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Research Paper

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

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ABSTRACT

A field experiment was conducted from the rainy (*kharif*) season of 2012 to the winter (*rabi*) season of 2013–14 at Research Farm, Main Campus, Chatha of the Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, to find out a suitable combination of soil organic amendments for *Basmati* rice. The experiment was laid out in a split-plot design with 3 replications. The main plot treatments comprised 4 *Basmati* cultivars, viz. '*Basmati* 370', '*Basmati* 564', 'Saanwal *Basmati*' and 'Ranbir *Basmati*', and subplots consisted of 6 treatments of soil organic amendments, viz. T_1, control (recommended fertilizer dose); T_2, *in-situ* green manuring of *dhaincha* [*Sesbania bispinosa* (Jacq.) W. Wight] 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 farmyard manure on N basis (1 : 1); and T_6, *in-situ* green manuring of *dhaincha* followed by application of farmyard manure and mulching with *dhaincha* on N basis (1 : 1 : 1), were applied on nitrogen basis @ 30 kg/ha. Among the *Basmati* cultivars, '*Basmati* 564' and 'Saanwal *Basmati*' were significantly superior to '*Basmati* 370' and 'Ranbir *Basmati*'. Application of recommended fertilizer dose (30 : 20 : 10 kg/ha) N : P_2O_5 : K_2O resulted in significantly highest yield attributes and yield of *Basmati* rice over organic-applied treatments. 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, *Dhaincha*, Farmyard manure, Quality parameters, Recommended fertilizer dose

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 the North-West Plains Zone of India where underground water is being used non-judiciously to irrigate rice, and 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 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 for 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 than with organic sources of nutrients (Manna *et al.,* 2007). Organic manures like farmyard manure, vermicompost and *dhaincha* would play an important role in crop nutrition, soil fertility and grain quality such as physical appearance, cooking characters and nutritional qualities. These are the important factors which determine its acceptability by the consumers in association with chemical fertilizers (Das, 2013). Hence, the present study was carried out using different organic matters to substitutes for N and to find out combinations of N and their influence on productivity and grain quality of aerobically grown *Basmati* rice.

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MATERIALS AND METHODS

An investigation was carried out at the Research Farm, Main Campus, Chatha of the Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu from the rainy (*kharif*) season of 2012 to the winter (*rabi*) season of 2013–14. The soil of the experimental field was sandy loam, slightly alkaline, low in organic carbon and available nitrogen but medium in available phosphorus and potassium, with sufficient quantity of available zinc. The electrical conductivity was in the safer range. The experiment was laid out in a split-plot design with 3 replications. Twenty four treatment combinations comprising 4 *Basmati* cultivars, viz. '*Basmati* 370', '*Basmati* 564', 'Saanwal *Basmati*' and 'Ranbir *Basmati*' were taken as main-plot treatments and 6 subplot treatments comprising soil organic amendments and recommended fertilizer dose (RFD), viz. T_1, control (recommended fertilizer dose) 30: 20 : 10 kg/ha N : P_2O_5 : K_2O; 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 subplot 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 to determine their N content (oven dry-weight basis) for deciding 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 N 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 (8.33 tonnes/ha) of its fresh biomass was spread in the inter-row spaces of each plot of mulching treatments 20 days after sowing. Recommended doses of N : P : K (30 : 20 : 10 kg/ha) were applied. Total P, K and half doses of N were broadcast 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 at row-to-row spacing of 20 cm using a seed rate of 40 kg/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 as per the procedure suggested 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). Per cent recovery of total rice and head rice was determined using the following formula:

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

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.

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 the *Basmati* cultivars, '*Basmati* 564' recorded the 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 found significantly superior to '*Basmati* 370' and 'Ranbir *Basmati*' (Table 1). Unlike number of effective panicles/m^2 and grains/panicle, a change in numerical trend of 1,000-grain weight was recorded and '*Basmati* 370' had lowest 1,000-grain weight than 'Ranbir *Basmati*'. Highest yield-attributing characters which by and large are governed by their respective genetic made 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 values of grain yield attributes can be ascribed to better nutrient mineralization under treatment T_1, RFD, which led to increase grain and straw yields. The treatment RFD (T_1) recorded the highest values of yield attributes and was found statistically superior to T_2, *in-situ* green manuring of *dhaincha* on N basis followed by T_5, *in-situ* green manuring of *dhaincha,* followed by application of FYM on N basis (1:1); T_3, *in-situ* green manuring of *dhaincha,* followed by application of vermicompost on N basis (1 : 1); T_6, *in-situ* green manuring of *dhaincha,* followed by application of FYM and mulching with *dhaincha* on N basis (1 : 1 : 1) followed by T_4, *in-situ* green manuring of *dhaincha* followed by application of vermicompost and mulching with *dhaincha* on N basis (1 : 1 : 1) (Table 1), which led to 12.62–42.51% increase in grain yield over organic applied treatments during *kharif* 2012 (Table 2). Awan *et al*. (2000) reported that, this might be owing to synchronized and balanced release of essential nutrients including micronutrients (Shanmugam and Veeraputhran, 2001; Bhattacharya *et al*., 2003) throughout the crop-growth period.

Table 2. Effect of cultivars and soil organic amendments on grain yield, straw yield (t/ha) and harvest index (%) of *Basmati* rice in aerobic culture condition (pooled data of 2 years)

Treatment	Grain yield (t/ha)	Straw yield (t/ha)	Harvest index (%)
Basmati cultivars			
V_1	1.87	4.14	31.6
V_2	2.41	5.04	32.8
V_3	2.32	4.70	32.1
V_4	1.75	3.82	31.2
SEm±	0.066	0.090	0.33
CD (P =0.05)	0.229	0.311	1.07
Soil organic amendments			
T_1	2.42	5.31	32.5
T_2	2.24	4.73	32.0
T_3	2.13	4.41	31.8
T_4	1.78	3.72	31.6
T_5	2.13	4.54	31.8
T_6	1.80	3.82	31.7
SEm±	0.054	0.142	NS
CD (P=0.05)	0.172	0.426	NS

Details of treatments are given under Materials and Methods

Grain quality

Grain quality was not significantly influenced by *Basmati* cultivars and different soil organic amendments. However, '*Basmati* 564' recorded the 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

Table 1. Effect of cultivars and soil organic amendments on yield-attributing characters of *Basmati* rice in aerobic culture condition (pooled data of 2 years)

Treatment	Plants/m^2	Effective panicles/m^2	Grains/panicle	1,000-grain weight (g)
Basmati cultivars				
V_1	196.8	184.2	65.9	21.9
V_2	209.1	193.1	72.8	22.7
V_3	206.5	189.5	71.5	22.7
V_4	194.1	180.3	64.5	21.9
SEm±	1.94	1.44	0.70	0.14
CD (P=0.05)	5.32	4.92	2.98	0.52
Soil organic amendments				
T_1	208.5	193.5	73.0	23.0
T_2	202.3	190.1	72.0	22.1
T_3	200.3	188.2	70.0	22.0
T_4	197.7	183.5	67.0	21.7
T_5	202.1	189.2	71.0	22.1
T_6	198.4	184.1	68.0	22.0
SEm±	1.88	0.98	0.19	0.16
CD (P=0.05)	5.56	2.94	0.61	0.47

Details of treatments are given under Materials and Methods
KY_1, *kharif* 2012 and KY_2, *kharif* 2013

Table 3. Effect of cultivars and soil organic amendments on qualitative parameters of *Basmati* rice in aerobic culture (pooled data of 2 years)

Treatment	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 cooking	After cooking
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
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
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
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS

Details of treatments are given under Materials and Methods

and after cooking, grain breadth before and after, recorded a different trend wherein rice grain with highest length registered the lowest grain breadth. Cultivar '*Basmati* 370' recorded the 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 for grain breadth before and after cooking. Quyen and Sharma (2003) also reported differences in the response of cultivars 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. Tittarelli *et al*. (2007) more specifically, 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.

REFERENCES

Awan, Z.I., Absasia, M.K. and Hashmi, N.I. 2000. Effect of organic and inorganic manures on growth and yield of rice variety Basmati 2000. *Pakistan Journal of Agricultural Research* **16**(2): 105–108.

Banoc, D.M., Yamauchi, A., Kamoshita, A., Wade, L.J. and Pardales, J.R. 2000. Dry-matter production and root system development of rice cultivars under fluctuating soil moisture. *Plant Production Science* **3**: 197–207.

Bhattacharya, S.P., Sitangshu, S., Karimadkar, A.J., Bera, P.S., Latika, M., Sarkar, S. and Mandal, L. 2003. Effects of humic acid (earth) on the growth and yield of transplanted summer rice. *Environment Ecology* **21**(3): 680–683.

Biswas, S.K. and Juliano, B.O. 1988. Laboratory paroboiling procedures and properties of parboiled rice from varieties differing starch properties. *Cereal Chemistry* **65**: 417–423.

Das, S.K. 2013. Integrated nutrient management using only through organic sources of nutrients. *Popular Kheti,* Volume 1, Issue 4 (October–December).

Hargilas. 2006. *Study on Organic Farming of Rice–Wheat Cropping System*. Ph.D. Thesis, Division of Agronomy, Indian Agricultural Research Institute, New Delhi.

Juliano, B.O. 1971. A simplified assay for milled-rice amylose. *Cereal Science Today* 16: 334–340.

Manna, M.C., Swarup, A., Wanjari, R.H., Mishra, B. and Shahi, D.K. 2007. Long-term fertilization, manure and liming effects on soil organic matter and crop yields. *Soil and Research* **94**: 397–409.

Miller, D.M. and Miller, W.P. 2000. Land application of wastes, (In:) *Handbook of Soil Science,* Sumner M. (Ed.) CRC Press, Boca Raton.

Murali, M.K. and Shetty, R.A. 2004. Effect of fertilizer, vermicompost and tricontanol on growth and yield of scented rice. *Oryza* **41**(1 and 2): 57–59.

Naveen, G.N., Naik, L.K. and Raghunandan, B.N. 2013. Effect of organics and microbial inoculants on the growth and yield of aerobic rice (*Oryza sativa* L.). *Bioinflet* **10**(4): 1,410–1,413.

Okuda, M., Aramaki, I., Koseki, T., Satoh, H. and Hashizume, K. 2005. Structural characteristics, properties, and *in vitro* digestibility of rice. *Cereal Chemistry* **82**(4): 361–368.

Peng, S., Bouman, B., Visperas, R.M., Castaneda, A., Nie, L. and Park, H.K. 2006. Comparision between aerobic and flooded rice in the tropics: Agronomic performance in an eight-season experiment. *Field Crops Research* **96**: 252–259.

Quyen, N.V. and Sharma, S.N. 2003. Relative effect of organic and conventional farming on growth, yield and grain quality of scented rice and soil fertility. *Archives of Agronomy and Soil Science* **49**(6): 623–629.

Rodell, M., Velicogna, I. and Famiglietti, J.S. 2009. Satellite-based estimates of ground water depletion in India. *Nature* **460**: 999–1,002.

Shanmugam, P.M. and Veeraputhran, R. 2001. Effect of organic and inorganic N and zinc application on soil fertility and nutrient uptake of *rabi* rice (*Oryza sativa*). *Madras Agricultural Journal* **88**(7/9): 514–517.

Sharma, N., Singh, N., Singh, M. and Bharaj, T.S. 2008. Quality characteristics of aromatic fine grained rice (*Oryza sativa*) genotypes for utilization in *Basmati* improvement. *Indian Journal of Agricultural Sciences* **78**(1): 42–49.

Singh, N., Kaur, R., Sharma, N., Mahajan, G. and Bharaj, T.S. 2012. Changes in yield and grain quality characteristics of irrigated rice (*Oryza sativa*) genotypes under aerobic conditions. *Indian Journal of Agricultural Sciences* **82**(7): 589–595.

Tittarelli, F., Petruzzelli, G., Pezzarossa, B., Civilini, M., Benedetti, A. and Sequi, P. 2007. Quality and agronomic use of compost (In:) *Compost Science and Technology, Waste Management Series* 8, pp. 119–145. Diaz, L.F., de Bertoldi, M., Bidlingmaier, W. and Stentiford E. (Eds). Elsevier Ltd., pp. 119–145, ISBN-13: 978-0-08-043960-0.

Tripathi, N. and Verma, R.S. 2008. Assessment of grain quality attributes of *Basmati* rice produced by organic system. *Pantnagar Journal of Research* **6**(2): 22–23.

USDA. 2007. *Estimating Soil Moisture by Feel and Appearance by Feel and Appearance*. United States Department of Agriculture, Natural Resources Conservation Service Program Aid Number 1619.