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Impact of Different Transplanting Method and Nitrogen Management Practices on Growth and Yield of Rice (*Oriza sativa* L.) cv. Pusa Basmati-1 in Eastern Uttar Pradesh, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

To investigate the " Impact of Different Transplanting Method and Nitrogen Management Practices on Growth and Yield of Rice (*Oriza sativa* L.) cv. Pusa Basmati-1 in Eastern Uttar Pradesh, India" a field experiment was conducted at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayajraj (U.P.) The treatment included three transplanting methods, viz. Transplanting of 21 days old seedlings (farmers practice), Mechanized transplanting of 14 days old seedlings, and Manual transplanting of 14 days old seedlings (SRI), as well as seven nitrogen management, practices viz. RDN (100% N inorganic), RDN (75% N inorganic +25% N through PM), RDN (75% N inorganic +25% N through VC), RDN (75% N inorganic +25 % N through PM + *Azospirillum* SI), RDN (75% N inorganic +25% N through VC + *Azospirillum* SI), Leaf Colour Chart (LCC) based N application and Soil Test Crop Response (STCR) based N application (based on target Yield). The experiment was laid out in Split Plot Design, with 21 treatments with the main plot consisting of three planting techniques and seven nitrogen management practices as

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subplots that were replicated thrice. The results demonstrated that rice productivity was influenced by transplanting methods and nitrogen management approaches. In terms of growth and yield characteristics, the method of transplanting had a considerable impact. Among the various transplanting methods, manual transplanting of 14-day-old seedlings (SRI) produced significantly highest growth contributing characters, yield attributes, and final yield of rice during both the years of experiment. In comparison to farmer practices, manual transplanting of 14-day-old seedlings (SRI) produced 13 percent more effective tillers/m2, 18 percent more panicle/hill, 14 percent more grain yield, and 12 percent more straw yield, followed by mechanized transplanting of 14-day-old seedlings. Furthermore, the application of RDN (75 percent N inorganic+25 percent N through PM+ *Azospirillum* SI) (N4) recorded significantly higher growth and yield attributes and yield, which is 20% more grain and 11% more straw yield as compared to RDN (100% N inorganic). As a result, rice growers in the ecological parameter of Uttar Pradesh may use the manual transplanting of 14-day-old seedlings (SRI) method with RDN (75 percent N inorganic + 25 percent N via PM + *Azospirillum* SI) to increase productivity and profitability.

Keywords: Rice; transplanting; nitrogen management; system of rice intensification; growth and yield; kharif.

1. INTRODUCTION

For more than half of the world's population, rice (*Oriza sativa* L.), which is farmed in a variety of climatic zones, is the most significant cereal crop. In irrigated low-land rice, transplanting is the most common and traditional technique of establishment. Due to a lack of labour and water, less rice is being transplanted globally. Therefore, to boost rice output, it is necessary to look for alternative crop establishment techniques [1]. Because it saves labour and ensures that young seedlings are transplanted promptly, the mechanical transplanting and SRI method of transplanting rice have been identified as the most promising options. By modifying the environmental factors that could alter the microclimate and soil conditions, there is plenty of room to boost rice productivity. Around the world, including India, the SRI technique of cultivation is gradually gaining popularity. The traditional method of transplanting rice is time- and labor-intensive. Planting is delayed due to a lack of labour at the proper time, which results in a low yield [2]. In this case, it is essential to cultivate rice using labor- and space-efficient approach without sacrificing grain production.

To get a good yield, most rice soils require nitrogen (N) fertilizer. For major rice-growing tracts, the Prayaraj region of Eastern Uttar Pradesh currently recommends fertilizer N at a predetermined rate and schedule. These "blanket" suggestions have produced good yields, but their ability to increase nutrient usage efficiency is constrained. The limited use of organic manure and uneven use of inorganic nitrogen sources of nitrogen, which can result in numerous nutritional deficits, are significant barriers to achieving increased yields, in addition to improved cultivars and irrigation. The twin aims of fertilizer economy and sustainability should be the focus of nutrient management techniques Dass et al. [3]. Combining organic and inorganic sources, such as farmyard manure, chicken manure, green manure, and vermicompost, with biofertilizer and their effective management, has the potential to increase soil health and production while also fulfilling some of the nutrient needs of crops [4]. Therefore, a field experiment is carried out in this competition to assess the growth and yield of rice under various nitrogen management and transplanting methods.

2. MATERIALS AND METHODS

The Crop Research Farm (CRF), Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj, undertook a field experiment during the Kharif seasons of 2018 and 2019. (U.P.). The soil at the test location had a sandy loam texture, a pH of 7.3 and 7.3, and EC of 0.23 and 0.34 dS/m, organic carbon of 0.42 and 0.34 percent, and usable amounts of N, P, and K of 180.6, 189.9, and 238.3 kg/ha, during 2018 and 2019 respectively. The experiment used a split-plot design that was replicated thrice with 21 treatments using three transplanting techniques as the main plot treatments: manual transplanting of 21 days old seedlings (farmers practice), mechanized transplanting of 14 days old seedlings, and Manual transplanting of 14 days old seedlings (SRI), and RDN (100 percent N inorganic), RDN

(75 percent N inorganic + 25 percent N through PM),

RDN (75 percent N inorganic + 25 percent N through VC), RDN (75 percent N inorganic + 25 percent N through VC + *Azospirillum* SI), Leaf Color Chart (LCC) based N application, and Soil Test Crop Response (STCR) based N application (based on target Yield) are seven nitrogen management practices. In the experiment, mechanical transplanting of rice was done using a self-propelled rice transplanter. The transplanter, which has a diesel motor, moves seedlings from mat-style nurseries. Seedlings that were 14 days old were used for SRI and mechanized transplanted rice. Every treatment received the appropriate dose of phosphorus at 60 kg/ha, potassium at 80 kg/ha, and zinc sulphate at 20 kg/ha as a baseline. In LCC-based nitrogen management, the suggested amount of nitrogen was applied anytime the LCC value was discovered to be below the fixed critical level of 3. By using the target yield based on the initial soil sample values of available N, P, and K as well as the amount of N, P, and K supplied, nitrogen was applied in STCR-based plots. The data on the various growth and yield attributing parameters were statistically analyzed using a standard formula [5].

3. RESULT AND DISCUSSION

3.1 Growth Attributes

Due to diverse nitrogen management techniques and the transplanting procedure, the growth characteristics of rice were significantly improved. During both the years of experimentation, manual transplantation of 14-day-old seedlings (SRI) (M3) led to significant plant height (99.57 and 101.85 cm) and dry weight (50.89 and 51.70 g/plant) than mechanical and traditional methods of transplanting. Compared to farmer practice, SRI approach produced 7% higher tillers, 20% more plant height, and 20% more dry weight. Higher plant height and dry matter production output resulted from the SRI method's wider spacing and decreased competition, which allowed the plant to grow vigorously and to utilize the vital nutrients for plants that are necessary for growth and development and might be because the optimal plant population per unit area and planting depth were maintained, increasing plant height [6] and Manjunatha et al. (2009) also described a near result. Additionally, during both the years of trial, the application of RDN (75 percent N inorganic +25 percent N via PM + Azospirillum SI) (N4) produced the significantly, highest plant height (97.55 and 97.24 cm) and dry weight (55.09 and 56.68 g/plant, respectively). Increased growth attributes value in the treatment when organic sources were treated with inorganic fertiliser may be related to the organic sources' lower nitrogen loss and longer availability to the crop. Organic manure provides nearly all or most of the needed nutrients for plant growth and development, assisting in the production of new tissues and the development of new shoots. Combining organic and inorganic nitrogen fertilizer ensures that it is released quickly at first and then more gradually to keep up with rice growth [7]. The majority of the nutrients required for plant better growth and development are provided by organic manure, which aids in the creation of new tissues and shoots that ultimately improve plant height and dry matter production in rice crops and also maintain the fertility status of the soil. As a result of the increased transfer of photosynthates from source to sink site generated by inorganic fertilizers in addition to organic manures, rice production contributing features increased (Barik et al., 2008).

The transplanting method and various nitrogen management practices greatly impacted on yield parameters of rice, namely the number of panicle/hill and test weight (Table 2). Manual transplanting of 14 days old seedlings (SRI) (M3), the significantly, highest number of panicle/hill (15.29 and 13.47), and test weight (29.86 and 27.71 g) were noted during two years of the study. The results however demonstrate that throughout the first and second years of study, mechanical transplanting of 14-day-old seedlings was discovered to be comparable to Manual transplantation at 14-days (SRI) (M3) in terms of the number of panicle/hills, respectively. In comparison to farmer practices, manual transplanting of 14-day-old seedlings (SRI) produced 13 percent more effective tillers/m2, and 18 percent more panicle/hill. The greatest number of panicles/hills can be related to the ideal plant population and geometry, which led to the plant having access to more resources being available to the plant [8]. Root growth and tillering are abundant, which assimilate synthesis and divert it to produce larger grain filling, resulting in a higher test weight in SRI. In comparison to RDN @100% or no organics, integrated application of nutrient sources

Table 1. Growth parameters of rice (*Oryza sativa L.*) under different method of transplanting and nitrogen management practices Yield attributes

Treatments	**Plant height (cm)**		**Dry weight (g/plant)**	
	2018	**2019**	**2018**	**2019**
Method of transplanting (M)				
M1: Transplanting of 21 days old seedlings (farmers practice)	81.77	82.88	40.52	45.34
M2: Mechanized transplanting of 14 days old seedlings	93.79	95.38	44.04	49.37
M3: Manual transplanting of 14 days old seedlings (SRI)	99.57	101.85	50.89	52.52
SEm(±)	2.00	2.16	1.22	0.91
CD (P=0.05)	6.92	7.48	4.21	3.13
Nitrogen management practices (N)				
N1: RDN (100% N inorganic)	90.62	93.08	42.42	45.86
N2: RDN (75% N inorganic +25% N through PM)	92.20	94.96	49.00	54.46
N3: RDN (75% N inorganic +25% N through VC)	91.28	92.19	45.05	47.97
N4: RDN (75% N inorganic +25% N through PM + Azospirillum SI)	97.55	97.24	55.09	58.27
N5: RDN (75% N inorganic +25% N through VC + Azospirillum SI)	93.18	93.30	47.00	51.24
N6: Leaf Colour Chart (LCC) based N application	88.96	90.74	39.87	43.75
N7: Soil Test Crop Response (STCR) based N application	88.18	92.08	37.63	41.99
SEm(±)	1.74	1.13	1.30	1.10
CD (P=0.05)	5.05	3.28	3.77	3.18

Table 2. Yield attributing characters and yield of rice (*Oryza sativa L.*) under different method of transplanting and nitrogen management practices

Treatments	Number of panicle/hills		Test weight (gm)		Grain yield (t/ha)		Straw yield (t/ha)	
	2018	2019	2018	2019	2018	2019	2018	2019
Method of transplanting (M)								
M1: Transplanting of 21 days old seedlings (farmers practice)	11.41	12.04	26.10	24.62	4.11	3.86	6.19	5.67
M2: Mechanized transplanting of 14 days old seedlings	14.64	12.71	27.90	25.76	4.43	4.20	6.67	6.43
M3: Manual transplanting of 14 days old seedlings (SRI)	15.29	13.47	29.86	27.71	4.81	4.46	7.01	6.48
SEm(±)	0.78	0.11	0.39	0.54	0.06	0.10	0.15	0.17
CD (P=0.05)	2.70	0.38	1.36	1.85	0.21	0.33	0.53	0.58
Nitrogen management practices (N)								
N1: RDN (100% N inorganic)	12.62	11.89	27.33	25.67	4.16	3.93	6.47	6.16
N2: RDN (75% N inorganic +25% N through PM)	13.93	12.94	29.89	27.56	4.83	4.57	7.05	6.41
N3: RDN (75% N inorganic +25% N through VC)	13.68	12.68	27.11	26.33	4.50	4.22	6.69	6.21
N4: RDN (75% N inorganic +25% N through PM + Azospirillum SI)	14.36	13.23	30.44	28.56	5.21	4.99	7.12	7.04
N5: RDN (75% N inorganic +25% N through VC + Azospirillum SI)	13.69	12.70	28.22	26.33	4.74	4.47	6.91	6.36
N6: Leaf Colour Chart (LCC) based N application	12.99	11.15	25.67	24.11	4.07	3.78	6.20	5.85
N7: Soil Test Crop Response (STCR) based N application	11.52	10.49	27.00	23.67	3.62	3.24	5.92	5.51
SEm(±)	0.15	0.14	0.93	0.86	0.15	0.15	0.17	0.25
CD (P=0.05)	0.47	0.40	2.68	2.49	0.44	0.44	0.50	0.72

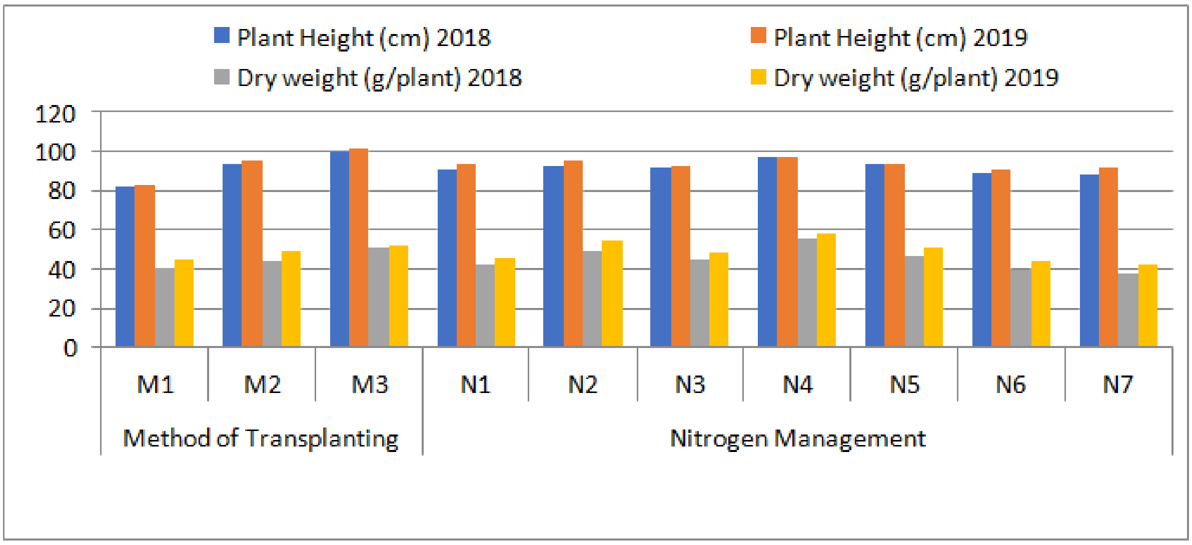

Fig. 1. Growth parameters of rice (*Oryza sativa L.*) under different method of transplanting and nitrogen management practices

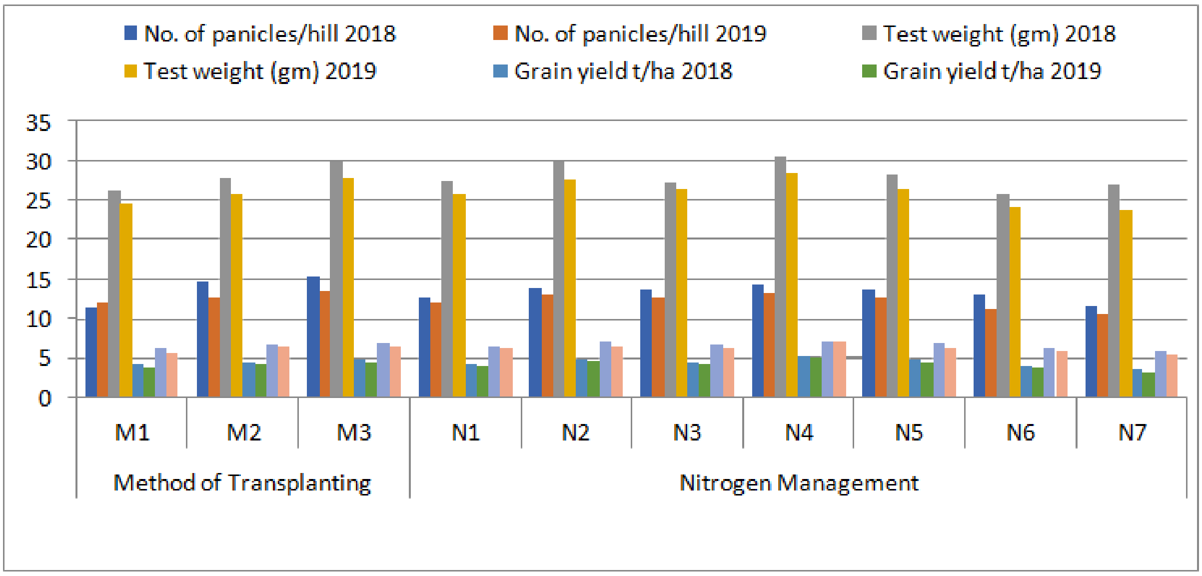

Fig. 2. Yield attributing characters and yield of rice (*Oryza sativa L.*) under different method of transplanting and nitrogen management practices

generally produced yield qualities with a much greater value. When comparing the various nitrogen management strategies, the treatment RDN (75 percent N inorganic +25 percent N via PM + Azospirillum SI) (N4) produced the highest value of yield attributes, including the number of panicle/hill (14.36 and 12.23) and test weight (30.44 and 28.56 g), in the experimental years 2018 and 2019, respectively. Increased panicle and test weight were signs of stimulated vegetative growth caused by adequate and sustained nitrogen supply received from organic fertilizer as well biofertilizer. It is a well-known fact that adding organic manure to soil enhances its biological and physical properties. Lower penetration impedance brought on by reduced bulk density (BD) may be to account for improved root development and greater yield qualities. As a result, the usage of inorganic fertilizer and organic manures in combination with biofertilizer resulted in enhanced photosynthate transfer from source to sink site, resulting in higher yield contributing to rice traits. The simultaneous application of nutrients has also been reported to have positive effects by Kumari et al. [9] and Chaudhary et al. [4].

3.2 Grain and Straw Yield

Under varied nitrogen management approaches, several transplanting methods produced distinctly different results. Manual transplantation at 14 days (SRI) (M3) produced significantly greater grain (4.81 and 4.46 t/ha) and straw yield (7.01 and 6.48 t/ha). Due to greater grain yield qualities and total biomass, the SRI approach has the potential to deliver a 16.6 percent higher grain output than traditional transplanting [10]. Higher root growth under SRI enabled them to acquire nutrients from a considerably larger amount of soil, which resulted in improved grain yield. It aided in the capture of all necessary nutrient elements required for plant growth, resulting in increased tillering and grain filling. Wider spacing and less competition for light, nutrients, and water under the SRI method allowed the plants to grow vigorously and helped to utilize the essential nutrients, important for plant growth and development, which led to higher grain and straw yield, which may have contributed to increasing rice productivity under saturation [6]. Low growth and production of rice were the results of insufficient and unbalanced plant nutrients interfering with regular operations. Additionally, significantly greater grain and straw yield was observed in RDN (75 percent N inorganic + 25 percent N through PM + Azospirillum SI) (N4) which is 20% more grain and 11% more straw yield as compared to RDN (100% N inorganic). A vigorous vegetative growth-enhancing enhancing plant height, the total number of tillers/hills, the total number of productive tillers/hills, number of panicles/hills, and dry weight under application of inorganic and organic manure along with biofertilizer could result in an increase in grain and straw yield of rice. Improved growth, which led to enhanced output and yield characteristics with increased N fertilizer efficiency in rice, was a major factor in integrated systems of organic and inorganic nutrient management [11]. Organic matter in the soil is particularly significant for improving rice nutrient absorption as well as soil fertility [12,13].

4. CONCLUSION

Thus, it can be concluded that the greatest choice for increasing the productivity and profitability of SRI is cultivated rice without endangering soil health. It is advised that the application of RDN (75 percent N inorganic + 25 percent N through PM) was found to be beneficial for the rice growers of Eastern Uttar Pradesh, India.

FUTURE SCOPE

Innovation and greater crop productivity improvement are needed to meet the continuous rising food demand of expanding human population and the need for eco-friendly agricultural development techniques. There is growing evidence that SRI principles and practices can provide a strategy for sustainable agriculture in India and elsewhere when paired with nutritional sources through, Integrated Nutrient Management. To help farmers, and development of viable techniques to increase rice yields with less reliance on inputs, this research examines prospects for enhancing agricultural production and food security while reducing the negative effect on soil and the environment.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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