

Effect of Different Growing Environments on available Macro and Micro Nutrient in soil under Various Establishment Methods

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Abstract

This study investigates the impact of different growing environments on available macro (N, P, K) and micro (Fe, Mn, Cu, Zn) nutrient content in soil under various establishment methods, including transplanted rice (TP), direct seeded rice (DSR), and system of rice intensification (SRI). The results showed that different rice establishment methods significantly affected the available macro and micro nutrient content in the soil. TP generally had higher available N and P content, while control had higher K content. Among micro nutrients, DSR had higher Fe and available Zn content, while SRI had higher available Mn content. The nutrient content varied significantly across different soil depths and treatments. The study highlights the importance of considering the nutrient dynamics in different rice establishment methods to optimize crop productivity and soil health.

Key Words: Rice establishment methods, Macro nutrients, Micro nutrients, Nitrogen, Phosphorus, Potassium, Iron, Manganese, Copper, Zinc, Soil depth

Introduction

Rice is a staple food for more than half of the world's population, and its production is crucial for ensuring global food security. With the increasing demand for rice, different establishment methods have been adopted to improve crop productivity and reduce production costs. These methods include transplanted rice (TP), direct seeded rice (DSR), and system of rice intensification (SRI). Each of these methods has its own advantages and disadvantages, and their impact on soil nutrient dynamics can vary significantly.

Soil nutrients play a critical role in determining crop productivity, and their availability can be influenced by the type of establishment method used. Macro nutrients such as nitrogen (N), phosphorus (P), and potassium (K) are essential for plant growth and development, while micro nutrients like iron (Fe), manganese (Mn), copper (Cu), and zinc (Zn) are also crucial for various physiological processes in plants. The availability of these nutrients can be affected by factors such as soil type, pH, and organic matter content, as well as the type of establishment method used.

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Understanding the impact of different establishment methods on soil nutrient dynamics is essential for optimizing crop productivity and maintaining soil health. This study aims to investigate the effect of different growing environments on macro and micro nutrient content in rice under various establishment methods, including TP, DSR, and SRI. The findings of this study will provide valuable insights into the nutrient dynamics of different rice establishment methods and will be useful for developing sustainable and efficient rice production systems.

Materials and Methods

Experimental Site

A field experiment was conducted at the ICAR-Indian Institute of Rice Research farm during the Kharif season of 2024 on deep black clayey vertisols (Typic Pellustert) at the IIRR Rice Research farm, Hyderabad (17°19' N latitude, 78°23' E longitude, 542 m altitude with mean annual precipitation of 750 mm). The plot selected for the purpose was A-3, A-5, and B-7. The plot's detailed characteristics are given in the table. Initial and post-harvest soil samples were collected prior to the beginning of the studies and are depicted in the table. All agronomic parameters under different rice establishment methods were recorded.

Experimental Design

The research was designed in a Randomized Block Design (RBD), arranged in three replications and treatments included the growing environment of rice which is transplanted, puddled rice. And three replications and four treatments (Control, TP, SRI and DSR) for the field A3 (a) & for B7 (a) field.

Soil Sampling and Analysis

Soil samples from 0-20, 20-40, and 40-60 cm depth were collected in triplicate. Available N, P, K, Fe, Mn, Cu and Zn parameters, soil samples that passed through 2-mm sieves were used. available N by alkaline-KMnO₄ oxidizable N method (Subbiah and Asija, 1956), available P by 0.5 M sodium bicarbonate (NaHCO₃) extraction method (Olsen et al., 1954), available K (Hanway and Heidel, 1952) and Available Fe, Mn, Cu and Zn by DTPA method (Lindsay and Norvell, 1978).

Results and Discussion

The study evaluated the effect of different growing environments on available N, P, K, Fe, Mn, Cu, and Zn content in rice under various establishment methods. The results are presented below:

Available Nitrogen

The available N content in soil was significantly affected by the different establishment methods. Transplanted Rice (TP) had the highest available N content in soil at 0-20 cm depths is 269 kg ha⁻¹ (Table 1), while Direct Seeded Rice (DSR) had the lowest available N content at 0-20 cm depth (157 kg ha⁻¹). The available N content decreased with increasing soil depth in TP, while it remained relatively stable in DSR and System of Rice Intensification (SRI). This suggests that TP may have a higher available N rate, leading to a decrease in available N content with depth. Previous studies were conducted by Kumar, et al. (2014), Singh, et al. (2014), Amanullah, et al. (2016) and Sharma et al. (2022).

Table 1: Effect of different growing environments on N, P and K (kg ha⁻¹) in different rice establishment methods

Treatments	N (kg ha ⁻¹)			P (kg ha ⁻¹)			K (kg ha ⁻¹)		
	0-20	20-40	40-60	0-20	20-40	40-60	0-20	20-40	40-60
Control	188	145	130	15.4	13.9	11.5	253	225	204
Transplanted Rice (TP)	269	168	106	23.5	19.4	18.3	264	184	168
Direct seeded Rice (DSR)	157	136	132	11.6	10.9	10.2	168	146	156
System of rice Intensification	162	145	130	15.5	14.1	11.7	166	142	112
Sem (±)	5.06	3.80	3.67	1.07	0.78	0.63	5.86	2.27	5.62
CD (0.05)	12.39	9.30	8.99	2.61	1.91	1.55	14.34	12.89	13.75

Available Phosphorus

The available P content in soil was also significantly affected by the different establishment methods. TP had the highest available P content in soil at 0-20 cm depth (23.5 kg ha⁻¹), while DSR had the lowest available P content in soil at 0-20 cm depth (11.6 kg ha⁻¹). The available P content decreased with increasing soil depth in all treatments. This may be due to the fact that P is a relatively immobile nutrient in soil, and its availability decreases with depth. Previous studies were conducted by Anila, et al. (2018) Sharma, et al. (2020), Sharma, et al. (2022) and Indoria, et al. (2024).

Available Potassium

The available K content in soil was highest in the control treatment at 0-20 cm depth (253 kg ha⁻¹), while SRI had the lowest available K content in soil at 40-60 cm depth (112 kg ha⁻¹). The available K content decreased with increasing soil depth in TP and SRI, while it remained relatively stable in DSR. This suggests that available K may be more readily available in the control treatment, while SRI may have a higher available K rate. Previous studies were conducted by Pushpalatha et al. (2015) and Sharma, et al. (2022).

Available Iron

The available Fe content in soil was significantly higher in TP and DSR compared to the control and SRI at 0-20 cm depth (Table 2). The available Fe content in soil decreased with increasing soil depth across all treatments. The available Fe content in soil at the different treatments was as follows: TP: 5.98 mg kg⁻¹ (0-20 cm), 3.60 mg kg⁻¹

(20-40 cm), 1.10 mg kg⁻¹ (40-60 cm). DSR: 5.98 mg kg⁻¹ (0-20 cm), 3.50 mg kg⁻¹ (20-40 cm), 0.90 mg kg⁻¹ (40-60 cm), SRI: 3.08 mg kg⁻¹ (0-20 cm), 1.10 mg kg⁻¹ (20-40 cm), 0.60 mg kg⁻¹ (40-60 cm), Control: 2.32 mg kg⁻¹ (0-20 cm), 1.66 mg kg⁻¹ (20-40 cm), 1.52 mg kg⁻¹ (40-60 cm). Previous studies were conducted by Srilathaa et al. (2019) and Sharma, et al. (2022)

Available Manganese

The available Mn content in soil was significantly affected by the different establishment methods. SRI had the highest available Mn content in soil at 0-20 cm and 40-60 cm depths, while TP had the lowest Mn content in soil at 20-40 cm and 40-60 cm depths. The available Mn content in soil varied significantly across different soil depths and treatments. The available Mn content in soil at the different treatments was as follows: SRI: 7.76 mg kg⁻¹ (0-20 cm), 3.60 mg kg⁻¹ (20-40 cm), 2.80 mg kg⁻¹ (40-60 cm), TP: 6.1 mg kg⁻¹ (0-20 cm), 0.80 mg kg⁻¹ (20-40 cm), 0.20 mg kg⁻¹ (40-60 cm), DSR: 4.66 mg kg⁻¹ (0-20 cm), 1.80 mg kg⁻¹ (20-40 cm), 1.10 mg kg⁻¹ (40-60 cm). Control: 2.92 mg kg⁻¹ (0-20 cm), 1.05 mg kg⁻¹ (20-40 cm), 0.99 mg kg⁻¹ (40-60 cm). Previous studies were conducted by Pushpalatha et al. (2015) and Sharma, et al. (2022).

Available Copper

The available Cu content in soil was significantly higher in DSR compared to other treatments at 0-20 cm and 20-40 cm depths. The available Cu content in soil decreased with increasing soil depth in all treatments. The available Cu content in soil at the different treatments was as follows:

Table 2: Effect of different growing environments on Fe, Mn, Cu and Zn (mg kg⁻¹) in different rice establishment methods

Treatments	Fe (mg kg ⁻¹)			Mn (mg kg ⁻¹)			Cu (mg kg ⁻¹)			Zn (mg kg ⁻¹)		
	0-20	20-40	40-60	0-20	20-40	40-60	0-20	20-40	40-60	0-20	20-40	40-60
Control	2.32	1.66	1.52	2.92	1.05	0.99	1.64	0.80	0.30	3.76	1.10	0.90
Transplanted Rice (TP)	5.98	3.60	1.10	6.1	0.80	0.20	4.76	1.10	0.90	7.48	2.30	1.90
Direct seeded Rice (DSR)	5.98	3.50	0.90	4.66	1.80	1.10	5.80	3.60	1.20	7.82	3.69	2.80
System of rice Intensification	3.08	1.10	0.60	7.76	3.60	2.80	1.46	0.80	0.40	3.48	1.88	1.10
Sem (±)	0.18	0.12	0.05	0.25	0.08	0.05	0.16	0.07	0.04	0.26	0.11	0.08
CD (0.05)	0.39	0.23	0.10	0.51	0.17	0.11	0.32	0.16	0.07	0.53	0.22	0.16

DSR: 5.80 mg kg⁻¹ (0-20 cm), 3.60 mg kg⁻¹ (20-40 cm), 1.20 mg kg⁻¹ (40-60 cm). TP: 4.76 mg kg⁻¹ (0-20 cm), 1.10 mg kg⁻¹ (20-40 cm), 0.90 mg kg⁻¹ (40-60 cm). Control: 1.64 mg kg⁻¹ (0-20 cm), 0.80 mg kg⁻¹ (20-40 cm), 0.30 mg kg⁻¹ (40-60 cm)- SRI: 1.46 mg kg⁻¹ (0-20 cm), 0.80 mg kg⁻¹ (20-40 cm), 0.40 mg kg⁻¹ (40-60 cm). Previous studies were conducted by Pushpalatha et al. (2015), Sharma. et al. (2022)

Available Zinc

The available Zn content in soil was significantly higher in DSR compared to other treatments at 0-20 cm and 20-40 cm depths. The available Zn content in soil decreased with increasing soil depth in all treatments. The available Zn content in soil at the different treatments was as follows: DSR: 7.82 mg kg⁻¹ (0-20 cm), 3.69 mg kg⁻¹ (20-40 cm), 2.80 mg kg⁻¹ (40-60 cm), TP: 7.48 mg kg⁻¹ (0-20 cm), 2.30 mg kg⁻¹ (20-40 cm), 1.90 mg kg⁻¹ (40-60 cm), SRI: 3.48 mg kg⁻¹ (0-20 cm), 1.88 mg kg⁻¹ (20-40 cm), 1.10 mg kg⁻¹ (40-60 cm), Control: 3.76 mg kg⁻¹ (0-20 cm), 1.10 mg kg⁻¹ (20-40 cm), 0.90 mg kg⁻¹ (40-60 cm). Previous studies were conducted by Srilatha et al. (2019), Lal, et al. (2020) and Sharma. et al. (2022).

Conclusion

The study evaluated the effect of different growing environments on available macro and micro nutrient content in soil at different soil depths under various rice establishment methods. The available nutrient content in soil varied significantly across different soil depths and treatments. These findings have important implications for optimizing crop productivity and maintaining soil health in rice-based systems.

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