Effect of soil organic amendments and basmati cultivars on productivity and grain quality of basmati rice (*Oryza sativa*) in aerobic culture

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ABSTRACT

A field experiment was conducted at Research Farm, Main Campus Chatha of Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu from kharif 2012 to rabi 2013-14 to find out a suitable combination of soil organic amendments for basmati rice. The experiment was laid out in a split plot design with three replications. The main plot treatments comprised of four basmati cultivars namely Basmati-370, Basmati-564, Saanwal basmati and Ranbir basmati and sub plots consisted of six treatments of soil organic amendments including control viz.T_1 *,*T_2*,* T_3*,* T_4*,*T_5 *and* T_6 *were applied on nitrogen basis @ 30 kg/ha. Basmati-564 and Saanwal basmati significantly increased yield per unit area over Basmati-370 and Ranbir basmati. Application of treatment* T_1 *(RFD)was significantly superior with respect to yield attributes and yield of basmati rice over organic applied treatments which led to 11.20-29.83% increase. There was non-significant effect among the basmati cultivars and soil organic applied treatments with respect to grain quality. However, organic applied treatments were found superior in improving the grain quality and thus hold a great promise in organic applied treatments on aerobically grown basmati rice.*

Key words: ***Aerobic rice, Basmati rice, Grain quality, Organic amendments, Productivity***

I.INTRODUCTION

Aerobic rice is a contemporary concept of growing rice with reduced water requirements where fields remain unsaturated throughout the season like an upland irrigated crop. The situation is worst in north-west plain zone of India where underground water is being used injudiciously to irrigate rice, as a consequence the water-table in this area is going down at an alarming rate (Rodell*et al.* 2009). There are strong indications that declining water availability is threatening the sustainability of the rice–wheat cropping system in this region. Basmati rice is a globally reputed aromatic group of rice, having pleasant aroma, superfine grain along with extensive kernel elongation and soft texture of cooked rice. Production of high quality basmati rice is therefore, a major concern of future agricultural strategy. Nitrogen is an essential component of any fertilizer management programme and particularly it is more so, for the rice crop. The interaction of chemical fertilizers with the soil is considered less favourable to the soil environment in comparison with organic sources of nutrients. Organic manures like farm yard manure, vermicompost and *dhaincha* (*Sesbania esculeata*) would play an important role in crop nutrition, soil fertility and grain quality such as physical appearance, cooking characters and nutritional qualities are the important factors which determine its acceptability by the consumers in association with chemical fertilizers. Hence, the present study involving different combinations of N to find out its influence on aerobically basmati rice was undertaken.

II.MATERIALS AND METHODS

An investigation entitled "Performance of promising basmati rice (*Oryza sativa L.*) cultivars in aerobic culture with different soil organic amendments in rice-wheat system" was conducted at the Research Farm, Main Campus, Chatha of Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu from *kharif* 2012 to *rabi* 2013-14.The soil of the experimental field was sandy loam in texture, slightly alkaline in reaction, low in organic carbon and available nitrogen but medium in available phosphorus and potassium with sufficient quantity of available zinc and electrical conductivity in the safer range. The experiment was laid out in split plot design with three replications. Twenty four treatment combinations comprising of four basmati cultivars viz.,Basmati-370, Basmati-564,Saanwal basmati and Ranbir basmati were taken as main plot treatments and six sub plot treatments comprising of soil organic amendments and RFD viz., T_1: Control (Recommended Fertilizer Dose), T_2 :*In-situ* green manuring of *dhaincha* on N-basis, T_3: *In-situ* green manuring of *dhaincha* followed by application of Vermicompost on N-basis (1:1), T_4:*In-situ* green manuring of *dhaincha* followed by application of vermicompost and mulching with *dhaincha* on N-basis (1:1:1),T_5: *In-situ* green manuring of *dhaincha* followed by application of FYM on N-basis (1:1) and T_6:*In-situ* green manuring of *dhaincha* followed by application of FYM and mulching with *dhaincha* on N-basis (1:1:1) as sub plot treatments. A seed rate of 60 kg/ha was used for sowing of *dhaincha*. For *in-situ dhaincha*, seed rate was worked out keeping in view the size of the plots of experimental treatments and the seed was sown by broadcasting. Besides this an additional *ex-situ* crop of *dhaincha* was also grown by using similar quantity of seed 10 days prior to the normal sown *in-situ.* This *ex-situ dhaincha* crop was used to assess nitrogen content to be taken as reference for working out the quantity of *dhaincha* to meet out the different nitrogen requirement as per of the experimental treatments. Application of organic amendments *viz*. FYM with 45% moisture, vermicompost with 50% moisture and fresh biomass of *dhaincha* with 80 % moisture used as sources of nitrogen were analysed for determine their N content (oven dry weight basis) to decide the total quantity of these organic amendments to be used to supplement 30 kg N/ha. The quantity of FYM, vermicompost and fresh biomass of *dhaincha* to fulfil the recommended dose of nitrogen on their respective N contents was 10.88, 5.00 and 8.30 tonnes/ha. The *ex-situ* raised *dhaincha* crop was cut near the ground surface and 10 kg's (8.33 tonnes/ha) of its fresh biomass was spread in the inter row spaces of each plot of mulching treatments at 20 days after sowing. Recommended doses of N:P:K(30:20:10 kg/ha) were applied. Total P, K and ½ doses of N were broadcasted before sowing and rest was top dressed at tillering and flowering stages in equal doses. Sowing of direct seeded basmati rice was done in lines giving row- row spacing of 20 cm using a seed rate of 40kg/ha. Pre-sowing irrigation was avoided due to receipt of sufficient rainfall of 130.40 mm before the sowing. Irrigation was applied when 50% depletion of soil moisture from field capacity was observed. This was ascertained by following the procedure underlined for feel and appearance method for determination of moisture status of soil (USDA-2007).Grain length and breadth before cooking of dehusked grains was measured by using standard scale and expressed in millimeters. Grain length and breadth after cooking was estimated according to the procedure reported by Biswas and Juliano (1988).Weighed samples of clean paddy, with a moisture content of 13–14%, were dehusked in a Satake Rubber Roll Laboratory Sheller and the shelled rice (brown rice) samples were milled (McGill miller No. 2). The time of polishing was adjusted to obtain a 6 % degree of polish in all the samples (Sharma *et al.* 2008). Percent recovery of total rice and head rice was determined using the following formulae:

$$\text{Head rice Recovery (\%)} = \frac{\text{Weight of head rice}}{\text{Weight of rough rice}} \times 100$$

The simplified procedure of (Juliano 1971) was used for estimating the amylose content. On the basis of their amylose content the rice varieties can be grouped into waxy (0–2%), very low (3–9%), low (10–19%), intermediate (20–25%) and high (>25%).Protein content in rice grains was calculated by multiplying the value of N-content of grains with the factor 6.25 and expressed it as per cent protein content in rice grains.

III.RESULTS AND DISCUSSION

Yield attributes and yields

Aerobic system enhances root development to the deeper soil layers and root shoot ratio (Banoc*et al*. 2000), thus, creating competition between root and shoot for photosynthates within the plant leading to low yields. Yield decline up to 40% was also reported by Peng *et al.* (2006) under aerobic system. Among basmati cultivars, Basmati-564 recorded highest plant population/m^2, effective panicles/m^2 and grains/panicle and was statistically at par with Saanwal basmati and both these cultivars were recognised significantly superior than Basmati-370 and Ranbir basmati. Unlike number of effective panicles/m^2 and grains/panicle, a change in numerical trend of 1000-grain weight was recorded and Basmati-370 registered lowest 1000- grain weight than Ranbir basmati. Highest yield attributing characters which by and large are governed by their respective genetic make-ups responsible for expression of their highest grain and straw yields under a given set of environment in both the crop growing seasons of *kharif* 2012 and 2013 (Murli and Shetty 2004).In *kharif* 2012, the treatment where recommended dose of fertilizer (RFD) was applied recorded significantly highest number of effective panicles/$m^2$and grains/panicle as compared to rest of the treatments. (Naveen *et al*. 2013) revealed that the highest grain yield attributes can be ascribed to better nutrient mineralization under treatment T_1- RFD which led to increase grain and straw yields. In *kharif* 2013, the treatment RFD (T_1) recorded highest number of yield attributes but found statistically close to the treatments T_2 followed by T_5 and T_3 and all these treatments registered their statistical superiority over treatment T_6 followed by T_4 (Table 1), which led to 12.62-42.51% increase in grain yield over organic applied treatments during *kharif* 2012 and 4.10-35.40 % during *kharif*2013 (Table 2). (Awan *et al*. 2000) reported that, this might be synchronized and balanced release of essential nutrients including micronutrients (Shanmugam and Veeraputhran 2001) and (Bhattacharya *et al*. 2003) throughout the crop growth period.

Table 1: Effect of cultivars and soil organic amendments on yield attributing characters of basmati rice in aerobic culture

	Plants /m^2		Effective panicles/ m^2		Grains/panicle		1000-grain weight (g)	
Treatments	**KY_1**	**KY_2**	**KY_1**	**KY_2**	**KY_1**	**KY_2**	**KY_1**	**KY_2**
Basmati cultivars								
V_1	190.33	203.22	179.11	189.11	63.00	68.94	21.68	22.04
V_2	206.00	210.28	189.28	195.94	70.95	74.61	22.62	22.78
V_3	202.56	208.44	185.56	193.61	69.48	73.56	22.59	22.74
V_4	188.72	199.50	175.06	185.50	61.74	67.17	21.74	22.16
SEm (±)	1.44	1.25	1.24	1.18	0.40	0.53	0.04	0.09
LSD (p = 0.05)	4.92	4.32	3.72	3.65	1.32	1.81	0.16	0.32
Soil organic amendments								
T_1	203.67	212.75	188.58	194.75	71.00	73.00	22.97	23.02
T_2	198.25	206.25	184.25	193.92	68.94	72.42	22.14	22.55
T_3	195.50	205.00	182.67	192.52	68.45	72.00	21.99	22.41
T_4	193.25	201.92	178.42	186.17	64.91	68.00	21.68	22.16
T_5	197.25	206.08	183.47	193.65	68.82	72.25	22.08	22.48

T_6	193.67	203.17	179.15	188.75	66.00	69.25	21.98	22.23
SEm (±)	1.77	1.84	0.96	1.05	0.46	0.68	0.16	0.15
LSD (p = 0.0 5)	5.35	5.69	2.90	3.09	1.41	2.09	0.47	0.42

KY_1= *kharif* 2012 and KY_2 = *kharif* 2013

Table 2: Effect of cultivars and soil organic amendments on grain yield, straw yield (q/ha) and harvest index (%) of basmati rice in aerobic culture

	Grain yield (q/ha)		Straw yield (q/ha)		Harvest index (%)	
Treatments	**KY_1**	**KY_2**	**KY_1**	**KY_2**	**KY_1**	**KY_2**
Basmati cultivars						
V_1	18.28	19.20	39.90	42.66	31.12	31.49
V_2	23.13	24.76	49.30	51.23	32.32	32.95
V_3	22.16	23.48	46.25	47.76	32.21	32.70
V_4	17.01	17.97	36.83	39.04	31.01	31.30
SEm (±)	0.66	0.70	0.90	1.09	0.33	0.36
LSD (p = 0.05)	2.29	2.42	3.11	3.80	1.07	1.16
Soil organic amendments						
T_1	24.00	24.40	52.9	53.15	31.96	

			0			32.93
	21.31		45.4	48.88	31.75	
T_2		23.44	8			32.35
	20.38	22.10	42.1		31.60	
T_3			0	45.90		31.93
	16.84	18.02	36.2		31.45	
T_4			1	37.82		31.72
	20.43	22.11	43.7	46.86	31.69	
T_5			7			32.00
	17.53	18.43	38.0	38.40	31.55	
T_6			1			31.77
SEm (±)	0.92	0.91	1.40	1.61	0.49	0.56
	2.61	2.62	4.01	4.60		
LSD (p = 0.05)					N.S.	N.S.

Table 3: Effect of cultivars and soil organic amendments on qualitative parameters of basmati rice in aerobic culture

	Grain length (mm)		**Grain length (mm)**		**Grain breadth (mm)**		**Grain breadth (mm)**	
	Before Cooking	**After Cooking**	**Before Cooking**	**After Cooking**	**Before Cooking**	**After Cooking**	**Before After Cooking Cooking**	
Treatments	**KY_1**	**KY_1**	**KY_2**	**KY_2**	**K Y_1**	**KY_1**	**KY_2**	**KY_2**
Basmati cultivars								
V_1	6.63	12.64	6.64	12.65	1.79	2.00	1.80	2.02
V_2	7.01	13.05	7.02	13.06	1.66	1.90	1.67	1.92
V_3	6.72	12.88	6.73	12.90	1.74	1.98		

							1.75	2.00
V_4	6.93	12.92	6.95	12.94	1.69	1.95	1.70	1.97
SEm (±)	0.15	0.20	0.15	0.21	0.08	0.08	0.08	0.09
LSD (p = 0.05)	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Soil organic amendments								
T_1	6.82	12.90	6.82	12.91	1.71	2.00	1.72	2.01
T_2	6.89	12.99	6.91	13.01	1.76	2.07	1.77	2.07
T_3	6.87	12.95	6.88	12.96	1.74	2.05	1.76	2.06
T_4	6.83	12.91	6.84	12.92	1.72	2.04	1.75	2.05
T_5	6.88	12.98	6.89	13.00	1.75	2.06	1.76	2.07
T_6	6.86	12.92	6.87	12.94	1.73	2.05	1.75	2.06
SEm (±)	0.03	0.10	0.06	0.10	0.03	0.06	0.03	0.04
LSD (p = 0.05)	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

IV.GRAIN QUALITY

Grain quality of basmati cultivars were not significant influenced by basmati cultivars and different soil organic amendments. However, Basmati-564 recorded highest grain length before and after cooking and length breadth ratio followed by Ranbir basmati, Saanwal basmati and Basmati-370. Contrary to grain length of basmati before and after cooking, grain breadth before and after, recorded a different trend wherein rice grain with highest length registered lowest grain breadth. Cultivar Basmati-370 recorded highest grain breadth before and after followed by Saanwal basmati, Ranbir basmati and Basmati-564.Head rice recovery percentage, amylose content and protein content followed same trend as was noticed in the grain breadth before and after cooking. (Quyen and Sharma 2003) also demonstrated that differences in cultivars response to grain quality. These quality traits remained unaffected by the application of different soil organic amendments. However, organic applied treatments exhibited higher increase in quality traits of basmati rice except protein content over T_1 (Control)

(Tripathi and Verma 2008). The protein content of organic rice was reduced as reported by (Okuda *et al.* 2005). (Miller and Miller 2000) highlighted that organic material application to cropland could affect soil properties, but the effects generally may not be apparent over a short time period. More specifically, (Tittarelli *et al*. 2007) pointed out that the simplest method of examining the agronomic value of stabilized organic materials is the calculation both of organic matter supply and plant nutrients. The slow release of these nutrients is responsible for the increase in crop yields in the subsequent years, thus determining the difficulty of quickly evaluating the true agronomic value of these organic materials as amendments. However, there is a considerable variability between experimental techniques, climate, soil type and organic material characteristics, and therefore attention must be paid to generalizing the effects of composts and green manure application on the soil-plant system.

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