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RESEARCH ARTICLE

QUALITY AND ECONOMICS OF BASMATI CULTIVARS UNDER DSR AS INFLUENCE BY SPLIT APPLICATION OF NITROGENOUS FERTILIZERS

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ABSTRACT

Rice (*Oryza sativa* L) is the most prominent crop over globe. In India, rice crop plays vital role in country's food security and is the backbone of livelihood for millions of people, so may be called as 'rice is life'. Traditional puddled rice is a major source of methane, nitrous oxide emission which is directly related to greenhouse gases to global warming. Transplanting is the dominant method of sowing in the rice-wheat growing areas of the Indo-Gangetic Plains (IGP). Direct Seeded Rice (DSR) is the technology which is water, labour and energy efficient along with eco-friendly characteristics. However, high weed infestation is the major bottleneck in DSR, especially in dry field conditions and, availability of several nutrients including N, P, S and micronutrients such as Zn and Fe, is likely to be a constraint With the increase in prices of inputs and low rice prices, rice production does not provide farmers with high income. Therefore, it is essential to know about best selection of cultivar with right time of input application for the success of the technology. Keeping this in view an experiment was conducted at Regional Research Station, CCSHAU, Karnal. Four basmati cultivars PB 1121, PB 1509, PB 1 and HB 2 were chosen as main plot treatments and three nitrogen doses with 3 & 4 splits as sub plot treatments in split plot design. Experimental results recorded highest gross returns with basmati cultivar HB-2 (Rs. 99955 & 102777 ha^{-1}) followed by PB-1121 (Rs. 99100 & 99500 ha^{-1}) and minimum net returns with PB 1. Highest net income was obtained with *basmati* cultivar HB-2 (Rs. 19681 & 22179 ha^{-1}) followed by PB-1121 (Rs. 18844 & 18902 ha^{-1}) and PB-1 (Rs. 4072 & 4981 ha^{-1}). The lowest net income was obtained with PB-1509 (Rs.2366 & 3653 ha^{-1}). There was increase in benefit-cost ratio in *basmati* rice cultivation with increase in N doses from 90 (1.06-1.10) to 100 (1.12-1.16) and 110 kg ha^{-1} (1.20-1.25) in succession. Similarly, benefit-cost ratio increased with increase in number of splits from three (1.06-1.21) to four (1.08-1.25) at same level of nitrogen.

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INTRODUCTION

Rice (Oryza sativa L.) is one of the most important cereal crops of the world, grown under wide range of climatic zones. The crop occupies one-third of the world's total area planted under cereals and provides 35-60% of the calories consumed by 2.7 billion people. Direct seeded rice (DSR) is becoming popular as alternative to conventional transplanting under continuous flooding particularly in Asia. Nitrogen is the most limiting for nutrient growth, yield attributes and yield of rice (Yoshida, 1981 and Roy and Mishra 1999).

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Post-anthesis nitrogen assimilation of dry matter is important for economic yield and high harvest index. Inadequate N leads to reduced leaf area, limited light interception, low photosynthesis which resulted in lower biomass and grain yield of rice (Sinclair, 1990). Nitrogen use efficiency (NUE) of rice is usually low due to volatilization (Prasad *et al*. 1999), runoff, denitrification and leaching losses (Prasad Rao and Prasad 1980). 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. Dose and time of N application is very important agronomic practice for improving NUE and crop yield (Fageria and Baligar 2005). Rice cultivars usually exhibit vigorous vegetative growth under direct seeded condition and perform poorly during reproductive stages due to N deficiency. Thus, Split application at 0, 20, 40 and 60 DAS was 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. Therefore, optimizing split doses to different crop growth stages for high yield in DSR.

MATERIALS AND METHODS

A field experiment was conducted at CCS Haryana Agricultural University, Regional Research Station, Karnal during *kharif* 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) and zinc sulphate (25 kg/ha) were applied at the time of sowing. 11.5 k N available from diammonium 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 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 atributes and yield were recorded at harvest of the crop. Harvesting was done on 1 November 2014 and 14 November 2015.

RESULTS AND DISCUSSION

Protein content in grains

Quality in terms of protein content is considered to be an important factor in *basmati* rice. The data presented in Table 1 show the effect of cultivars and nitrogen scheduling on protein content in grains. Cultivar PB-1121 recorded maximum protein content (6.99 & 7.01%) which was statistically at par with *basmati* cultivar HB-2 (6.82 & 6.90%) and significantly higher than PB-1 (6.76 & 6.81%) and PB-1509 (6.71 & 6.85%). Gururani (1997) also observed the better quality in terms of milling and head rice recovery in tall photosensitive variety (Basmati-370) than semi dwarf photo-insensitive cultivars (Pusa Basmati-1 and Haryana Basmati-1). The difference in quality traits might be due to different genetic constitution of the cultivars. Similar findings were also reported by Gill (1984), and Uppal and Shidul (1995). Protein content in grains increased with increase in N levels and number of splits (Table 1). Protein content was recorded maximum (7.08 & 7.12 %) at 110 kg N ha^{-1} with four splits at 0, 20, 40, and 60 DAS which was significantly higher than rest of treatments. Minimum protein content (6.50 & 6.67%) was recorded at 90 kg N ha^{-1} with thee splits at 0, 15 and 50 DAS during both the years. There was increase in protein content percent with increase in N levels from 90 (6.50-6.80%) to 100 (6.77-6.95%) and 110 kg ha^{-1} (7.01-7.12%). Similarly, grain protein increased with increase in number of splits from three (6.50-7.05%) to four (6.65-7.12%) at same level of nitrogen. The nitrogen levels and number of splits had significant effect on protein content. Maximum protein content was recorded with highest dose of N (110 kg N ha^{-1}) with four splits as compared to lower levels of N application with three or four number of splits. Ahmed *et al*. (2009), Zhang *et al*. (2008) and Kavitha *et al*. (2008) also found that protein content of rice increased significantly with increase in levels of nitrogen. This might be due to maximum absorption & utilization of applied N. These results are in accordance with earlier findings by Maity and Mishra (2001), Duhan *et al*. (1989) and Kaushik *et al*. (1984).

Table 1. Effect of nitrogen levels and time of application on protein content (%) of different cultivars of *basmati* rice

Treatment Cultivars	Protein content (%)	
	2014	2015
PB-1121	6.99	7.01
PB-1509	6.71	6.85
PB-1	6.76	6.81
HB-2	6.82	6.90
SEm ±	0.05	0.05
CD at 5%	0.19	0.16
Nitrogen levels (kg ha^{-1}) and number of splits		
90-3 splits	6.50	6.67
90-4 splits	6.65	6.80
100-3 splits	6.77	6.86
100-4 splits	6.90	6.95
110-3 splits	7.01	7.05
110-4 splits	7.08	7.12
SEm ±	0.01	0.02
CD at 5%	0.04	0.06

Economics

The data pertaining to comparative economics (total cost, gross income and return over variable cost) of *basmati* rice as affected by N levels and split timings is presented in Table 2.

Total variable cost

Total variable cost of *basmati* cultivars PB-1121 and HB-2 (Rs. 25275 & 26725 ha^{-1}) was higher than PB-1 and PB-1509 (Rs. 24975 & 26412 ha^{-1}) during 2014 and 2015, respectively (Table 2). Among nitrogen levels and split timings, maximum variable cost (25400 & 26856 ha^{-1}) was recorded with 110 kg N ha^{-1} with four split timings and lowest (Rs. 24850 & 26281 ha^{-1}) noted with 90 kg N ha^{-1} with three splits. There was increase in total variable cost of *basmati* rice crop with increase in N doses from 90 (Rs. 24850-26595 ha^{-1}) to 100 (Rs. 24975-26725 ha^{-1}) and 110 kg ha^{-1} (Rs. 25100-26856 ha^{-1}) in succession. Similarly, total variable cost in *basmati* rice crop increased with increase in number of splits from three (Rs. 24850-26543 ha^{-1}) to four (Rs. 25150-26856 ha^{-1}) at same level of nitrogen.

Total cost of cultivation

Total cost of cultivation of cultivar HB-2 and PB-1121 was higher (Rs. 80274 & 80598 ha^{-1}) than PB-1 and PB-1509 (Rs. 79917 & 80253 ha^{-1}). Lowest total cost recorded with PB 1509 (Rs. 79917 & 80253 ha^{-1}). Nitrogen levels and number of splits influenced the total cost of cultivation as indicated in Table 2. Nitrogen application at 110 kg ha^{-1} with four splits recorded highest (Rs. 80411 & 80742 ha^{-1}) cost of cultivation and minimum cost was recorded with 90 kg Nha^{-1} with 3 splits (Rs. 79774 & 80109 ha^{-1}) during 2014 and 2015, respectively.

Table 2. Effect of nitrogen levels and time of application on economics of different cultivars of *basmati* rice

Treatment	Total variable cost (Rs. ha^{-1})		Total cost of cultivation (Rs. ha^{-1})		Gross returns (Rs. ha^{-1})		Return over variable cost (Rs. ha^{-1})	
Cultivars	2014	2015	2014	2015	2014	2015	2014	2015
PB-1121	25275	26725	80256	80598	99100	99500	72687	72774
PB-1509	24975	26412	79917	80253	82283	83907	56184	57494
PB-1	24975	26412	79923	80253	83995	85235	57896	58822
HB-2	25275	26725	80274	80598	99955	102777	73543	76051
Nitrogen levels (kg ha^{-1}) and number of splits								
90-3 splits	24850	26281	79774	80109	84641	86056	58673	59775
90-4 splits	25150	26595	80119	80454	86783	88700	60501	62104
100-3 splits	24975	26412	79919	80253	89566	90665	63467	64252
100-4 splits	25275	26725	80265	80598	92323	93593	65910	66867
110-3 splits	25100	26543	80065	80397	95727	97424	69497	70881
110-4 splits	25400	26856	80411	80742	98958	100690	72415	73833

Table 4. Effect of nitrogen levels and time of application on net returns and benefit-cost ratio of different cultivars of *basmati* rice

Treatment	Net returns (Rs ha^{-1})		B-C ratio	
Cultivars	2014	2015	2014	2015
PB-1121	18844	18902	1.23	1.23
PB-1509	2366	3653	1.03	1.05
PB-1	4072	4981	1.05	1.06
HB-2	19681	22179	1.25	1.28
Nitrogen levels (kg ha^{-1}) and number of splits				
90-3 splits	4868	5947	1.06	1.07
90-4 splits	6663	8245	1.08	1.10
100-3 splits	9647	10411	1.12	1.13
100-4 splits	12057	12995	1.15	1.16
110-3 splits	15662	17027	1.20	1.21
110-4 splits	18547	19948	1.23	1.25

There was increase in total cost of *basmati* rice cultivation with increase in N doses from 90 (Rs. 79774-80454 ha^{-1}) to 100 (Rs. 79919-80598 ha^{-1}) and 110 kg ha^{-1} (Rs. 80065-80772 ha^{-1}) in succession. Similarly, total cost of cultivation in *basmati* rice crop increased with increase in number of splits from three (Rs. 79774-80397 ha^{-1}) to four (Rs. 80119-80772 ha^{-1}) at same level of nitrogen.

Returns over variable cost

The highest returns over variable cost were obtained with cultivar HB-2 (Rs. 735543 & 76051 ha^{-1}) followed by PB-1121 (Rs. 72687 & 72774 ha^{-1}), PB-1 (Rs. 57896 & 58822 ha^{-1}) and PB-1509 (Rs. 56184 & 57494 ha^{-1}) during both the years. The increase in N dose and number of splits favoured increase in returns. The maximum returns over variable cost (Rs. 72415 & 73833 ha^{-1}) were recorded with 110 kg N ha^{-1} with four splits. The lowest returns over variable cost were received at 90 kg N ha^{-1} with three splits (Rs. 58673 & 59775 ha^{-1}). There was increase in returns over variable cost in *basmati* rice cultivation with increase in N doses from 90 (Rs. 58673-62104 ha^{-1}) to 100 (Rs. 63467-66867 ha^{-1}) and 110 kg ha^{-1} (Rs. 69497-73833 ha^{-1}) in succession. Similarly, returns over variable cost increased with increase in number of splits from three (Rs. 58673-70881 ha^{-1}) to four (Rs. 60501-73833 ha^{-1}) at same level of nitrogen. *Basmati* rice cultivars HB-2 gave the highest gross income, net returns and benefit-cost ratio followed by PB-1121, PB-1 and PB-1509, in succession (Table 2). This indicated that the economics was governed mainly by grain yield. Increasing levels of NPK increased both grain and straw yield of rice, thus increased the economic returns (Das *et al*. 2003, Ravisankar *et al*. 2003, Sharma *et al*. 2003, and Duraisami and Mani, 2002).

Net income

Data in the Table 3 indicated that the highest net income was obtained with *basmati* cultivar HB-2 (Rs. 19681 & 22179 ha^{-1}) followed by PB-1121 (Rs. 18844 & 18902 ha^{-1}) and PB-1 (Rs. 4072 & 4981 ha^{-1}). The lowest net income was obtained with PB-1509 (Rs.2366 & 3653 ha^{-1}).The net income increased with increased in N dose and number of splits. Highest net income (Rs. 18547 & 19948 ha^{-1}) was recorded at 110 kg N ha^{-1} with four split timings and lowest obtained with 90 kg N ha^{-1}with three splits (Rs. 4868 & 5947 ha^{-1}) during 2014 and 2015 respectively. There was increase in net income in *basmati* rice cultivation with increase in N doses from 90 (Rs. 4868-8245 ha^{-1}) to 100 (Rs. 9647-12995 ha^{-1}) and 110 kg ha^{-1} (Rs. 15662-19948 ha^{-1}) in succession. Similarly, net income increased with increase in number of splits from three (Rs. 4868-5947 ha^{-1}) to four (Rs. 6663-19948 ha^{-1}) at same level of nitrogen.

Benefit-cost ratio

The data indicated in Table 3 showed that highest benefit-cost ratio was received with cultivar HB-2 (1.25 & 1.28) followed with PB-1121 (1.23 & 1.23), PB-1 (1.05 & 1.06) and lowest with PB-1509 (1.03 & 1.05). Application of 110 kg N ha^{-1} with four splits obtained highest benefit-cost ratio (1.23 &1.25) followed by 100 and 90 kg N ha^{-1} application. Lowest benefit-cost ratio was recorded with 90 kg N ha^{-1} application with three splits (1.06 & 1.07). There was increase in benefit-cost ratio in *basmati* rice cultivation with increase in N doses from 90 (1.06-1.10) to 100 (1.12-1.16) and 110 kg ha^{-1} (1.20-1.25) in succession. Similarly, benefit-cost ratio increased with increase in number of splits from three (1.06-1.21) to four (1.08-1.25) at same level of nitrogen.

Conclusion

Maximum protein content was recorded in cultivar PB-1121 (6.99 & 7.01 %) which was statistically at par with *basmati* cultivar HB-2 (6.82 & 6.90 %) and significantly higher than PB-1 (6.76 & 6.81 %) and PB-1509 (6.71 & 6.85 %) during both the years. N levels and number of splits also had significant effect on protein content. Significantly maximum protein content was recorded with highest dose of N (110 kg N ha^{-1}) with four number of splits as compared to lower levels of N application with three or four number of splits. Among the basmati cultivars HB 2 recorded highest gross returns, net income and cost-benefit ratio followed by PB 1121, PB1 and PB 1509 respectively. The returns were maximum under 110 kg N ha^{-1} with 4 splits. The increase in returns recorded under 110 kg N ha^{-1} with 4 splits might be due to higher grain yield that contributed more return over 90 and 100 kg N ha^{-1} with 3 or 4 splits.

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