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Scheduling of nitrogen in integrated mode in basmati rice (*Oryza sativa* L.)

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Abstract

The field experiment entitled "Scheduling of nitrogen in integrated mode in basmati rice (Oryza sativa L.)" was conducted at Agronomy Research Farm, Sardar Vallabhbhai Patel University Of Agriculture and Technology Meerut (U.P.) during Kharif, 2012. The fifteen treatments comprised of Control, 100% N (1/2 basal+1/4 tillering+1/4 panicle initiation), 75% N + 6 t FYM(1/2 basal+1/2 tillering), 75% N + 6 t FYM (1/2 basal +1/2 panicle initiation), 75% N + 6 t FYM (1/3 basal +1/3 tillering +1/3 panicle initiation), 75% N + 6 t FYM (1/2 basal +1/4 tillering+ 1/4 panicle initiation), 75% N + 6 t FYM (1/4 basal +1/2 tillering +1/4 panicle initiation), 75% N + 6 t FYM (1/4 basal +1/4 tillering +1/2 panicle initiation), 75% N + 2 t vermicompost (1/2 basal +1/2 tillering), 75% N + 2 t vermicompost (1/2 basal +1/2 panicle initiation), 75% N + 2 t vermicompost (1/3 basal +1/3 tillering +1/3 panicle initiation), 75% N + 2 t vermicompost (1/2 basal +1/4 tillering +1/4 panicle initiation), 75% N + 2 t vermicompost (1/4 basal +1/2 tillering +1/4 panicle initiation), 75% N + 2 t vermicompost (1/4 basal +1/4 tillering+ 1/2 panicle initiation), 75% N +3 t FYM+1.0 t vermicompost (1/2 basal +1/4 tillering+ 1/4 panicle initiation) were executed in factorial randomized block design with three replications. The soil of the experimental field was silt loam in texture with low in organic carbon (0.49%) and phosphorus (15.02 kg ha^{-1}), medium in nitrogen (156.58 kg ha^{-1}) and high in potassium (138.76 kg ha^{-1}).

Key words: Scheduling, Nitrogen, Basmati rice.

Introduction

The world entered in the 21st century facing many challenges, often in an agricultural context. Prominent still is the concern for feeding an ever growing population with safe and healthy food. However, a sustainable living environment is a major issue as well. This is strongly related to management of natural resources such as land, water, nutrients and energy etc. This is posing a serious problem to even maintain the food grain production and leaving only the option of increasing the productivity of grain crops particularly rice (*Oryza sativa* L.).

Rice is one of the most important food crops in the world, forms the staple diet of 2.7 billion people. In India, it is cultivated on an area of 44.1 m ha which is maximum among all rice growing countries having annual production of about 131.3 m tonnes with productivity of 3.0 tonnes ha^{-1} (Paula Bianca Farer, 2011). It accounts for about 42% of total food grain production and 55% of cereal production in the country. Uttar Pradesh is the largest rice growing state after West Bengal but its productivity is low. In U.P. rice is grown on an area of about 5.69 million ha with a production of 11.7 million tonnes and productivity of about 2.06 tonnes ha^{-1}. Basmati Rice is nature's exclusive gift to the Indian sub-continent. No other rice in the world has this combined characteristic of exquisite aroma, sweet taste and the post cooking elongation. Basmati rice has been known to the world since the early days of the 19th Century. India's basmati rice production is expected to increase by 1 m tonnes in 2011-12 due to good weather conditions in Punjab, Haryana and Western Uttar Pradesh. The nation produced 6.5 million tons of basmati rice in 2010-11 which is expected to record 15.3 % growth to 7.5 m tonnes in 2011-12 harvest. Punjab accounts for 70-75% of India's basmati rice output.

Nitrogen is one of the major nutrients which determine the growth and development of rice crop, has many fold function to its credit, predominantly as an integral part of almost all the bio-molecules which play a crucial role in one or other metabolic function. It is integral part of chlorophyll and maintains the green luster of the plants; consequently get them photo synthetically active for longer period. It is also responsible for more leaf area and dry matter

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production due to higher rate of photosynthesis. Correct timing of nitrogen application is an important aspect of overall nitrogen management in rice for its efficient utilization. One of the major disadvantages of applying all the nitrogen at planting is that it induces excessive foliage and encourages development of weeds. Several workers (Jaya *et al.,* 2004; Manzoor *et al*., 2006 and Malik and Kaleem, 2007) reported that the levels and time of nitrogen application play an important role in increasing rice production. They reported higher paddy yield (4-5 t ha^{-1}), where nitrogen fertilizer was applied in two or three splits as compared to full nitrogen application at the time of transplanting.

Thus, the optimum dose of nitrogen and suitable time of application may play an important role in minimizing the present large gap between potential and achievable yields of basmati rice. Keeping all these fact in view, the present investigation entitled "Scheduling of nitrogen in integrated mode in basmati rice (*Oryza sativa* L.)" was planned to find out the effect of time of nitrogen application on growth and yield of Basmati rice.

Materials and Methods

The field experiment was conducted at Agronomy Research Farm, Sardar Vallabhbhai Patel University of Agriculture and Technology Meerut (U.P.) during Kharif, 2012. The fifteen treatments comprised of Control, 100% N 100 kg ha^{-1} (1/2 basal+1/4 tillering+1/4 panicle initiation), 75% N + 6 t FYM(1/2 basal+1/2 tillering), 75% N + 6 t FYM (1/2 basal +1/2 panicle initiation), 75% N + 6 t FYM (1/3 basal +1/3 tillering +1/3 panicle initiation), 75% N + 6 t FYM (1/2 basal +1/4 tillering+ 1/4 panicle initiation), 75% N + 6 t FYM (1/4 basal +1/2 tillering +1/4 panicle initiation), 75% N + 6 t FYM (1/4 basal +1/4 tillering +1/2 panicle initiation), 75% N + 2 t vermicompost (1/2 basal +1/2 tillering), 75% N + 2 t vermicompost (1/2 basal +1/2 panicle initiation), 75% N + 2 t vermicompost (1/3 basal +1/3 tillering +1/3 panicle initiation), 75% N + 2 t vermicompost (1/2 basal +1/4 tillering +1/4 panicle initiation), 75% N + 2 t vermicompost (1/4 basal +1/2 tillering +1/4 panicle initiation), 75% N + 2 t vermicompost (1/4 basal +1/4 tillering+ 1/2 panicle initiation), 75% N +3 t FYM+1.0 t vermicompost (1/2 basal +1/4 tillering+ 1/4 panicle initiation) were executed in factorial randomized block design with three replications. The soil of the experimental field was silt loam in texture with low in organic carbon (0.49%) and phosphorus (15.02kg ha^{-1}), medium in nitrogen (156.58kg ha^{-1}) and high in potassium (138.76 kg ha^{-1}). The basmati rice (PB-1) was transplanted on 23^{st} July. The FYM and Vermicompost applied as basal and nitrogen fertilizer applied in split doses as per treatment.

Results and discussion

In the present investigation, the scheduling of nitrogen in integrated mode envisaged pronounced variation in growth characters of basmati rice. Application of nitrogen fertilizer alone or in combination with FYM or vermicompost increased plant height (Table-1). Scheduling of nitrogen in integrated mode with 75% N + 2 t VC (1/3 B +1/3 T 1/3 PI) registered significantly tallest plant than other treatments except 75% N + 2 t VC (1/2 B +1/4 T+1/4 PI), 75% N + 2 t VC (1/4 B +1/2 T+ 1/4 PI) and 75% N + 3 t FYM +1.0 t VC (1/2 B +1/4 T+ 1/4 PI) which produced similar plant height. The effect of nitrogen in the improvement of plant height can be explained by the fact that nitrogen is the main growth promoter element and helps for more synthesis of food resulting into greater cell division and cell enlargement. More or less similar effects of nitrogen in accelerating the height of rice plant have also been reported by Geethadevi *et al.* (2000); Shivay and Singh (2003) and Meena *et al*. (2003).

Similarly, the highest values for growth characters viz. number of tillers m^{-2}, leaf area index and dry matter accumulation (Table-1) were associated with the application of 75% N + 2 t VC (1/3 B +1/3 T 1/3 PI). The increase in growth characters with the application of nitrogen and FYM+Vermicompost may be attributed to the fact that judicial use of organic and inorganic fertilizers improves the supply of plant nutrients and increasing nitrogen supply played a vital role in the formation of new tissues which are dependent on the protoplasmic structure, cell division and cell elongation. The results are in agreement with those of Pandey *et al*. (2001), Meena *et al*. (2003) and Surjit *et al.* (2004).

The yield attributes *viz.,* panicles m^{-2}, length and weight of $panicle^{-1}$, grains $panicle^{-1}$ and 1000-grain weight (Table-1) increased significantly with the application of nitrogen fertilizer along with FYM or vermicompost. The application of 75% N + 2 t vermicompost (1/3 basal +1/3 tillering 1/3 panicle initiation) resulted in higher values of yield attributes. This might be due to application of inorganic and organic fertilizers increased the growth attributes that provides more photosynthetic surface resulted in the synthesis of more food materials, consequently better development of yield attributes. The results of present investigation in respect of these yield attributes are in agreement with the findings of Shivay and Singh (2003)

Table 1: Growth and yield attributes of basmati rice as influenced by different treatments.

Treatments	Plant height (cm)	No. of tillers (m^{-2})	Dry matter accumulation (g m^{-2})	No. of Panicle/m^{-2}	Length of Panicle (cm)	No. of Grains/Panicle	Test Weight (g)
Control	90.27	278.98	20.07	236.00	15.29	165.91	19.75
100% N (1/2 B+1/4 T+1/4 PI)	104.82	332.82	25.51	305.00	21.03	193.54	20.23
75% N + 6 t FYM (1/2 B+1/2 T)	95.76	286.65	23.37	262.00	17.57	175.81	20.54
75% N + 6 t FYM(1/2 B +1/2 PI)	96.67	295.81	23.54	269.00	18.06	181.59	20.61
75% N + 6 t FYM (1/3 B +1/3 T+ 1/3 PI)	104.51	331.70	25.19	299.00	20.82	192.66	21.23
75% N + 6 t FYM (1/2 B +1/4 T+ 1/4 PI)	103.12	327.15	24.84	292.00	20.38	191.05	21.01
75% N + 6 t FYM (1/4 B +1/2 T+ 1/4 PI)	102.34	321.85	24.02	282.00	19.26	190.24	20.88
75% N + 6 t FYM (1/4 B +1/4 T+ 1/2 PI)	101.01	315.25	23.97	279.00	19.02	188.54	20.75
75% N + 2 t VC (1/2 B +1/2 T)	97.91	302.76	23.65	273.00	18.39	184.05	20.90
75% N + 2 t VC (1/2 B +1/2 PI)	99.54	309.37	23.84	275.00	18.87	186.12	20.46
75% N + 2 t VC (1/3 B +1/3 T 1/3 PI)	109.75	345.88	27.06	335.00	22.170	196.97	21.54
75% N + 2 t VC (1/2 B +1/4 T+1/4 PI)	109.01	341.56	26.84	332.00	22.02	195.32	21.51
75% N + 2 t VC (1/4 B +1/2 T+ 1/4 PI)	107.37	335.24	25.73	316.00	21.34	194.03	21.35
75% N + 2 t VC (1/4 B +1/4 T+ 1/2 PI)	102.73	325.91	24.34	287.00	19.97	191.54	20.98
75% N + 3 t FYM +1.0 t VC (1/2 B +1/4 T+ 1/4 PI)	108.89	338.79	26.34	321.00	21.87	194.76	21.47
SEm±	1.50	1.45	0.62	1.40	1.23	1.46	0.03
C.D. at 5%	4.38	4.24	1.93	4.134	3.606	4.236	0.11

B-Basal, T-Tillering, PI-Panicle Initiation.

Table 2: Yield and nutrient uptake by basmati rice as influenced by different treatments

Treatments	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Harvest index (%)	Nutrients uptake (kg ha^{-1})		
				N	P	K
Control	12.28	28.25	30.29	46.12	8.96	55.68
100% N (1/2 B+1/4 T+1/4 PI)	30.29	44.19	40.66	79.39	14.01	74.49
75% N+6 t FYM (1/2 B+1/2 T)	18.18	32.32	36.00	59.27	9.78	60.24
75% N+6 t FYM(1/2 B+1/2 PI)	21.05	34.05	38.20	60.97	9.89	61.57
75% N+6 t FYM (1/3 B+1/3 T+1/3 PI)	29.37	43.58	40.26	76.46	13.46	72.68
75% N+6 t FYM (1/2 B+1/4 T+1/4 PI)	29.11	44.17	39.72	73.25	13.09	70.16
75% N+6 t FYM (1/4 B+1/2 T+1/4 PI)	25.29	42.05	37.55	70.89	12.26	68.48
75% N+6 t FYM (1/4 B+1/4 T+1/2 PI)	25.02	40.25	38.33	67.57	11.34	66.26
75% N+2 t VC (1/2 B+1/2 T)	22.83	37.32	37.95	63.74	10.23	62.43
75% N+2 t VC (1/2 B+1/2 PI)	22.32	38.18	36.89	61.01	10.68	64.46
75% N+2 t VC (1/3 B+1/3 T 1/3 PI)	37.32	50.76	42.37	86.65	15.86	80.59
75% N+2 t VC (1/2 B+1/4 T+1/4 PI)	35.25	50.32	41.19	85.16	15.56	79.01
75% N+2 t VC (1/4 B+1/2 T+1/4 PI)	32.14	48.31	39.95	81.56	14.98	75.64
75% N+2 t VC (1/4 B+1/4 T+1/2 PI)	29.06	50.05	36.73	76.18	12.86	73.16
75% N+3t FYM+1.0 t VC (1/2 B+1/4T+1/4PI)	33.05	44.21	42.77	83.56	15.21	77.37
SEm±	0.65	1.57	0.25	1.67	0.82	2.84
C.D. at 5%	1.89	4.57	0.78	4.866	2.392	8.272

B-Basal, T-Tillering, PI-Panicle Initiation.

Table 3: Economics of basmati rice as influenced by different treatments.

Treatments	Cost of cultivation (Rs. ha^{-1})	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	Benefit: Cost ratio
Control	20232	40595	20363	1.00
100% N (1/2 B+1/4 T+1/4 PI)	25518	91192	65674	2.57
75% N + 6 t FYM (1/2 B+1/2 T)	24882	56768	31886	1.28
75% N + 6 t FYM(1/2 B +1/2 PI)	24882	64542	39660	1.59
75% N+6 t FYM (1/3 B +1/3 T+1/3 PI)	25122	88679	63557	2.52
75% N+6 t FYM (1/2 B +1/4 T+1/4 PI)	25122	88240	63118	2.51
75% N+6 t FYM (1/4 B +1/2 T+1/4 PI)	25122	77950	52828	2.10
75% N+6 t FYM (1/4 B +1/4 T+ 1/2PI)	25122	76637	51515	2.05
75% N + 2 t VC (1/2 B +1/2 T)	25882	70135	44253	1.70
75% N + 2 t VC (1/2 B +1/2 PI)	25882	69156	43274	1.67
75% N + 2 t VC (1/3 B +1/3 T 1/3 PI)	26122	111067	84945	3.25
75% N + 2 t VC (1/2 B +1/4 T+1/4 PI)	26122	105738	79616	3.04
75% N + 2 t VC (1/4 B +1/2 T+ 1/4 PI)	26122	97267	71145	2.72
75% N + 2 t VC (1/4 B +1/4 T+ 1/2 PI)	26122	90167	64045	2.45
75% N + 3 t FYM +1.0 t VC (1/2 B +1/4 T+ 1/4 PI)	25622	98098	72476	2.82

B-Basal, T-Tillering, PI-Panicle Initiation and Kumar *et al*. (2005) who reported the response of rice crop to nitrogen in augmenting the yield attributes.

The ultimate aim of agronomical investigation is to enhance the productivity of crop by manipulating the growth characters as well as yield attributes in favour of crop yield (grain). The basmati rice PB1 produced the maximum grain (37.32q ha^{-1}) and straw (50.76q ha^{-1}) yields (Table-2) with the application of 75% N + 2 t vermicompost (1/3 basal +1/3 tillering 1/3 panicle initiation). Grain yield is the function of yield attributes viz. number of tillers, number of grains/ panicle and 1000-grain weight and the higher values of yield attributes with this treatment resulted in to higher yields. Nitrogen is an integral constituent of photo synthetically active pigments, the chlorophyll by virtue of which plants are able to utilize light, energy and enzyme nucleotides, which play an important role in cell development. Vigorous growth of crop plants with increase in fertility is associated with higher sink capacity. Nitrogen fertilization have resulted an increase in P and K uptake which increases photosynthetic activity and translocation of photosynthates from source to sink which might have promoted the growth and developments of yield attributes having the positive correlation with grain yield. These findings are in conformity with the findings of Kumar *et al*. (2005) and Singh *et al*. (2005).

The nitrogen, phosphorus and potassium uptake (Table 2) by plant (grain +straw) were increased significantly with increasing levels of nitrogen up to 75% N + 2 t vermicompost (1/3 basal +1/3 tillering 1/3 panicle initiation). This was mainly due to significant increase of NPK content in grain and straw as well as their respective yields with the application of inorganic and organic fertilizers. These results are in close conformity to the findings of Singh *et al*. (2005).

Among the various treatment combinations, the maximum gross monetary return (Rs. 40595 ha^{-1}), net income (Rs. 84945 ha^{-1}) and benefit cost ratio (Rs 3.25 per rupee invested) Table-3 were recorded with the application of 75% N + 2 t vermicompost (1/3 basal +1/3 tillering 1/3 panicle initiation). This might be due to the higher yields under this treatment resulted in higher net return and benefit cost ratio.

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