutrient in soil initially during decomposition of organic matter may reduce the supply of nutrient to plant in growth stage. It was also observed by Kumar, 2008. In this experiment the highest net return and benefit cost ratio (45380, 48452,50237 and 0.93, 0.91, 0.87) in first, second and third year, respectively were recorded with application of 100% RDF followed by biofertilizer application alone and no manuring might be due to lower input cost (Table 5).

CONCLUSION

On the basis of above result it has been concluded that the incorporation of organic resources shows increasing trends in production of rice-wheat system, but initially it reduce the net return and benefit cost ratio due to high input cost. But

stagnation of yield was observed with application of inorganic fertilizer alone. Therefore, on the basis of result it has been suggested that the combination of inorganic and organic sources should be started initially to maintain the input cost for sustainable production and may be reduced inorganic fertilizer after longer period when soil become healthier sufficiently to fulfill the nutrition supply demand of crop.

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