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Basmati rice performance as influenced by application timing of organic N sources

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ABSTRACT

Field experiments were conducted during 2019 and 2020 at the Crop Research Centre, Sardar Vallabhbhai Patel University of Agriculture and technology, Meerut, Uttar Pradesh. The experiment consisted of 14 different treatments replicated thrice in a randomized block design. Soil of the experimental field was sandy clay loam in texture, neutral in reaction with low in available nitrogen, medium in available phosphorus and potassium. Result on pool basis reveal that highest growth and yield attributes parameters, viz. plant height (97.04 cm), effective tiller (225.22/m^2), panicle length (30.67 cm), grain weight (1.77 g/panicle), filled grains/panicle (82.18), test weight (28.50 g) along with biological yield 108.24 q/ha and grain yield 40.78 q/ha were recorded with the application of 25% recommended N through dhaincha incorporated on planting date + rest N through chemical fertilizer followed by application of 25% recommended N through vermicompost incorporated 10 day before transplanting + rest N through chemical fertilizer.

Keywords: Basmati Rice, Dhaincha, INM, Vermicompost

'Rice is Life' is most appropriate statement for India since this crop plays a vital role in country's food security and is the backbone of livelihood for millions of rural households. Basmati is lengthy, fragrant rice grown for centuries in the unique geographical region of the Himalayan foot hills of Indian sub-continent. India contributes more than 70% of the overall global production (Udhayakumar *et al* 2021). There is about 1.5 mha land under basmati rice which provides steady income for farmers and there is no obvious alternative crop with similar economic returns. Farmers of western Uttar Pradesh, a basmati export zone are focussing on cultivation of basmati rice due to more remunerative, however its export will depend on its quality. It is therefore important to reduce the use of chemical fertilizer in basmati cultivation by substituting through organic sources.

Dhaincha being a leguminous crop utilizes atmospheric nitrogen through symbiotic nitrogen fixation to meet a major part of its nitrogen requirement. Nitrogen contained by dhaincha can benefit the succeeding crop with its incorporation in soil. Vermicompost, humus like material produced by vermicomposting is rich with various essential plant nutrients. Vermicompost helps to improve and protect fertility of top soil and also helps to boost up productivity by 40% with 20–60% lower inputs, it also enhances the quality of end products and thereby creating significant impact on flexibility in marketing. Readable availability of nutrient from vermicompost signifies its effect in soil. Organic materials may be a boon to the poor marginal farmers who cannot afford to purchase fertilizer in the required quantities due to escalating prices. Organic materials such as green manure with its succulence and comparatively a narrow C:N ratio decomposes rapidly after incorporation into the soils resulting in release of nitrogen for use by the succeeding crops. There is no doubt about the role of organic sources on the crop productivity and soil sustainability but the question arises regarding timing of their application. Therefore, present investigation was undertaken to study basmati rice performance as influenced by application timing of organic N sources.

MATERIALS AND METHODS

The present study was carried out during *kharif* 2019 and 2020 at Reaserch farm of Sardar Vallabhbhai Patel University of Agriculture and technology, Modipuram, Meerut, Uttar Pradesh. Soil of the experimental field was sandy clay loam in texture and neutral in reaction with low in organic carbon, available nitrogen, medium in available phosphorus, potassium and zinc. The experiment was laid out with fourteen (14) treatments of INM, viz. Control (T_1); Recommended dose of N P K through chemical fertilizer (T_2); 25% recommended N through dhaincha incorporated 10 days before transplanting (DBT) + rest N through

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chemical fertilizer (T_3); 25% recommended N through dhaincha incorporated 5 DBT + rest N through chemical fertilizer (T_4); 25% recommended N through dhaincha incorporated on planting date + rest N through chemical fertilizer (T_5); 25% recommended N through vermicompost incorporated 10 DBT + rest N through chemical fertilizer (T_6); 25% recommended N through vermicompost incorporated 5 DBT + rest N through chemical fertilizer (T_7); 25% recommended N through vermicompost incorporated on planting date + rest N through chemical fertilizer (T_8); 37.5% recommended N through dhaincha incorporated 10 DBT + rest N through chemical fertilizer (T_9); 37.5% recommended N through dhaincha incorporated 5 DBT + rest N through chemical fertilizer (T_{10}); 37.5% recommended N through dhaincha incorporated on planting date + rest N through chemical fertilizer (T_{11}); 37.5% recommended N through vermicompost incorporated 10 DBT + rest N through chemical fertilizer (T_{12}); 37.5% recommended N through vermicompost incorporated 5 DBT + rest N through chemical fertilizer (T_{13}); 37.5% recommended N through vermicompost incorporated on planting date + rest N through chemical fertilizer (T_{14}) in randomized block design with three replications. Rice seedlings (Pusa Basmati-1509) with plant geometry (20 cm × 10 cm) were transplanted on 15 July 2019 and 16 July 2020. Recommended dose of phosphorus and potassium were applied through DAP, SSP and MOP, and nitrogen was applied through urea and organic sources such as dhaincha (*Sesbania aculeata*) and vermicompost. Full dose of phosphorus and potassium was applied at the time of transplanting while 25–37.5% N through organic sources as per treatment and 12.5–25.0% through chemical fertilizer was applied before or at time of transplanting. Remaining 50% nitrogen was applied in two equal split at maximum tillering and panicle initiation stage. For the growth parameters, plant height of 5 randomly selected tagged hills was measured from the soil surface to the tip of the fully opened leaf. Total tillers were counted from 1.0 m^2 area from each plot. Grains obtained from 10 randomly selected panicles were counted and expressed as grains/panicle. Length of 10 panicles was measured and average length was calculated. Net plot was harvested and sun dried for 4–5 days and biological yield was recorded. Threshing was done manually and weight of grain was subtracted from biological yield to get straw yield.

RESULTS AND DISCUSSION

Growth parameters: The two years pool data (Table 1) clearly reflect a significant effect of different treatments on height of basmati rice crop measured at different stages. Application of 25% recommended N through dhaincha at planting date along with rest N through chemical fertilizer (T_5) produced significantly taller plant than T_1, T_{12}, T_{13}, T_{14} at tillering (57.42 cm), panicle initiation (84.39 cm), flowering (94.28 cm) and harvest (97.04 cm). Short plant with the height 79.62 cm significantly lower than the rest of the treatments was found in control T1 where no plant nutrients were supplied. Substitution of 25% nitrogen through dhaincha produced slightly taller plant than the vermicompost although the difference was non-significant in most of the cases.

Table 1 Effect of INM treatments on growth of basmati rice at different growth stages (pool data 2019–2020)

Treatment	Plant height (cm)				Tiller Density (m^2)				LAI		
	Tillering	Panicle	Flowering	Harvesting	Tillering	Panicle	Flowering	Harvesting	Tillering	Panicle	Flowering
T_1	48.60	68.60	75.92	79.62	172.30	208.62	182.75	161.84	1.48	3.82	3.07
T_2	57.64	82.`56	93.47	95.17	194.2	291.19	278.50	220.34	2.25	4.73	4.02
T_3	56.10	81.24	91.24	93.27	184.55	288.52	269.18	216.01	1.97	4.59	3.81
T_4	55.60	82.01	92.11	95.12	187.36	290.10	275.30	220.75	2.08	4.66	3.82
T_5	57.42	84.39	94.28	97.04	189.50	298.41	281.87	225.22	2.35	4.96	4.15
T_6	56.99	83.52	93.43	96.29	188.54	291.61	280.38	219.91	2.26	4.87	4.06
T_7	54.94	82.79	91.58	92.84	185.55	288.47	275.28	214.47	2.08	4.69	3.87
T_8	53.67	79.99	89.21	91.88	182.64	287.48	272.28	212.40	2.03	4.40	3.87
T_9	51.70	79.77	87.06	90.86	179.39	273.94	264.52	203.00	2.00	4.39	3.88
T_{10}	52.80	79.36	87.75	91.83	180.78	276.66	269.33	208.83	2.11	4.62	3.96
T_{11}	54.67	83.10	89.77	94.78	183.78	283.92	273.08	214.99	2.28	4.79	4.05
T_{12}	53.13	78.19	85.96	91.43	184.34	279.59	269.25	202.93	2.26	4.72	3.94
T_{13}	51.57	76.08	84.91	89.66	180.97	277.12	261.25	194.00	2.09	4.43	3.86
T_{14}	51.31	73.67	85.13	89.18	178.81	272.49	254.92	187.50	2.02	4.35	3.67
SE(m)±	1.33	2.07	2.32	2.06	2.56	3.90	3.15	4.00	0.08	0.17	0.13
CD at 5%	3.86	6.03	6.73	5.51	7.43	11.34	9.17	11.63	1.48	3.82	0.36

*Treatment details are given in Material and Methods.

The number of tillers/m^2 of basmati rice as influenced by different treatments at different growth stages are shown in Table 1. Pool data reveal that at maximum tillering, tiller density in all the treatments consisting substitution of 37.5% N through dhaincha or vermicompost incorporated at any time decline significantly from T_2. Tiller density in comparison to T_2 was also significantly lower in T_3, T_7, T_8 where 25% N was substituted through vermicompost or dhaincha applied at any time. At panicle stage maximum tiller density 298.41/m^2 recorded in T_5 was significantly higher than T1 and other treatments consisting 37.5% N through organic sources applied at any time. Almost similar trend was also found at flowering stage.

The Leaf area index (LAI) an important parameter of plant growth was influenced by different treatments. From the table it is clear that leaf area index increased up to panicle initiation stage and thereafter declined at flowering. At maximum tillering 2.35 recorded in T_5 was significantly higher than T_1, T_3, T_4, T_8, T_9, T_{13} and T_{14} and statistically at par to rest of the treatments. At panicle initiation stage also, maximum LAI 4.96 recorded in T_5 was significantly higher than T_1, T_8, T_9, T_{13} and T_{14}. With exception of T_1 and T_{14} rest of the treatments differ non-significantly in respect of LAI at flowering stage.

Yield and yield attributes: On the two years pool basis application of 25% recommended N through dhaincha at planting date along with rest N through chemical fertilizer (T_5) produced significantly higher panicle length (30.67 cm) than the treatments with exception of T_2, T_5, T_6, T_{11} and T_{12} (Table 2). Panicle length (23.36 cm) significantly lower than the rest of the treatments was found in control T1 where no plant nutrients were applied. Substitution of 25% nitrogen through dhaincha produced comparatively larger panicle than the vermicompost, although the difference was non-significant cases.

The filled grains/panicle differs significantly under various treatments and ranged from 54.28–82.18. Application of 25% recommended N through dhaincha at planting date along with rest N through chemical fertilizer (T_5) produced significantly maximum number of filled grain/panicle (82.18) at harvest than the T_1, T_{14}, T_3, T_{13}. Lower filled grains/panicle (54.28) significantly lower than the rest of the treatments were found in control T_1 where no plant nutrients were applied externally. Substitution of 25% nitrogen through dhaincha produced comparatively a greater number of filled grains/panicle than the vermicompost although the difference was non-significant in most of the cases.

Data regarding the effect of different treatments on grain weight/panicle (g) of basmati rice are presented in Table 2. It is clear from the table that the grain weight g/panicle differs significantly under different treatments and ranged from 1.33–1.77 g/panicle. Application of 25% recommended N through dhaincha at planting date along with rest N through chemical fertilizer (T_5) recorded maximum grain weight/panicle (1.77 g) at harvest. Minimum grain weight/panicle (1.33 g) significantly lower than the rest of the treatments was found in control T_1 where no plant nutrients were applied externally. Substitution of 25% nitrogen through dhaicha produced comparatively higher grain weight/panicle than the vermicompost. On the pool basis, maximum test weight

Table 2 Yield and yield attributes of Basmati rice as influenced by INM

Treatment	Panicle length(cm)	Grain weight (g)/panicle	Filled grain/ panicle	Test weight(g)	Biological yield (q/ha)	Grain yield (q/ha)	Straw yield (q/ha)
T_1	23.36	1.33	54.28	26.73	58.46	19.68	38.56
T_2	28.58	1.73	79.47	28.27	102.83	38.39	64.44
T_3	25.35	1.68	75.17	27.54	97.74	34.95	62.79
T_4	26.77	1.75	77.93	27.60	101.58	38.82	62.76
T_5	30.67	1.77	82.18	28.50	108.24	40.78	67.47
T_6	29.04	1.73	79.95	28.30	106.21	39.35	66.36
T_7	27.63	1.67	76.34	28.05	101.69	38.81	62.88
T_8	26.37	1.62	74.53	27.80	97.74	37.29	60.46
T_9	27.32	1.69	70.22	27.56	95.73	34.25	61.48
T_{10}	27.22	1.74	72.81	27.51	94.93	36.13	58.81
T_{11}	28.11	1.75	77.18	28.17	100.84	36.65	64.20
T_{12}	28.23	1.74	76.94	27.84	91.75	31.65	59.95
T_{13}	27.40	1.72	70.88	27.74	90.01	30.96	59.05
T_{14}	25.32	1.67	67.97	27.60	87.11	30.18	56.93
SE(m)±	0.78	0.06	1.22	0.65	3.09	1.44	2.75
CD at 5%	2.26	0.17	3.56	NS	8.98	4.17	8.00

*Treatment details are given in Material and Methods.

was found in T_5 (28.50 g) but did not differ significantly under different treatments.

Effect of different treatments on biological yield of basmati presented in Table 2 on the two years pool basis application of 25% recommended N through dhaincha at planting date along with rest N through chemical fertilizer (T_5) produced significantly higher biological yield (108.24 q/ha) than T_1, T_3, T_8, T_9, T_{10}, T_{12}, T_{13} and T_{14} weight. Minimum biological yield of 58.24 q/ha significantly lower than the rest of the treatments was found in control plot where no plant nutrients were supplied.

Grain yield varied from 19.68–40.78 q/ha with the maximum production in T_5. Grain yield was higher by 6.2% with the substitution 25% N through dhaincha applied on date of planting and 2.5% with vermicompost incorporated at 10 DBT than T_2. Grain yield of rice did not decline significantly from T_2 with the substitution of 25% N through dhaincha or vermicompost incorporated at any time or 37.5% N substitution through dhaincha. Significant reduction in grain yield was noted with the substitution of 37.5% N through vermicompost at any time.

Data presented on the two years pool basis indicate that there was significant effect of different treatments on the straw yield of basmati rice crop. It is clear from the table that the straw yields differ significantly under different treatments. Straw yield varied from 38.56–67.47 q/ha with the maximum production in T_5 was slightly higher with the substitution 25% N through dhaincha incorporated at the time of planting or vermicompost 10 day before planting. Straw yield of rice did not decline significantly from T_2 with the substitution of 25 and 37.5% N dhaincha and vermicompost incorporated at any time of planting.

Results reveal the better performance of growth and yield attributes with the application of dhaincha on planting date or vermicompost 10 DBT. Growth which ultimately affects the crop yield depends on adequate nutrient supply since the planting of the crop. Among the plant nutrients, nitrogen plays a vital role in plant growth and development. Although most of the nitrogen in crop production is supplemented through chemical fertilizers but with foreseeing adverse effect on environment integrated approach of nitrogen management came into existence and being followed in different cropping system. The chemical fertilizers supply the nitrogen immediately while in organic sources it may be delayed due to slow mineralization. In Integrated Nutrient Management (INM) the aim is to ensure the timely availability of nitrogen as per crop requirement. Release of plant available nitrogen from various organic sources is different. The material susceptible for fast decomposition will release nitrogen immediately. Incorporation of dhaincha, 10 DBT will release the nitrogen at the time of planting when rice roots are not fully established to absorb the released nitrogen and it may get lost. Nitrogen release from vermicompost will depend on mineralization. To get the better response of applied vermicompost it must be applied before transplanting and in our study application 5 or 10 DBT was found better. It may be due to release of nitrogen from vermicompost at the time when plants require maximum nitrogen. The result find support from findings of Murugan and Swarnam (2013) who reported the peak release of nitrogen from vermicompost at 48 days after incorporation in acid soil. In our study, soil is alkaline and in comparison to acid, soil mineralization will be at faster rate due to more microbial activity. Therefore, release of nitrogen may be earlier than 48 days benefitting the rice crop between maximum tillering and panicle initiation stage if applied 5 or 10 DBT.

Increase in plant height with the application of organic sources was also reported by Shekara *et al*. (2010). Paramesh *et al.* (2014) also reported that 50% RDN through chemical fertilizers + 50% RDN through vermicompost recorded significantly higher leaf area over control. Manivannan and Sriram Chandrasekharan (2016) recorded significantly higher grain and straw yield when 50% of recommended nitrogen was substituted by vermicompost compared to control. Application of dhaincha and vermicompost 5 DBT was also found better. This may be due to the availability of nitrogen at right time. No better response of dhaincha applied 10 DBT get support from the findings of Sardar *et al.* (2015) who reported that application of dhaincha 20 DBT yielded lower than FYM and vermicompost. Similarly, the study conducted by Hoque *et al*. (2007) also reveal that application of Sisso as well as acacia leaves 8 DBT was not better than poultry manure and cow dung applied at planting time. Puli *et al.* (2017) reported more uptake of nitrogen with the application of dhaincha 7 DBT than the vermicompost applied at the time of planting. Chaudhary *et al*. (2018) also reported a significant reduction in yield of rice with the application of sesbania 7 or 10 DBT than one DBT.

Based on the two-year experimentation it can be concluded that 25% nitrogen requirement of rice crop can be substituted by incorporation of dhaincha 5 DBT or at the time of transplanting. Similarly, vermicompost incorporation can be made 10 or 5 DBT.

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