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Tillers dynamics and yield of rice (*Oriza sativa* L.) as influenced by different transplanting method and nitrogen management practices

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Abstract
A field experiment was carried out during the *kharif* seasons of 2018 and 2019, at Crop Research Farm (CRF), Department of Agronomy, NAI, SHUATS, Prayajraj, U.P. In order to compare the effects of three different transplanting techniques—manual transplantation of 14-day-old seedlings, mechanized transplanting of 14-day-old seedlings, and transplanting of 21-day-old seedlings (SRI) and seven nitrogen management practices *viz*. 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) N application a based-on target Yield. The experiment was set up using a split plot design, with a main plot consisting of three planting techniques and seven nitrogen management techniques as sub plots that were replicated thrice. During both of the experiment's years, manual transplantation of 14-day-old seedlings (SRI) resulted in considerably greater growth parameter, yield, and yield attributes while being equivalent to other planting techniques. Comparable to the application of RDN (75 percent N inorganic +25 percent N through PM), RDN (75 percent N inorganic+25 percent N through PM+ *Azospirillum* SI) produced significantly higher growth and yield parameters.

Keywords: Method of transplanting, nitrogen management, system of rice intensification, growth and yield

Introduction
One of the most significant cereal crops is rice (*Oriza sativa* L.), which is used as a main diet by more than 70% of the world's population. The early stand and uniformity of rice are significantly impacted by the transplanting technique. Although transplanting rice is thought to be the best practise for increasing crop output, it is not very profitable because to greater labour costs and issues with labour shortages during the busiest times of operation. To get over these issues, it may be necessary to investigate other alternatives as SRI and mechanized transplanting under puddles (Uphoff and Randriamiharisoa, 2002) [12]. SRI has been suggested as a workable method of increasing rice harvests. Studies by Husain *et al.* (2004) [5] and Namara *et al*. (2003) [8] showed that SRI increased yields by 30percent in Bangladesh and by 44 percent in Sri Lanka. It is crucial to develop methods for increasing rice yield while using less water, fewer inputs, and a production system that is favourable to the environment.

Achieving the best crop yield, quality, environmental safety, and financial returns depends on the effective use and control of nitrogen in agricultural production. Nitrogen (N) is a necessary input for achieving high output in the majority of rice soils. Application of nitrogen can aid to strengthen the root system, making it easier for nutrients and water to be absorbed. In order to increase production potential and maintain photosynthetic activity throughout the grain-falling stage of the crop, nitrogen is crucial, according to Yoshida (2004) [13]. Because of nutrient deficiencies brought on by the continuous and uneven use of inorganic fertilisers, productivity declines or plateaus. Long-term fertiliser trials showed that combining inorganic and organic sources of nutrients such farmyard manure, press mud, and crop residues is the only way to ensure the long-term viability of the rice. Prudent application of chemical fertilisers in conjunction with organic manures is crucial to improving soil health and ensuring sustained output. According to Shekar *et al.* (2009) [9] the use of organic manures in addition to organic fertilisers boosted rice yield. The most efficient method for preserving a healthy, sustainable soil system and increasing crop yield is probably integrated nutrient management, which involves applying both organic and inorganic fertilisers at the same time (Kumar *et al.*, 2020) [6]. A combination of chemical and organic fertiliser treatments must be employed to enhance the physical properties of the soil and give essential plant nutrients for best production. However, research including the integrated use of fertilisers and manures is necessary in order to achieve sustainable crop production without lowering soil fertility. In light of the aforementioned, the current study was conducted.

Material and Method

The current experiment was conducted at the Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj, during the *Kharif* seasons of 2018 and 2019. (U.P.). The experiment is conducted at a height of 98 metres above mean sea level, which is located at 25 24'42" N latitude and 81 50'56" E longitude. This location lies along the Rewa Road on the right side of the Yamuna River, about 6 km from Prayagraj city. During the first and second years of the experiment, the soil at the experimental site had a sandy loam texture class, a pH of 7.3 and 7.3, an EC of 0.23 and 0.34 dS/m an organic carbon content of 0.42 and 0.34 percent, and available N and P concentrations of 180.6 and 189.9 kg/ha, 3.6 kg/ha, and 240.1 kg/ha, respectively. The current study's split-plot design (SPD) included 21 treatments and three replications. 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).

An implement pulled by a tractor was used to harrow, disc, and level the experimental field. The field was appropriately levelled after being twice puddled with a disc harrow and a puddler. In the instance of farmer practise, seedlings were transplanted at 21 days old; as part of the treatment, seedlings at 14 days old were transplanted mechanistically and in an SRI. Raised nursery beds of both standard and SRI design, measuring 10 m by 1 m by 0.15 m (length, width, and height), were prepared with a 30centimetre space between each bed. For mechanical transplanting, seedlings are sown on a thin layer of soil and organic manure in 30 cm 60 cm trays (mats of seedlings) that fit into the planting trays of the transplanter. Nitrogen @ 120 kg/ha was applied as per the different N management practice treatment. A basal dose of phosphorus, potassium, and zinc sulphate was administered. After the border rows were taken out, the net plots (1m2) were harvested, tied, and labelled before being left in the field for two to three days to dry. After weighing the entire amount of product from each plot, the threshing process was done manually. The grain weight of each plot was measured at 14 percent moisture after thorough cleaning and winnowing. According to the normal formula analysis process, the data pertaining to each experiment parameter were statically analysed, (Gomez and Gomez, 1984).

Result and Discussion

Growth attributes

During both years of the experiment, manual transplanting of 14-day-old seedlings (SRI) recorded significantly maximum plant height (88.66 and 94.80 cm), and dry weight (40.90 and 45.14 g/plant) followed by mechanized transplanting of 14-day-old seedlings (M3). This might also be the result of an improved establishing technique, early seedlings, and wider spacing, which encourages the growth of more tillers (Mahajan *et al.*, 2017) [7]. A robust and deeper root system is encouraged when younger seedlings are carefully transplanted by keeping the roots upright (ensuring that the roots do not acquire a "J" shape), leading to more prolific and taller plants in SRI. The same outcome was also observed by Shekhar *et al*. (2009) [9]. The plant height in SRI was significantly higher than in mechanised transplantation (MT) and conventional transplantation (CT). This might be due to SRI's greater spacing, which makes more space, sunlight, and nutrients available (Thakur *et al*., 2010) [11]. During the two years of the experiment, significantly, maximum height (84.83 and 91.61), and dry weight (40.09 and 45.14 g/ha) were recorded with application of RDN (75 percent N inorganic + 25 percent N through PM + *Azospirillum* SI) (N4). In both years of the experiment, there was no interaction between the nitrogen management strategies and the transplanting method that affected the growth attributes of the rice plants or the number of tillers per running row metre.

Yield attributes and yield of rice

An in-depth analysis of mean yield attributes and grain yield data revealed that the transplanting techniques significantly influenced grain attributes and grain yield in both the years of experiment. The significantly highest number of effective tillers per square meter (285.22 and 239.87), filled grain/panicles (130.39 and 122.20 cm), length of panicle (30.10 and 29.55 cm) and grain yields (4.81 t/ha and 4.46 t/ha) respectively, were notably achieved by manual transplanting of 14-day-old seedlings (SRI) (M3), However, mean results also show that during the second year of the experiment, Manual transplantation of 14 days old seedlings (SRI) (M3) was determined to be equivalent to Mechanized transplanting of 14 days old seedlings (4.20 t/ha) (M3) in terms of grain yield, respectively. Strategies for nitrogen management significantly affected grain yield. Application of RDN (75 percent N inorganic
+ 25 percent N through PM + *Azospirillum* SI) (N4) recorded significantly highest number of effective tillers per square meter (282.77 and 234.25), filled grain/panicles (117.68 and 114.23cm), length of panicle (30.64 and 30.15 cm) and grain yields (4.81 t/ha and 4.46 t/ha) over the years of the experiment when compared to all other nitrogen management treatments. The results also demonstrate that nitrogen management practises alone have less of an effect on rice grain output than the interaction effect of nitrogen management practises at various transplanting procedures. The SRI method has the potential to produce 16.6 percent more grain yield than conventional transplanting due to increased grain yield characteristics and total biomass (Singh *et al*., 2013) [10]. A greater amount of soil's nutrients could be absorbed by the plants owing to high root growth under SRI, which increased yield attributes and grain yield of rice. For increasing rice's ability to absorb nutrients and increase soil fertility, organic matter in the soil is especially important

(Gogoi *et al*., 2016) [3]. This information backs up the findings of the current study, which showed that using biofertilizer with inorganic fertilizer and organic manure increased grain output. The advantage of SRI transplanting coupled with integrated nutrient management practices may help to their quick supply of nitrogen during mineralization, resulting in higher N uptake by rice due to higher grain yield. This is because the providential air-moisture percentage prevailed in the field due to SRI.

Table 1: Growth parameter of Rice as influenced by transplanting method and nitrogen management practices

Treatments	Plant height (cm)		Dry weight (G/plant	
	2018	2019	2018	2019
Method of transplanting (M)				
M_1: Transplanting of 21 days old seedlings (farmers practice)	72.27	75.25	32.63	37.09
M_2: Mechanized transplanting of 14 days old seedlings	81.64	87.27	35.55	41.02
M_3: Manual transplanting of 14 days old seedlings (SRI)	88.66	94.80	40.09	45.14
SEm (±)	1.45	1.51	0.75	0.80
CD (P-41.05)	5.04	5.24	2.61	2.76
Nitrogen management practices (N)				
N_1: RDN (100% N inorganic)	79.99	84.68	34.85	38.15
N_2:RDN (75%N inorganic -25%N through PM)	82.54	86.26	38.62	46.08
N^3: RDN (75%N inorganic -25%N through VC)	79.77	85.34	36.00	40.04
N^4 RDN (75%N inorganic -0-25%N through PM + *Azospirillum* SI)	84.83	91.61	42.90	49.18
N^5: RDN (75%N inorganic -25% *N* through VC +*Azospirillum* SI)	80.88	87.24	37.15	43.09
N_6: Leaf Colour Chart (LCC) based N application	78.33	83.02	3133	36.20
N_7: Soil Test Crop Response (STCR) based N application	79.66	82.24	3079	34.84
SEm (±)	1.11	1.74	1.18	1.24
CD (P-41.05)	3.32	5.05	3.40	3.58

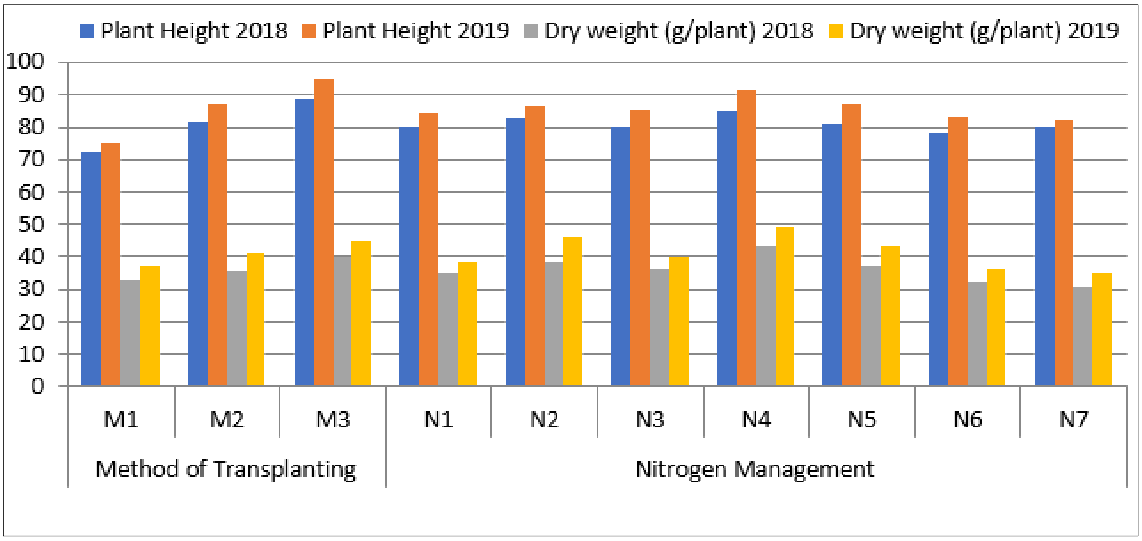

Fig 1: Growth parameter of rice as influenced by transplanting method and nitrogen management practices

Table 2: Yield attributes and yield of rice as influenced by transplanting method and nitrogen management practices

Treatments	Effective tillers/m2 (No.)		Filled grain/panicles (no)		Length of Panicles (cm)		Grain yield (t/ha)	
Method of transplanting (M)	**2018**	**2019**	**2018**	**2019**	**2018**	**2019**	**2018**	**2019**
M1: Transplanting of 21 days old seedlings (farmers practice)	249.89	203.72	98.67	89.25	26.54	25.78	4.11	3.86
	268.96	220.97	111.20	107.91	28.63	27.58	4.43	4.20
M2: Mechanized transplanting of 14 days old seedlings	285.22	239.87	130.39	122.20	29.55	30.10	4.81	4.46
M3: Manual transplanting of 14 days old seedlings (SRI)	2.91	3.34	5.684	3.652	0.19	0.39	0.06	0.10
SEm(±)	10.07	11.57	19.67	12.63	0.67	1.36	0.21	0.33
CD (P=0.05)	268.96	220.97	111.20	107.91	28.63	27.58	4.43	4.20
Nitrogen management practices (N)								
N1: RDN (100% N inorganic)	264.29	218.84	111.92	105.14	28.22	27.01	4.16	3.93
N2: RDN (75% N inorganic +25% N through PM)	277.65	223.67	116.46	112.01	29.35	29.56	4.83	4.57
N3: RDN (75% N inorganic +25% N through VC)	265.40	219.92	111.49	106.05	29.39	27.81	4.50	4.22
N4: RDN (75% N inorganic +25% N through PM +	282.77	234.25	117.68	114.23	30.64	30.15	5.21	4.99
N5: RDN (75% N inorganic +25% N through VC + *Azospirillum* SI)	265.89	220.29	113.48	109.15	29.21	4.47	4.74	27.91
N6: Leaf Colour Chart (LCC) based N application	264.43	218.50	110.25	100.69	26.93	25.35	4.07	3.78
N7: Soil Test Crop Response (STCR) based N	261.74	215.23	112.68	97.90	26.02	26.67	3.62	3.24
application	2.33	3.57	1.64	1.53	0.78	0.91	0.15	0.15
SEm(±)	6.74	10.33	4.75	4.43	2.26	2.66	0.44	0.44
CD (P=0.05)								

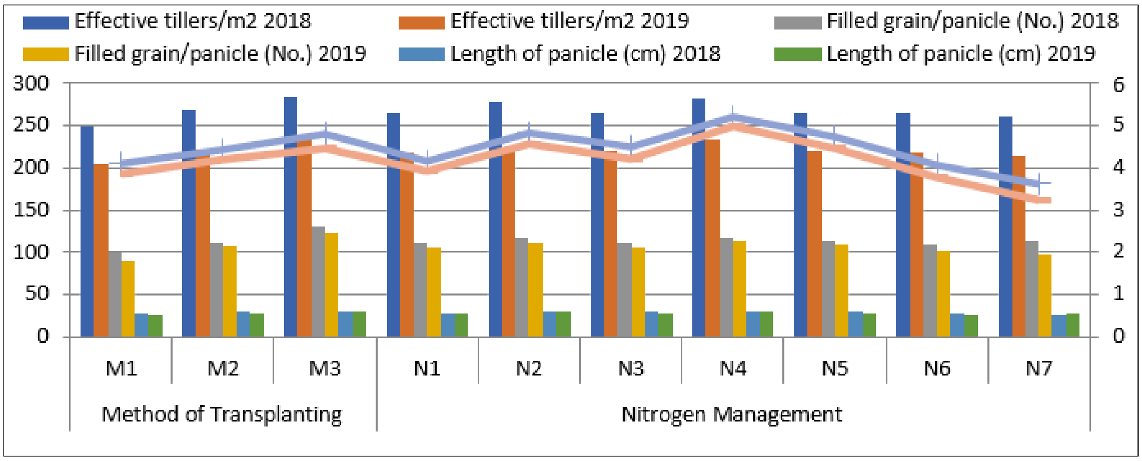

Fig 2: Yield attributes and yield of rice as influenced by transplanting method and nitrogen management practices

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