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Research Article

Water expense efficiency and Economics of Basmati rice (*Oryza sativa* L.) grown in System of rice intensification under different nutrient management practices and transplanting windows

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Abstract

A field experiment was carried out at the Research Farm, Division of Agronomy, Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu during the *kharif* season of 2014 to study the water expense efficiency (WEE) and economics of basmati rice grown under system of rice intensification (SRI). The experiment consisted of three dates of transplanting and five nutrient sources. The transplanting on June 30 produced significantly higher grain yield over rest of treatments. The magnitude of increase in grain yield due to transplanting on June 30 and July 15 was 18.59 and 9.71, respectively over July 30. The application of 100% inorganic fertilizer recorded significantly higher grain yield (33 q/ha) and straw yield (56 q/ha). In case of WEE, transplanting on July 30 realized maximum WEE as compared to July 15 and June 30 transplanting. The magnitude of increase in WEE of July 30 was 32% over July 15 and 8.9% over June 30 transplanting. Among nutrient sources, application of N, P and K at (100% inorganic) resulted in higher WEE (42.56 kg/ha/cm) than other organic nutrient sources. However, in case of organic nutrient sources highest WEE was recorded in treatments with application of FYM + vermicompost + neem oil cake (39.24 kg/ha/cm). Net returns (Rs 80501) and benefit: cost (2.78) of Basmati rice also recorded higher at June 30. Net returns (Rs 84892) and B: C ratio (3.41) were recorded higher at 100% inorganic fertilizer (RDF), followed by brown manuring + 25% RDF (2.94).

Keywords: Basmati rice, Dates of transplanting, organic sources, SRI, water expense efficiency, economics

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Introduction

The total acreage and production of rice in India are 43.8 M ha, 106.19 MT [1]. Out of 42.2 M ha of rice area in the country basmati or aromatic rice is cultivated over an area of about 7.76 M ha with production of about 6.5 MT and is an important asset for country as it fetches premium price in the international market and is a major source of foreign exchange of about 227184.4 M [2]. In Jammu and Kashmir region rice has been recognized as one of the most widely grown crop in the sub-tropical irrigated belts with acreage, production and productivity of 2.71 lakh ha, 5567 thousand quintals, 20.51 q/ha, respectively [1]. Aromatic or basmati rice is the back bone of the farmers of the sub-tropical irrigated belts of Jammu region. The productivity of basmati rice in Jammu is lesser than the national average. There is an ample scope for improvement in its production vertically rather than horizontal expansion. Under present agriculture scenario, the recommended management practice needs relook as due to global warming total shift of agricultural practices are being realized. It is an established fact that not only the monitoring input plays important role in targeting the higher yield and profitability but also the non- monitoring inputs is having much wider role. Among various non-monitoring climatic parameters date of sowing/transplanting especially in Basmati rice plays a necessary role. Increase in temperature and erratic rainfall pattern during the crop season had led multifaceted problem in realizing higher yield. Another agronomic management practice for increasing the yield and productivity of the basmati is attributed to efficient nutrient management. Balanced dose of fertilization through integrated nutrient management practice is considered an important factor which is having the potential to increase the yield, quality and address the sustainability issues to a greater extent. The Basmati rice requires low nutrients as compared to coarse grain rice. Excessive nutrition tends the plant to lodge, thereby affect the yield and productivity. Besides, inorganic fertilizers, it has become imperative to work out organics fertilization, as the organically grown basmati rice is in greater demand and is more profitable. Also, the increasing scarcity of water for agriculture is becoming a major problem in many countries, particularly the leading rice-producing countries like China and India, where competition for freshwater and growing demands for other sectors are increasing in future. In such a situation, the use of water-saving approaches, such as aerobic rice, direct-seeded rice and system of rice intensification (SRI) may prove beneficial while improving rice productivity as well. Water expense efficiency is used exclusively to denote the amount or value of product over volume or value of water depleted or diverted. When speaking of food security, it is important to account for such criteria [3]. The SRI is an alternative for conventional rice cultivation that saves the expensive external inputs, improves soil health/quality and protects the environment substantially [4]. Therefore, it becomes necessary to work out the suitable date of transplanting under the changing climatic scenario. To ensure and enhance the success of SRI on yield of Basmati rice, with different transplanting dates and the use of soil organic sources like green manuring, brown manuring with *Sesbania* spp. as source of nutrients, which as expected shall play a crucial role in not only improving soil health, but also can play an important role in climate resilient agriculture.

Material and Methods

A field experiment was conducted at the research farm of Division of Agronomy of Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu during the year 2014. Jammu is situated at 32^0-40´ N latitude and 74^0-58´ E longitude with an altitude of 332 m above mean sea level. The soil of the experimental site was sandy clay loam, slightly alkaline in reaction, low in organic carbon (0.35 %) and available nitrogen (231.73 kg/ha), but medium in available phosphorus (13.86 kg/ha) and potassium (156.93 kg/ha). The experiment was laid under Randomized block design which consisted of three dates of transplanting (June 30^{th}; July 15^{th} and July 30^{th}) and five nutrient sources (100% inorganic fertilizer (RDF); Brown manuring with *Sesbania* spp + 25% inorganic fertilizer (RDF); Brown manuring with *Sesbania* spp (100 %); FYM + Vermicompost+ neem oil cake (1:1:1) and Green manuring with *Sesbania* spp + Vermicompost (1:1). The rice variety basmati-370 was used as test material. Green manure crop was raised and incorporated in soil at 30 days crop stage after sowing during puddling. The FYM, Vermicompost and Non-Edible oil cake were applied 20 days before transplanting, where as *Sesbania* in brown manuring treatments was sown one day after transplanting of Basmati rice (sprayed with 2-4, D @ 1.5 kg/ha at 30 days stage). Application of inorganic nutrients as RDF @ 30-20-10 kg/ha were applied. Nitrogen was applied in three splits (1/2 as basal and remaining half in two equal splits at maximum tillering and panicle initiation stage) as per the treatment. Transplanting of 12 days old seedling was done at spacing of 25×25 cm apart. The yields were recorded from the net plot area and expressed as q/ha. Grain and Straw yield in soil were observed by standard procedures. The water expense efficiency was calculated as the ratio of yield to the total amount of water applied and expressed in kg $ha^{-1}cm^{-1}$ using formula

WEE = Y/WE×100. Where, WEE = Water expense efficiency, Y = Grain yield (kg ha^{-1}), WE = Water expense (WE= irrigation water + effective rainfall – water in soil profile). The data were analyzed as per the standard procedure for "Analysis of Variance" (ANOVA) as described by [5]. The critical differences at 0.05% level of probability were calculated to assess the significance between treatments if significant.

Results and Discussion

Grain and straw yield

The mean data on grain yield revealed that the basmati rice transplanted on June 30 produced significantly higher grain yield (32.72 q/ha) than July 15 (30.27 q/ha) and July 30 (28 q/ha (**Figure 1**). However, straw yield was on par with each other in June 30 and July 15 transplanting but significantly higher over July 30 transplanting (Figure 1). Higher yields at earlier transplanting might be due to better vegetative phase that favored uptake of nutrients and there by increased grain and straw yields. These findings are in general agreement with those reported by [6, 7]. The lower yield under late planting may also be attributable to comparatively low temperature in the late planting crop [8].

The application of 100% nutrients through inorganic sources significantly increased the grain yield of basmati over the other organic nutrient sources. Among the organic sources FYM + vermicompost + neem oil cake produced higher grain yield of basmati rice and found to be on par with green manuring + vermicompost and brown manuring + 25% RDF, over application of organic nutrients through brown manuring (100%). Straw yield of basmati observed a similar significant trend as that of grain yield. This may owe to greater release of nutrients and their ready availability in soil in case of recommended (inorganic) dose which facilitated higher uptake and hence contributing towards higher grain and straw yield.

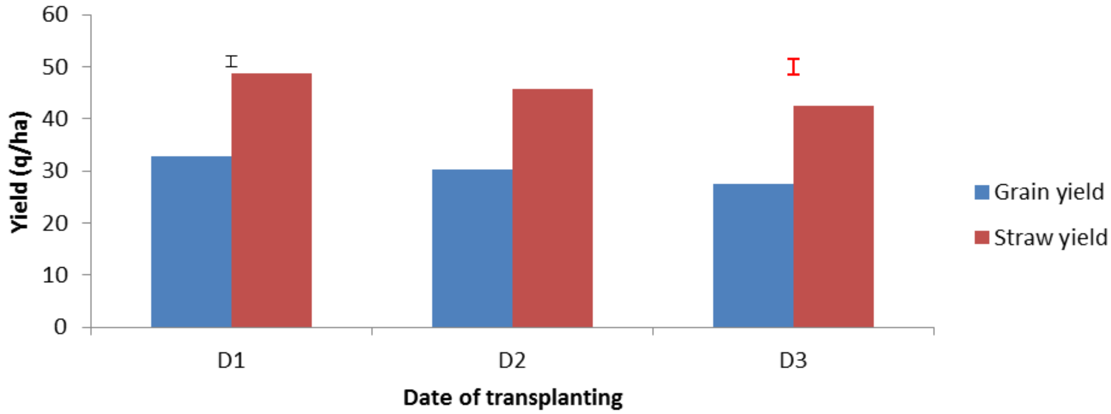

Figure 1 Grain and straw yield of Basmati Rice as influenced by different transplating dates

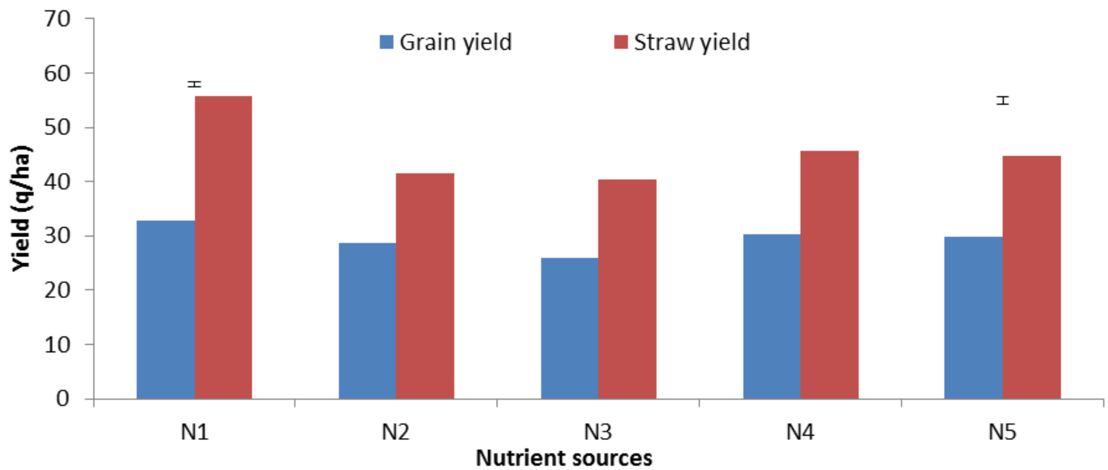

Figure 2 Grain and straw yield of Basmati Rice as influenced by different nutrient sources

Table 1 Influence of transplanting dates and nutrient sources net returns, B: C ratio and water expense efficiency of Basmati rice

Treatments	Net Return (`/ha)	B:C Ratio	Effective rainfall (cm)	Irrigation water applied (cm)	Water expense (cm)	Water expense efficiency (kg/ha/cm)
Transplanting dates						
June 30	80501	2.78	57.46	43.0	94.58	32.48
July 15	72773	2.54	53.42	29.0	76.54	39.55
July 30	64653	2.28	47.94	22.0	64.06	43.07
Nutrient sources						
100% inorganic	84892	3.41	529.40	313.33	78.39	42.56
Brown manuring + 25% RDF	72448	2.94	529.40	313.33	78.39	37.35
Brown manuring 100%	63783	2.62	529.40	313.33	78.39	33.84
FYM+Vermicompost + non edible oil cake	59828	1.45	529.40	313.33	78.39	39.24
Green manuring + Vermicompost	71625	2.54	529.40	313.33	78.39	38.83

Water expense efficiency

The observed data revealed that different transplanting dates and nutrient sources showed varied difference in water expense efficiency (WEE). Among the different transplanting dates, July 30 date of transplanting realized an increasing WEE (43.07 kg/ha/cm) of basmati (B-370) than July 15 (39.55 kg/ha/cm). The percent increase in water expense efficiency of July 30 was 32 % over July 15 and 8.9 % June 30. The decreased water use with late transplanting conditions was associated with lower potential evapotranspiration demand by the atmosphere [9] resulting in improving water productivity and reducing the pressure on resources and generate the scope for transfer to saved water resource to other users expanded. Whereas, in case of nutrient sources, application of N, P and K at (100% inorganic) resulted in higher WEE (42.56 kg/ha/cm) than other organic nutrient sources. However, in case of organic nutrient sources highest WEE was recorded in treatments where FYM + vermicompost + neem oil cake.

Economics

The treatment wise economic returns were worked out with the help of operating cost of individual treatment and the cost of production. The data so obtained revealed that the net returns were found to be increased in June 30 date of transplanting (Rs 80501) with the benefit cost ratio of 2.78 over July 15 (Rs. 72773 and B: C ratio of 2.54) and July 30 (Rs. 64653 and B: C ratio 2.28). In case of nutrient sources higher net returns were fetched in treatments supplied with recommended dose of fertilizer (inorganic) (Rs 84892) with the benefit cost ratio of 3.41 as compared to application of different organic source nutrients [10].

Conclusion

On the basis ofabove presented data, it may be concluded that June 30 date of transplanting has with 100 % inorganic dose of fertilizer (recommended dose) followed by brown manuring +25% RDF or green manuring + vermicompost found to be the most suitable for achieving economic yield advantage with higher net returns and benefit cost ratio. Whereas, water productivity is also a crucial factor and it was found that WEE was highest with last transplanting on July 30 maintained, the pressure on resources can be reduced and the scope for transfers to other users expanded. The increase in agricultural water productivity has been the result of strategic investment in water development but also in research and development and in agricultural extension

References

[1] Anonymous (2014). Economic survey, 2013-2014. Directorate of Economics and Statistics, Jammu and Kashmir.

[2] Anonymous (2015). The Agricultural and Processed Food Products Export Development Authority (APEDA).

[3] Renault, D., Hemakumara, M.H. & Molden, D.W. (2000). Importance of water consumption by perennial vegetation in irrigated areas of the humid tropics: evidence from Sri Lanka. Ag. Wat. Man., 46(3): 201-213.

[4] Ram, H., Singh, J.P., Bohra, J.S., Singh, R.K. and Sutaliya, J.M. (2014). Effect of seedlings age and plant spacing on growth, yield, nutrient uptake and economics of rice (Oryza sativa) genotypes under system of rice intensification. Indian Journal of Agronomy, 59(2): 256-260.

[5] Gomez, K. A. and Gomez, A. A. (1984). Statistical procedures for agricultural research, 2nd ed. New York, J. Wiley and Sons.

[6] Chopra, N. and Chopra, N. 2004. Influence of transplanting dates on heat requirement of different phonological stages and subsequently yield and quality of scented rice (Oryza sativa) seed. Indian J. Agric. Sci., 74(8): 415-419

[7] Chopra, N.K., Chopra, Nisha and Yadav, R.N. (2006). Effect of transplanting dates on seed yield and quality of paddy cv. Pusa-44. Seed Res., 94(2): 288-290.

[8] Ram, Mangat, Singh, Ishwar, Om, H. and Nandal, D.P. (2005). Performance of rice (Oryza sativa L.) varieties and hybrids under varying time of transplanting in Haryana. Haryana J. Agron., 21(1): 18-20.

[9] Evapotranspiration and water productivity of rice (Oryza sativaL.)–wheat (Triticum aestivum L.) system in Punjab-India as influenced by transplanting date of rice and weather parameters. Agric. Water Manage. 88, 14–27.

[10] Panigrahi Trinath, L. M. Garnayak, M. Ghosh, D. K. Bastia and D. C. Ghosh. (2014). Productivity and Profitability of Basmati Rice Varieties under SRI. International Journal of Bio-resource and Stress Management. 5(3): 333-339.

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