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Impact of differential substitution of nutrients through organics on yield, nutrient uptake and economics of Basmati rice in irrigated Shivalik foothills of J&K, India

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ABSTRACT

A field experiment was conducted for two years at research farm of division of Agronomy at SKUAST-Jammu during *kharif* 2015 and 2016 to assess the effect of differential substitution of nutrients through organics on yield, nutrient uptake and economics of basmati rice in irrigated Shivalik foothills of J&K. The pooled data of two year study on basmati rice revealed that grain yield, straw yield and total nutrient uptake in basmati rice were significantly influenced by differential substitution of nutrients through organics in irrigated Shiwalik foothills of J &K. Significantly higher pooled grain yield (30.38 q/ha) and straw yield (72.42 q/ha) of two year of basmati-370 were recorded with treatment 100% RDF which were found statistically at par with yields recorded with treatments T_{12}, T_{16}, T_2 and T_6 whereas significantly lowest grain and straw yield of basmati-370 were recorded with treatment 100 % NPK through FYM which was found statistically at par with treatment 100 % NPK through vermicompost and 100 % NPK through vermicompost and FYM (1:1) in grain and straw yield whereas significantly higher (75.37 kg/ha) total N uptake , total P uptake (13.13 kg/ha) and total K uptake (86.53 kg/ha) were recorded with treatment $T_{11.}$ Further, highest net returns (Rs 66056/ha) and b:c ratio (3.18) in basmati-370 after two years were recorded with treatment 100% NPK whereas lowest net returns (Rs 23213/ha) and b:c ratio (0.68) were recorded with treatment 100 % NPK through Vermicompost in basmati rice.

***Key words :** Differential substitution of nutrients, Basmati rice, J & K*

Introduction

"Basmati Rice" is the unique varietal group that has eminent itself as a result of natural and human selection found wider reception all over the world due to its cooking qualities, extra-long slender grain, length wise excessive elongation on cooking, softness and aroma. It has a high demand in the international market and fetches more than double price than coarse rice (Singh and Sikka 2007). Diminishing land resources coupled with augmented demand for food to feed the mounting population has over dominated the cultivated lands and modelled a stern challenge to the traditional litheness of these crop lands. Furthermore, unfair and inappropriate use of inorganic nutrients devoid of requisite quantity of organics has not only degraded the soil reserve base by reducing the population of beneficial micro-organisms and the factor productivity of most of the crop lands but also worsened the quality of the crops.

Increased health awareness among the common people has augmented the demand for safe and quality foods for which a comprehensive food production technology needs to be developed with emphasis on quality enhancement and yield stability in comparison to the yield and quality aspects realized under conventional practices of crop production. In fact, it is not affordable for an average Indian farmer to jump immediately from inorganic source of nutrients to organics in their crop production programme as it may lead to unbearable drastic reduction in crop yields in the initial years. This may become possible through the progressive substitution of organic sources of nutrients in place of in organics to meet crop nutrient requirement for attaining higher and stable crop yield of better quality with an improvement in soil health. Keeping these facts in view, the present study was under taken to study the "Impact of differential substitution of nutrients through organics on yield, nutrient uptake and economics of basmati rice in irrigated Shivalik foothills of J&K".

Materials and Method

The field experiment was conducted at research farm of Skuast-Jammu, main campus Chatha located at 32°40' N latitude and 73^{0} 64' E longitude at an elevation of 293 meters above mean sea level in the sub-tropical Shiwalik foot hill lands of Jammu and Kashmir. The soil of the experimental field was sandy clay loam in texture with pH 7.81, organic carbon 0.45 percent, available nitrogen (249.88 kg/ha), available phosphorus (13.79 kg /ha) and available potassium (148.45 kg/ha). The experiment was conducted in randomized block design with sixteen treatments. The sixteen treatments comprised of T_1-100 % NPK(Recommended dose of fertilizer); T_2-75% NPK+25% N through vermicompost; T_3- 50% NPK+50 % N through vermicompost; T_4-25 % NPK+75% N through vermicompost; T_5-100 % N through vermicompost; T_6- 25 % yearly replacement of RDF through vermicompost on N basis ; T_7- 75 % NPK+ 25 % N through FYM; T_8-50 % NPK+50% N through FYM ; T_9- 25% NPK+75% N through FYM ; T_{10} -100% N through FYM; T_{11}-25% yearly replacement of RDF through FYM on N basis ; T_{12}-75 % NPK+25 % N through vermicompost and FYM (1:1); T_{13}-50 % NPK+50 % N through Vermicompost and FYM (1:1); T_{14}-25% NPK+75% N through vermicompost and FYM (1:1); T_{15}- 100% N through vermicompost and FYM (1:1); T_{16}-25% yearly replacement of RDF through vermicompost and FYM (1:1) on N basis.The rice variety basmati-370 was used in the experiment during both the years. Basmati rice was transplanted on 13th July during *kharif* 2015 and 11th July during *kharif* 2016 into main experiment field. The basmati rice was transplanted on spacing of 20 cm × 10 cm.Application of the fertilizers including organic manures was done on the basis of recommended nutrients. The half quantity of nitrogen was applied as basal along with whole quantity of phosphorus, potassium and organic manure while remaining nitrogen was top dressed in two equal splits in basmati-370 and applied at tillering and panicle initiation stages during both the years. The inorganic sources of nitrogen, phosphorus and potassium were urea, diammonium phosphate and muriate of potash and the sources of organic manure were farm yard manure and vermicompost. The grain yield of basmati rice was calculated from weighing threshed grains obtained from each net plot separately and finally converted into quintal per hectare. The total biological yield (grain + straw) from the net plot was recorded and straw yield was worked out by subtracting the grain yield from the biological yield and expressed in q/ha. The nitrogen, phosphorous and potassium uptake in grain and straw in basmati rice were calculated by multiplying the per cent nutrient content with their respective dry matter as per the formula given below:

$$\text{Nutrient uptake (kg/ha)} = \frac{\text{Nutrient content (\%)} \times \text{dry matter accumulation (kg/ha)}}{100}$$

The total cost of cultivation of each treatment was calculated on per hectare basis. The input used were calculated on the basis of then prevailing, respective, market rates of different operations/input used and then average of two years i.e *kharif* 2015 and 2016 was calculated as expressed as mean cost of cultivation of basmati rice. Gross returns (Rs/ ha) were worked out by multiplying the saleable products (grains and straw of basmati rice, by their then prevailing respective, sale rates and then were presented on per hectare basis as per the treatments. The average of gross returns of basmati-370 during *kharif* 2015 and 2016 was worked out to calculate the mean gross returns. Net returns (Rs/ ha) were computed by deducting the total cost of cultivation from the gross returns as per the treatments where as

Benefit-Cost (B:C) ratio was calculated by dividing the net returns with cost of cultivation for different treatments. The data recorded for various characters were subjected to statistical analysis according to procedure outlined by Cochran and Cox (1963). All the comparisons were worked out at 5 per cent level of significance.

Result and Discussion

Yield

The data with respect to pooled two-year grain yield of basmati rice presented in Table 1 revealed that grain and straw yield of basmati rice were significantly influenced by differential substitution of nutrients through organics during both the seasons. Significantly highest pooled grain yield (30.38 q/ha)and straw yield (72.42 q/ha) of basmati rice were recorded with treatment 100% NPK through recommended dose of fertilizer which was found statistically at par with treatment T_{12} with grain and stover yield (29.37 q/ha and 71.97q/ha) ,T_{16} (28.90 q/ha and 71.60q/ha), T_2 (28.73 q/ha and 71.55q/ha) ,T_6 (27.95 q/ha and 71.19) whereas significantly lowest grain yield and straw yields were recorded with T_{10} (16.76 q/ha and 43.05q/ha) which was found statistically at par with treatments T_5 (17.00 q/ha and 43.22q/ha) , T_{15}(17.29 q/ha and 44.07) ,T_9 (19.13 q/ha and 45.12q/ha) and T_4 (19.15 q/ha and 48.33q/ha) in the increasing order, respectively whereas remaining treatments were significantly different from all the treatments. Significantly highest yield in T_1 could be attributed to their greater availability and uptake of macro and micronutrients and their active participation in carbon assimilation, photosynthesis and translocation etc. Combination of organic and inorganic fertilizers also enhances the process of tissue differentiation, *i.e* from somatic to reproductive phase leading to higher grain and straw yields. These results are also in conformity with findings of Mohantey *et al.* (2013). On the other hand lowest yield of basmati rice with treatment T_{10} and T_5 and T_{15} was might be due reason that organic manures contain nutrients in organic form which mineralized into available form after a particular time therefore unavailable to fulfil the timely needs of the crop. These results were similar to the findings of Singh *et al*. (2007).

Nutrient Uptake

The pooled data two-year data of total nutrient uptake in basmati -370 presented in Table 2 stated that total nutrient uptake, i.e NPK uptake were significantly influenced by differential substitution of nutrients through organics in basmati rice. Significantly highest N uptake (75.37 kg/ha), P uptake (13.13 kg/ha) and total K uptake (86.53 kg/ha) in basmati rice was recorded with treatment T_{11} whereas significantly lowest N uptake (50.57 kg/ha) was recorded with treatment T_{10}, significantly lowest P uptake (9.87 kg/ha) was recorded with treatment T_1 and significantly total K uptake (60.30 kg/ha) in basmati rice was recorded with treatment T_5.

Table 1. Effect of differential substitution of nutrients through organics on grain yield (q/ha) and straw yield (q/ha) of basmati rice (Pooled data of 2 years)

Treatments	Grain yield (q/ha)	Straw yield (q/ha)
T_1	30.38	72.42
T_2	28.73	71.55
T_3	23.71	60.08
T_4	19.15	48.33
T_5	17.00	43.22
T_6	27.95	71.19
T_7	27.80	71.03
T_8	23.54	59.33
T_9	19.13	45.12
T_{10}	16.76	43.05
T_{11}	27.74	70.89
T_{12}	29.37	71.97
T_{13}	23.90	61.71
T_{14}	19.66	50.15
T_{15}	17.29	44.07
T_{16}	28.90	71.60
S.E.m (±)	0.87	2.25
CD (5%)	2.45	6.38

Treatment details : T_1 -100 % NPK (Recommended dose of fertilizer); **T_2**-75 % NPK +25 % N through Vermicompost ; **T_3**-50 % NPK + 50 % N through Vermicompost ; **T_4**-25 % NPK +75 % N through Vermicompost ; **T_5**-100 % N through Vermicompost ; **T_6**-25 % yearly replacement of RDF through Vermicompost; **T_7**-75 % NPK +25 % N through FYM ; **T_8**-50 % NPK + 50 % N through FYM ; **T_9**-25 % NPK +75 % N through FYM ; **T_{10}**-100 % N through FYM; **T_{11}**-25 % yearly replacement of RDF through FYM ;**T_{12}**-75 % NPK +25 % N through Vermicompost and FYM (1:1) ; **T_{13}**-50 % NPK + 50 % N through Vermicompost and FYM (1:1) ; **T_{14}**-25 % NPK +75 % N through Vermicompost and FYM (1:1) ; **T_{15}**-100 % N through Vermicompost and FYM (1:1) ; **T_{16}**-25 % yearly replacement of RDF through Vermicompost and FYM (1:1).

Table 2. Effect of differential substitution of nutrients through organics on total nutrient uptake (kg/ha) of basmati rice (Pooled data of 2 years)

Treatment	Total uptake (kg/ha)		
	Nitrogen	Phosphorus	Potassium
T_1	67.40	9.87	78.56
T_2	73.94	12.51	83.76
T_3	65.44	12.94	77.64
T_4	56.22	11.41	66.12
T_5	50.96	10.44	60.30
T_6	73.79	12.54	83.56
T_7	74.51	12.99	84.84
T_8	64.95	12.96	77.35
T_9	54.36	11.14	62.62
T_{10}	50.75	10.47	60.49
T_{11}	75.37	13.13	86.53
T_{12}	72.84	12.25	82.75
T_{13}	66.26	13.03	78.61
T_{14}	57.80	11.64	68.01
T_{15}	51.68	10.54	61.21
T_{16}	72.97	12.36	83.10
S.E.m (±)	3.03	0.59	3.49
CD (5%)	8.74	1.71	10.08

Treatment details : T_1 -100 % NPK (Recommended dose of fertilizer); T_2-75 % NPK +25 % N through Vermicompost; T_3-50 % NPK + 50 % N through Vermicompost; T_4-25 % NPK +75 % N through Vermicompost; T_5-100 % N through Vermicompost ; T_6-25 % yearly replacement of RDF through Vermicompost; T_7-75 % NPK +25 % N through FYM ; T_8-50 % NPK + 50 % N through FYM ; T_9-25 % NPK +75 % N through FYM ; T_{10}-100 % N through FYM; T_{11}-25 % yearly replacement of RDF through FYM; T_{12}-75 % NPK +25 % N through Vermicompost and FYM (1:1); T_{13}-50 % NPK + 50 % N through Vermicompost and FYM (1:1); T_{14}-25 % NPK +75 % N through Vermicompost and FYM (1:1); T_{15}-100 % N through Vermicompost and FYM (1:1); T_{16}-25 % yearly replacement of RDF through Vermicompost and FYM (1:1).

The difference in nutrient uptake in basmati rice was might be due to cumulative effect of nutrient content and yield of basmati rice. Similar findings were also given by Satish *et al.* (2011).

Economics

The practicability and usefulness of a treatment is judged in terms of net returns. From 2 years mean data on effect of differential substitution of nutrients through organics on economics of basmati rice pre-

Table 3. Effect of differential substitution of nutrients through organics on economics of basmati rice (Mean data of 2 years)

Treatments	Cost of cultivation (Rs/ha) (A)	Gross returns (Rs/ha) (B)	Net returns (Rs/ha) C = B-A	B:C ratio D=C/A
T_1	20782	86838	66056	3.18
T_2	24223	82545	58322	2.41
T_3	27665	68275	40611	1.47
T_4	31107	55124	24018	0.77
T_5	34255	57467	23213	0.68
T_6	25987	80541	54554	2.10
T_7	21637	80067	58429	2.70
T_8	22493	67737	45244	2.01
T_9	23346	54581	31235	1.34
T_{10}	23912	56513	32601	1.36
T_{11}	22065	80046	57980	2.63
T_{12}	22930	84209	61278	2.67
T_{13}	25079	68994	43915	1.75
T_{14}	27228	56660	29433	1.08
T_{15}	29083	58466	29383	1.01
T_{16}	24026	82991	58965	2.45

Treatment details : T_1 -100 % NPK (Recommended dose of fertilizer); T_2-75% NPK +25 % N through Vermicompost; T_3-50 % NPK + 50 % N through Vermicompost; T_4-25 % NPK +75 % N through Vermicompost ; T_5-100 % N through Vermicompost; T_6-25% yearly replacement of RDF through Vermicompost; T_7-75 % NPK +25 % N through FYM; T_8-50 % NPK + 50 % N through FYM; T_9-25 % NPK +75 % N through FYM ; T_{10}-100 % N through FYM; T_{11}-25 % yearly replacement of RDF through FYM; T_{12}-75 % NPK +25 % N through Vermicompost and FYM (1:1); T_{13}-50% NPK + 50% N through Vermicompost and FYM (1:1); T_{14}-25 % NPK +75 % N through Vermicompost and FYM (1:1); T_{15}-100 % N through Vermicompost and FYM (1:1); T_{16}-25 % yearly replacement of RDF through Vermicompost and FYM (1:1).

sented in Table 3 it was revealed that maximum cost of cultivation (Rs 31107/ha) of basmati rice was recorded with treatment T_5 (100% N through Vermicompost) whereas lowest cost of cultivation (Rs 20872/ha) of basmati rice was recorded with treatment T_1(100 % NPK recommended). The highest cost of cultivation in T_5 was might be due to highest per kg cost of vermicompost associated with this treatment. Highest gross returns (Rs 86838/ha), net returns (Rs 66056/ha) and b:c ratio (3.18) were recorded with treatment T_1 followed by treatment T_{12} with gross returns (Rs 84209/ha), net returns (Rs 61278/ha) and b:c ratio (2.67) whereas lowest gross returns (Rs 54581/ha) were recorded with treatment T_9 whereas lowest net returns (Rs 23213/ha) and b:c ratio (0.68) were recorded with treatment T_5. The highest gross returns in treatment T_1 were might be due to higher yield attained under this treatment and prevailing market price of basmati rice during the respective years whereas highest net returns and benefit cost ratio in T_1 was due to higher net returns and minimum cost of cost cultivation associated with treatment T_1-100% NPK (recommended dose of fertilizer). Similar results were also reported by Malviya *et al.* (2012).

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