

## Original Research Article

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## Performance of Different Basmati Rice on Phenology, Growth and Quality under Different Nitrogen Scheduling as Dry DSR Sown Condition in IGP

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### ABSTRACT

#### Keywords

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To standardize the nitrogen scheduling in DSR, a field was conducted with different *Basmati* rice varieties with different nitrogen rates and splits at CCS Haryana Agricultural University, Regional Research Station at Karnal, India during rainy *kharif* seasons of 2014 and 2015. Nitrogen had significant positive effect on *basmati* rice crop resulting in improvement in plant height, number of tillers and effective tillers, grains/panicle, panicle length, 1000-grain weight, grain yield and straw yield with increase in dose from 90 to 100 and 110 kg ha<sup>-1</sup> in succession. Also, the grain yield was further improved with increase in number of splits from three to four. Nitrogen at 110 kg ha<sup>-1</sup> with four splits at 0, 20, 40, and 60 days after sowing was realized to be the optimum schedule for attaining maximum grain yield (49.3 & 50.2 q ha<sup>-1</sup>) and yield attributes. Among *basmati* varieties, highest grain yield (47.5 & 48.9 q ha<sup>-1</sup>) was recorded in HB-2 followed by PB-1121 (47.1 & 47.0 q ha<sup>-1</sup>), PB-1 (43.9 & 44.6 q ha<sup>-1</sup>) and PB-1509 (42.9 & 43.8 q ha<sup>-1</sup>) under direct seeding conditions.

### Introduction

Rice (*Oryza sativa* L.) is one of the most important cereal crops of the world, grown in wide range of climatic zones. Rice is the staple food for nearly half of the world's population. The crop occupies one-third of the world's total area planted to cereals and provides 35 to 60% of the calories consumed by 2.7 billion people. Direct seeded rice (DSR) is becoming popular as alternative to conventional transplanting under continuous flooding in Asia (Farooq *et al.*, 2011). Nitrogen use efficiency (NUE) of rice is usually low due to volatilization, runoff, denitrification and leaching losses. Moreover,

direct seeded rice soils are often exposed to dry and wet conditions and difference in N dynamics and losses pathways often results in different fertilizer recoveries in aerobic soils (De Datta and Buresh, 1989). Rice cultivars usually exhibit vigorous vegetative growth under direct seeded condition and perform poorly during reproductive stages due to N deficiency. However, high plant density and absence of transplanting shock in direct seeded rice produces high leaf area and tillers under favorable growing conditions. Nitrogen application has great impact on crop yield in rice when acquired during early and mid

tillering stages to produce high number of panicles, spikelets per panicle (Murty *et al.*, 1992). Thus, for maximum yield and increased NUE, optimum nitrogen schemes require to be developed for this rice system (Mahajan *et al.*, 2011). High fertilizer N efficiency in rice can be achieved through N efficient varieties; improved timing, application methods and better incorporation of basal fertilizer without standing water (De Datta, 1986; Ali *et al.*, 2007). Split application is one of strategies for efficient use of N fertilizers throughout the growing season by synchronizing with plant demand, reducing denitrification losses and improved N uptake for maximum straw and grain yield, and harvest index in DSR (Fageria, 2010, Lampayan *et al.*, 2010). However, further studies to evaluate crop dry matter and N translocation response to nutrient supply to find optimum N management strategies for improved productivity and NUE in DSR were suggested (Mahajan and Timsina, 2011). This suggest optimizing split doses to different crop growth stages for high yield in DSR and find appropriate management of nitrogenous fertilizers to improve NUE.

## Materials and Methods

A field experiment was conducted at CCS Haryana Agricultural University, Regional Research Station, Karnal during *khariif* 2014 and 2015. The soil of the experimental field was clay loam in texture, slightly alkaline in reaction, low in available nitrogen, and medium in phosphorus and potassium. The treatments included four varieties of basmati rice, viz. PB-1121, PB-1509, PB-1 and HB-2 and six N levels, viz. N @ 90, 100, 110 kg/ha applied as 3-splits (at 0, 15, 50 days after sowing (DAS) or 4-splits (0, 20, 40, 60 DAS). The experiment was laid out in split-plot design with cultivars in main plots and nitrogen levels in sub-plots with three replications. Full dose of phosphorus (30 kg

ha<sup>-1</sup>) and zinc sulphate (25 kg ha<sup>-1</sup>) were applied at the time of sowing. 11.5 k N available from di-ammonium phosphate (used as source of P) was taken as basal dose and the remaining N was applied in equal splits. Recommendations of the state University were adopted for raising the crop. Twenty kg seed per hectare was used for sowing. The seeds were soaked in water along with carbendazim (1g/L water solution per kg seed) for 24 hours and then water was completely drained. The soaked seeds were sown in the evening by using seed drill on 10 June, 2014 and 24 June 2015, keeping row spacing of 20 cm and depth of 2-3 cm. Pre-emergence herbicide pendimethalin 1.0 kg/ha was applied just after sowing (JAS) in a spray volume of 500 L water and bispyribac sodium 25 g ha<sup>-1</sup> at 20 DAS as spray in a spray volume of 300 L water. Manual weeding was also done at 40 DAS to avoid any infestation of weeds in the crop. Data on yield attributes and yield were recorded at harvest of the crop. Harvesting was done on 1 November 2014 and 14 November 2015.

## Results and Discussion

### Days to 50% flowering

Days to 50% flowering (Table 1) showed that tall cultivars (HB-2, PB-1121 and PB-1) took longer time to reach 50% flowering as compared to semi dwarf cultivar (PB-1509). During both the years, basmati cultivar HB-2 took maximum (97 and 100 days) days to 50 % flowering which were statistically at par with PB-1121 (97 and 99 days) but significantly more than PB-1 (89 and 92 days) and PB-1509 (85 and 86 days). Days to 50% flowering increased with increasing N levels and number of splits. Maximum days to 50% flowering were recorded at 110 kg N ha<sup>-1</sup> with four splits (0, 20, 40 and 60 DAS) which was significantly higher than rest of the treatments and minimum number of days to 50%

flowering were recorded at 90 kg N ha<sup>-1</sup> with three splits (0, 15 and 50 DAS) during years of succession. Number of days to 50% flowering in basmati cultivars increased with increase in N doses from 90 (87-91 days) to 100 (90-95 days) and 110 kg ha<sup>-1</sup> (94-100 days) in succession. Similarly, there was delay in 50% flowering with increase in number of splits from three (87-97 days) to four (88-100 days) at same level of nitrogen. Increasing levels of N helped the plants to remain photosynthetically active for longer time and thus prolonged vegetative period. Similar results have been reported earlier as well (Chopra *et al.*, 2006; Anonymous, 2004).

### Days to maturity

The data indicated in (Table 1) showed that tall basmati cultivars HB-2, PB-1121 and PB-1 matured late, whereas the semi dwarf cultivar PB-1509 matured earlier in both the years of study. Increasing levels of N and number of splits of application delayed maturity of all the basmati cultivars. Maximum days to maturity (131 and 135 days) were recorded at 110 kg N ha<sup>-1</sup> with four splits and found significantly higher than 90 kg N ha<sup>-1</sup> with 3 split application (121 and 124 days). There was increase days to maturity with increase in N doses from 90 (121-126 days) to 100 (124-130 days) and 110 kg N ha<sup>-1</sup> (128-135 days) in succession. Similarly, days to maturity increased with increase in number of splits from three (121-125 days) to four (123-135 days) at the same level of nitrogen. Higher level of nitrogen increased number of splits increased the cell division and cell enlargement, which slowed the development of phenophases and finally the process of senescence, hence delayed in maturity (Ashrafuzzaman *et al.*, 2009).

### Plant height

Plant height of basmati rice was influenced by cultivars and nitrogen levels with number of

splits are presented in table 2. The plant height of basmati cultivars increased successively with the advancement in the age of crop, highest recorded at maturity. Among varieties, HB-2 attained maximum plant height at 60 (69.1 and 69.7 cm), 80 (89.8 and 88.6 cm) DAS and at maturity (105.2 and 105.9 cm), which was statistically at par with PB-1121 but significantly higher than PB-1 and PB-1509 during both the years. At 40 DAS basmati cultivar HB 2 recorded more height than PB 1121, PB 1 and HB 2. Varietal differences in growth parameters of various basmati rice cultivars were also recorded by Mannan *et al.*, (2010).

Increase in N levels from 90 to 110 kg ha<sup>-1</sup> increased plant height at all crop growth stages (Table 2). Increasing the number of splits also increased the plant height at all crop growth stages except at 40 DAS where application of N in three splits resulted in higher plant height as compared to four splits at same levels of nitrogen. Maximum plant height was recorded at maturity (104.3 and 102.1 cm) at 110 kg N ha<sup>-1</sup> with four splits, which was significantly higher than the rest of treatments in both the years.

Evidently, minimum plant height at maturity (88.9 and 92.5 cm) was recorded at 90 kg N ha<sup>-1</sup> with three splits. There was increase in plant height with increase in N doses from 90 (88.9-93.9 cm) to 100 (95.7-98.6 cm) and 110 kg ha<sup>-1</sup> (98.6-104.3 cm) in succession at maturity. Similarly, plant height increased with increase in number of splits from three (88.9-99.1 cm) to four (93.1-104.3 cm) at same level of nitrogen. Increase in plant height with increase in number of splits has been reported by Ehsanullah *et al.*, (2012) and Awan *et al.*, (2011). There was close impact elaborated by regression lines drawn between grain yield and plant height as (Fig. 2) with following equations, Grain yield = 0.439 plant height + 2.98 (r<sup>2</sup>=0.86).

### Number of tillers m.r.l.<sup>-1</sup>

The cultivars differed with respect to number of tillers m.r.l.<sup>-1</sup> at all the growth stages. The data presented in table 3 showed that there was no significant difference in number of tillers m.r.l.<sup>-1</sup> among cultivars at 40 DAS number of tillers but increased with the advancement in crop age up to 80 DAS. The HB-2 produced maximum number of tillers m.r.l.<sup>-1</sup> which was statistically alike with PB-1121 cultivar and significantly better than PB-1 and PB-1509 at 60 and 80 DAS. Maximum number of tillers m.r.l.<sup>-1</sup> (87.5 and 88.2) was recorded in HB-2 while minimum was recorded with cultivar PB-1509 (80.5 and 81.3) at 80 DAS. Varietal differences in growth parameters of various basmati rice cultivars were also recorded by Paliwal *et al.*, (1996).

Nitrogen application rates and number of splits significantly influenced the number of tillers m.r.l.<sup>-1</sup> at different crop growth stages.

Data in the table 3 indicated that the maximum number of tillers m.r.l.<sup>-1</sup> was recorded under 110 kg N ha<sup>-1</sup> with four splits (0, 20, 40 and 60 DAS) which was statistically alike at 110 kg N ha<sup>-1</sup> with three splits (0, 15 and 50 DAS) but significantly higher than rest of treatments. Data in the table 3 also indicated at 40 DAS that number of tillers were higher in three split than the four splits might be due to higher amount of N is applied at same level of dose. There was increase in tillers m.r.l.<sup>-1</sup> with increase in N doses from 90 (77.2-81.3) to 100 (83.3- 87.0) and 110 kg ha<sup>-1</sup> (88.7-92.0) in succession at 80 DAS. Similarly, tillers m.r.l.<sup>-1</sup> increased with number of splits from three (77.2-89.1) to four (80.0-95.5) at same level of nitrogen in years of succession. Similar trends have been reported by Kaushal *et al.*, (2010). These facts were further elaborated by regression lines drawn between grain yield and effective tillers with following equation, Grain yield = 0.527 number of effective tillers + 6.582 (r<sup>2</sup>=0.85).

**Table.1** Effect of nitrogen levels and time of application on phenophases of different cultivar of basmati rice

Treatment Cultivars	Days to 50 % flowering		Days to maturity	
	2014	2015	2014	2015
PB-1121	97	99	128	133
PB-1509	85	86	113	116
PB-1	89	92	128	132
HB-2	97	100	132	135
SEm ±	0.7	0.6	1.2	1.2
CD at 5%	2	2	4	4
<b>Nitrogen levels (kg ha<sup>-1</sup>) and number of splits</b>				
90-3 splits	87	89	121	124
90-4 splits	89	91	123	126
100-3 splits	90	93	124	128
100-4 splits	93	95	127	130
110-3 splits	94	97	128	132
110-4 splits	97	100	131	135
SEm ±	0.4	0.4	0.4	0.4
CD at 5%	1	1	1	1

**Table.2** Effect of nitrogen levels and time of application on plant height of different cultivars of basmati rice at different growth stages

Treatment Cultivars	Plant height (cm)							
	40 DAS		60DAS		80 DAS		At maturity	
	2014	2015	2014	2015	2014	2015	2014	2015
PB-1121	39.6	40.1	68.8	69.7	86.9	87.7	104.1	102.9
PB-1509	35.3	36.4	62.0	62.2	79.5	79.3	89.2	90.8
PB-1	39.3	41.3	63.1	63.7	80.7	80.6	93.3	93.1
HB-2	37.9	40.4	69.1	69.7	89.8	88.6	105.2	105.9
SEm ±	0.4	0.8	1.3	1.4	1.7	1.6	2.5	0.9
CD at 5%	1.4	2.7	4.5	2.7	5.8	5.8	8.8	3.2
<b>Nitrogen levels (kg ha<sup>-1</sup>) and number of splits</b>								
90-3 splits	37.9	37.8	61.5	62.7	80.3	80.3	88.9	92.5
90-4 splits	36.8	37.2	62.9	64.0	82.0	81.1	93.1	93.9
100-3 splits	39.6	39.9	64.7	65.9	83.5	83.6	95.7	96.5
100-4 splits	38.8	39.2	66.6	67.4	85.6	85.2	98.6	98.1
110-3 splits	41.7	42.4	68.9	69.1	86.0	85.7	98.6	99.1
110-4 splits	40.7	40.8	70.3	71.5	88.1	88.4	104.3	102.1
SEm ±	0.2	0.2	0.7	0.8	0.8	0.9	1.0	0.9
CD at 5%	0.5	0.5	2.0	2.2	2.3	2.7	2.2	2.6

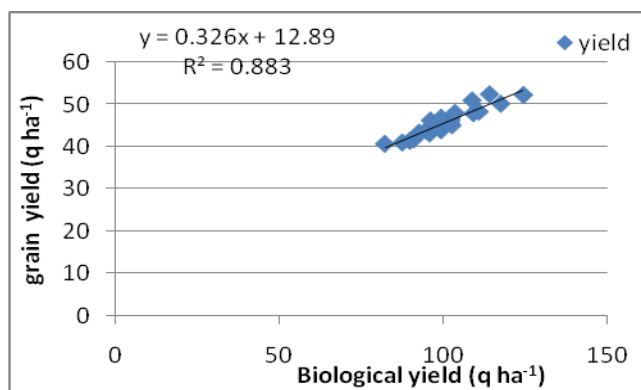
**Table.3** Effect of nitrogen levels and time of application on number of tillers of different cultivars of basmati rice at different growth stages

Treatment Cultivars	Number of tillers m.r.l. <sup>-1</sup>					
	40 DAS		60DAS		80 DAS	
	2014	2015	2014	2015	2014	2015
PB-1121	40.7	41.4	69.0	71.1	86.0	87.3
PB-1509	39.5	40.7	65.6	65.6	80.5	81.3
PB-1	40.6	41	66.3	66.7	83.4	83.8
HB-2	40.7	42.4	71.4	72.1	87.5	88.2
SEm ±	2.9	4.6	0.8	0.4	0.9	1.4
CD at 5%	NS	NS	2.8	1.3	3.0	1.7
<b>Nitrogen levels (kg ha<sup>-1</sup>) and number of splits</b>						
90-3 splits	37.0	38.7	62.8	64.7	77.2	78.5
90-4 splits	35.7	36.3	64.0	66.2	80.0	81.3
100-3 splits	41.0	42.1	67.5	68.0	82.4	83.3
100-4 splits	40.3	40.2	69.9	70.1	88.5	87.0
110-3 splits	44.7	46.8	71.3	70.8	89.1	88.7
110-4 splits	43.5	44.2	72	73.7	92.0	91.5
SEm ±	2.0	1.5	1.1	1.0	1.2	0.9
CD at 5%	5.8	4.3	3.0	3.1	3.4	2.6

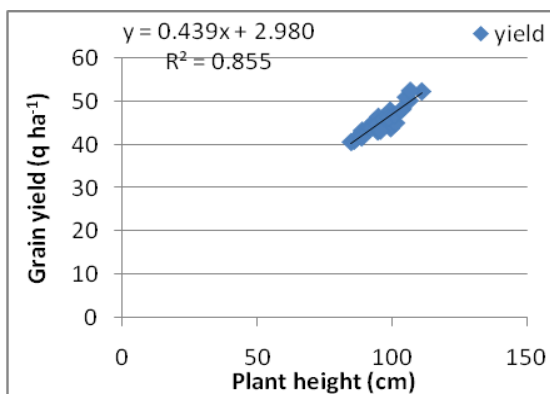
**Table.4** Effect of nitrogen levels and time of application on grain yield and biological yield of different cultivars of basmati rice

Treatment Cultivars	Grain yield (q ha <sup>-1</sup> )		Pooled Grain yield (q ha <sup>-1</sup> )	Biological yield (q ha <sup>-1</sup> )	
	2014	2015		2014	2015
PB-1121	47.1	47.1	47.1	109.7	106.8
PB-1509	42.9	43.4	43.4	94.6	96.7
PB-1	43.9	44.2	44.2	98.2	99.9
HB-2	47.5	48.2	48.2	106.9	111.5
SEm ±	0.9	1.0	1.0	1.8	2.4
CD at 5%	3.1	3.3	3.3	6.3	8.2
<b>Nitrogen levels (kg ha<sup>-1</sup>) and number of splits</b>					
90-3 splits	41.9	42.6	42.2	91.2	91.5
90-4 splits	42.9	43.9	43.5	95.0	95.8
100-3 splits	44.4	45.0	44.8	99.0	99.5
100-4 splits	45.8	46.5	46.2	104.0	105.7
110-3 splits	47.6	48.5	48.1	109.2	111.9
110-4 splits	49.3	50.2	49.8	115.6	117.9
SEm ±	0.5	0.6	0.5	1.2	1.1
CD at 5%	1.3	1.6	1.4	3.4	3.1

**Fig.1** Regression lines showing relation between grain yield (q ha<sup>-1</sup>) with biological yield (q ha<sup>-1</sup>)



**Fig.2** Regression lines showing relation between grain yield (q ha<sup>-1</sup>) with plant height at maturity (cm)



### Grain yield

The data pertaining to grain yield presented in table 4 indicate that the grain yield of different cultivars of basmati rice differed significantly. Long duration cultivars (HB-2, PB-1121 and PB-1) performed better than short duration cultivar (PB-1509) in respect of grain yield. Basmati cultivar HB-2 gave the

highest grain yield (47.5 and 48.2 q ha<sup>-1</sup>) which was statistically alike to with PB-1121(47.1 and 47.1 q ha<sup>-1</sup>) but significantly higher than PB-1 (43.9 and 44.2 q ha<sup>-1</sup>) and PB-1509 (42.9 and 43.4 q ha<sup>-1</sup>). Minimum yield was recorded with cultivars PB 1509. Singh *et al.*, (1999) also observed higher grain yield of Pusa Basmati-1 than Taraori Basmati.

Grain yield of cultivars increased significantly with increase in N dose and number of splits. Maximum grain yield was recorded with 110 kg N ha<sup>-1</sup> with four number of splits at 0, 20, 40, and 60 DAS (49.3 and 50.2 q ha<sup>-1</sup>) which was significantly higher than rest of treatments (Table 4). Minimum grain yield was recorded with 90 kg N ha<sup>-1</sup> with three splits at 0, 15 and 50 DAS (41.9 and 42.6 q ha<sup>-1</sup>). There was increase in grain yield of basmati rice with increase in N doses from 90 (41.9-43.9 q ha<sup>-1</sup>) to 100 (44.4-46.5 q ha<sup>-1</sup>) and 110 kg ha<sup>-1</sup> (47.6-50.2 q ha<sup>-1</sup>) in succession. Similarly, grain yield increased with increase in number of splits from three (41.9-47.6 q ha<sup>-1</sup>) to four (42.9-50.2 q ha<sup>-1</sup>). Similar results were also reported earlier by Pramanik and Bera (2013) and Abou-Khalifa (2012). Pooled grain yield of basmati cultivars significantly increased with increase in N dose and number of splits (Table 4). Maximum grain yield was recorded with 110 kg N/ha with four number of splits at 0, 20, 40 and 60 DAS (49.8 q/ha) which was significantly higher than rest of the treatments. There was increase in grain yield of basmati rice with increase in N doses from 90 (42.2-43.5) to 100 (44.8-46.2) and 110 kg/ha (48.1-49.8 q/ha) in succession. Similarly, grain yield increased with increase in number of splits from three (42.2-48.1 q/ha) to four (43.5-49.8 q/ha) at same level of nitrogen. Similar findings have also been reported by Yadav and Yadav (2012). Increase in grain yield at higher nitrogen rates might be primarily due to increase in chlorophyll concentration in leaves leading to higher photosynthetic rate.

### Biological yield

The data presented in table 4 indicate that biological yield of different basmati cultivars differed significantly. Maximum biomass production was observed with basmati cultivar HB-2 (106.9 and 111.5 q ha<sup>-1</sup>) which was statistically at par with PB-1121(109.7

and 106.9 q ha<sup>-1</sup>) but significantly higher than PB-1 (98.2 and 99.9 q ha<sup>-1</sup>) and PB-1509 (94.6 and 96.7 q ha<sup>-1</sup>). Minimum biological yield was recorded with PB-1509 during 2014 and 2015. Biological yield of basmati cultivars increased with increase in N dose and number of splits. The maximum biological yield (115.6 and 117.6 q ha<sup>-1</sup>) was recorded with 110 kg N ha<sup>-1</sup> with four splits (0, 20, 40 and 60 DAS) which was significantly higher than rest of treatments. Minimum biological yield (91.2 and 91.5 q ha<sup>-1</sup>) was recorded at 90 kg N ha<sup>-1</sup> with three splits (0, 15 and 50 DAS). There was increase in biological yield of basmati rice with increase in N doses from 90 (91.2-95.8 q ha<sup>-1</sup>) to 100 (99.0-105.7 q ha<sup>-1</sup>) and 110 kg ha<sup>-1</sup> (109.2-117.9 q ha<sup>-1</sup>) in succession. Similarly, biological yield increased with increase in number of splits from three (91.2-111.9 q ha<sup>-1</sup>) to four (95.0-117.9 q ha<sup>-1</sup>) at same level of nitrogen. Sharma *et al.*, (2012) also observed differences in growth, yield components and yield of different basmati rice cultivars with increase in nitrogen doses. There was close impact elaborated by regression lines drawn between grain yield and biological yield as (Fig. 1) with following equations, Grain yield = 0.326 biological yield + 12.89 (r<sup>2</sup>=0.883).

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