



Evaluating the effect of integrated nutrient management on yield, economics and post-harvest nutrient status of transplanted rice (*Oryza sativa* L.)

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Abstract

A field experiment was carried out in the Experimental Farm, Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Cuddalore district, Tamil Nadu, India during June to September, 2023 (Kuruvai) to investigate the the impact of application of organic manures and inorganic fertilizers with the foliar spray of panchagavya on the yield, economics and post - harvest nutrient status of rice (*Oryza sativa* L.). The experimental design was a Randomized Block Design (RBD) with nine treatments and three replications. The treatments are T₁ - Control (no NPK); T₂ - 75% RDF+ FYM @ 12.5 t ha⁻¹ + 3% Panchagavya foliar spray @ AT, PI & 50% flowering; T₃ - 75% RDF + Vermicompost @ 5 t ha⁻¹ + 3% Panchagavya foliar spray @ AT, PI & 50% flowering; T₄ - 75% RDF + Green leaf manure @ 6.25 t ha⁻¹ + 3% Panchagavya foliar spray @ AT, PI & 50% flowering; T₅ - 75% RDF + Pressmud @ 6 t ha⁻¹ + 3% Panchagavya foliar spray @ AT, PI & 50% flowering; T₆ - 50% RDF + FYM @ 12.5 t ha⁻¹ + 3% Panchagavya foliar spray @ AT, PI & 50% flowering; T₇ - 50% RDF + Vermicompost @ 5 t ha⁻¹ + 3% Panchagavya foliar spray @ AT, PI & 50% flowering; T₈ - 50% RDF + Green Leaf manure @ 6.25t ha⁻¹ + 3% Panchagavya foliar spray @ AT, PI & 50% flowering; T₉ - 50% RDF + Pressmud @ 6 t ha⁻¹ + 3% Panchagavya foliar spray @ AT, PI & 50% flowering had significant effect on yield, economics and post-harvest nutrient status of transplanted rice.

Keywords: FYM, Vermicompost, Green leaf manure, Pressmud, Panchagavya, post harvest-nutrient status

Introduction

Rice (*Oryza sativa* L.) is a staple food for over half the world's population, particularly in Asia, where 90 per cent of global production and cultivation occur. Its widespread cultivation and consumption have earned the title as a "global grain". In India, the world second-largest rice producer after China, faces significant challenges in meeting the increasing demand for rice while addressing environmental concerns (Jehangir *et al.*, 2022) [3]. In India, 47.83 million hectares are used for rice cultivation, with a production of 135.75 million tonnes of grain annually and 2.8 t ha⁻¹ of productivity (MAFW, 2023) [5].

Conventional farming practices often generate relatively steady crops, but overuse of synthetic chemical pesticides and fertilizers can lead to serious environmental and socio economic problems as well as health concerns for humans. One of the most crucial elements of the production technology to maintain crop productivity and soil fertility is integrated nutrient management. Utilizing both organic and inorganic plant nutrition sources

simultaneously increased field crop productivity and profitability while preserving the soil's fertility. It has been demonstrated that using both organic and inorganic nutrition sources together is preferable than using either one alone for integrated nutrient management. Even while fertilizers have significantly increased agricultural output nation wide, ongoing uneven fertilizer application has led to a decline in soil health (Prasath *et al.*,2023) ^[7].

Integrating NPK (nitrogen, phosphorus, potassium) fertilizers and organic manures of FYM, pressmud, Green leaf manure and vermicompost with foliar spray of panchagavya in rice cultivation represents a multifaceted strategy to enhance soil health, increased crop yield, and ensure nutrient efficiency. By combining these elements, rice cultivation can achieve a good balanced nutrient profile, improved soil fertility and greater resilience against nutrient deficiencies, leading to increased productivity and sustainability.

Materials and methods

A field study was carried out during June 2023 - September 2023 at the Experimental Farm, Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Cuddalore District, Tamil Nadu. The experimental farm is situated at 11° 24' N latitude and 79° 44' E longitude and an elevation of + 5.79 m above Mean Sea Level (MSL). The experimental was laid out in RBD with nine treatments and replicated thrice. The treatments are T₁ - Control (no NPK); T₂ - 75% RDF + FYM @ 12.5 t ha⁻¹ + 3% Panchagavya foliar spray @ AT, PI & 50% flowering; T₃ - 75% RDF + Vermicompost @ 5 t ha⁻¹ + 3% Panchagavya foliar spray @ AT, PI & 50% flowering; T₄ - 75% RDF + Green leaf manure @ 6.25 t ha⁻¹ + 3% Panchagavya foliar spray @ AT, PI & 50% flowering; T₅ - 75% RDF + Pressmud @ 6 t ha⁻¹ + 3% Panchagavya foliar spray @ AT, PI & 50% flowering; T₆ - 50% RDF + FYM @ 12.5 t ha⁻¹ + 3% Panchagavya foliar spray @ AT, PI & 50% flowering; T₇ - 50% RDF + Vermicompost @ 5 t ha⁻¹ + 3% Panchagavya foliar spray @ AT, PI & 50% flowering; T₈ - 50% RDF + Green Leaf manure @ 6.25 t ha⁻¹ + 3% Panchagavya foliar spray @ AT, PI & 50% flowering; T₉ - 50% RDF + Pressmud @ 6 t ha⁻¹ + 3% Panchagavya foliar spray @ AT, PI & 50% flowering. A short duration rice variety ADT 43 was selected for the study with a seed rate of 60 kg ha⁻¹. Organic manures of FYM, pressmud, vermicompost and Green leaf manure were applied as a basal in the field.

The data for yield viz., grain and straw yield and economics were computed. And also the post-harvest nutrient status were also analyzed. Standard agronomic practices were adopted. The experimental crop was harvested plot wise leaving the border rows to avoid border effect. Grains were separated by hand threshing, cleaned and sun dried to bring the moisture content to 14 per cent and the weight of grain and straw were recorded and expressed as kg ha⁻¹. Additionally, the weight of the dried straw was measured and recorded in kg ha⁻¹. Post-harvest soil samples were collected randomly from the experimental fields to a depth of 15 cm and then pooled together. To assess the available nutrient content, composite soil samples were dried, ground into a fine powder, and sieved through a 2 mm mesh.

The various growth and yield parameters observed during the study were analyzed statistically using the methods outlined by Gomez and Gomez (1984) ^[2]. Significant differences between treatments were determined using the 'F' test at a 5% probability level (P=0.05), and the critical difference (CD) was calculated accordingly. Non-significant treatment differences were indicated by 'NS'.

Result and Discussion

Yield

The data revealed that the application of 75% RDF + Vermicompost @ 5 t ha⁻¹ + 3% Panchagavya foliar spray @ AT, PI and 50% flowering (T₃) was the most effective treatment. This treatment resulted in the highest grain yield (5625kg ha⁻¹) and straw yield (8428 kg ha⁻¹) at harvest (Table 1). Increase in the grain and straw yield of rice was obtained by the integrated use of different organic and chemical fertilizers might be increased the vegetative growth of plants as well as higher availability of essential nutrients and also occurrence of different beneficial microorganisms. Presence of growth promoting substances, hormones, enzymes, and antibiotics in vermicompost. Further it also increased due to the availability of nutrients for a shorter period as mineralization of nitrogen is

more rapid. These findings were collaborated with the findings of Mahmud *et al.* (2016) ^[6] and along with the foliar spray of panchagavya which contains most of the macro and micro nutrients that create favourable condition for the crop growth and development that ultimately resulted in increasing yield of a crop. Also, combination of panchagavya and vermicompost increased the microbial activity of soil system and enhance the crop yield. These findings were already supported by Das (2021) ^[1].

Increase in the straw biomass from combined application of organic and inorganic fertilizer is attributed due to the presence of adequate amounts of both nitrogen and soil moisture that increases accessibility and uptake of NH_4^+ . Increase in nitrogen absorption goes along with absorption of both phosphorus and potassium. which promotes the straw yield of the rice. This findings were already confirmed by the findings of Sci *et al.* (2018) ^[8].

Economics

The study demonstrated a significant disparity in economics of the crop examined across various nutrient management practices (Table 2). Among all treatments, the application of 75% RDF + Vermicompost @ 5 t ha⁻¹ + 3% Panchagavya foliar spray @ AT, PI and 50% flowering (T₃) emerged as the optimal practice. This treatment resulted in the highest gross returns (Rs.134962 ha⁻¹), net returns (Rs.77644 ha⁻¹) and BCR (2.35). The optimal treatment led to better economic performance because the synchronized release and efficient use of nutrients from both organic and inorganic sources significantly enhanced the crop yield. This, combined with effective agronomic practices, further boosted both grain and straw yield, resulting in a higher benefit-cost ratio. Furthermore, foliar application of panchagavya with fertilizer also contributed to the increased yield and, consequently, greater net returns. (Sucharita *et al.*, 2023) ^[9].

Post - harvest nutrient status

Integrated nutrient management significantly influenced post- harvest nutrient status (nitrogen, phosphorus and potassium). The treatment combining 75% RDF + Vermicompost @ 5 t ha⁻¹ + 3% Panchagavya foliar spray @ AT, PI and 50% flowering (T₃) demonstrated the highest post-harvest nutrient status (Table 3). This treatment resulted in highest post-harvest soil available N (242.00 kg ha⁻¹), P (24.08 kg ha⁻¹) and K (270.28 kg ha⁻¹). This is due to the integrated application of inorganic fertilizers, organic manures, and foliar spray of panchagavya significantly improved soil nutrient content and availability, promoting optimal crop growth and nutrient cycling through root exudates. Application of organic manure and chemical fertilizer had an impact of increase in available nitrogen. It could be attributed due to the application of vermicompost that results in greater multiplication of soil microbes which could convert organically bound nitrogen to inorganic form. Similar results were already reported by Kiruthika *et al* (2022) ^[4] and Upadhyay *et al* (2018) ^[10], claiming that chemolithotrophs and autotrophic nitrifiers (ammonifiers and nitrifiers) present in enriched panchagavya or panchagavya that colonised the leaves increased ammonia intake and N supply. The increase in available phosphorus might be due to the fact that application of vermicompost increases organic matter content and microbial activity. Hence, production of organic acids during decomposition of organic matter by microbes which might have solubilized the unavailable forms of phosphorus.

Table 1: Effect of integrated nutrient management on yield of transplanted rice

Treatments	Grain yield (kg ha ⁻¹)	Straw yield (kg ha ⁻¹)
T1- Control (no NPK)	1768	4007
T2- 75% RDF+ FYM @ 12.5 t ha ⁻¹ + 3% Panchagavya foliar spray @ AT, PI and 50% flowering	4883	7526
T3 - 75% RDF+ Vermicompost @ 5 t ha ⁻¹ + 3% Panchagavya foliar spray @ AT, PI and 50% flowering	5625	8428
T4 - 75% RDF+ Green leaf manure @ 6.25 t ha ⁻¹ + 3% Panchagavya foliar spray @ AT, PI and 50% flowering	5188	7827
T5 - 75% RDF+ Presmud @ 6 t ha ⁻¹ + 3 % Panchagavya foliar spray @ AT, PI and 50% flowering	5397	8133
T6 - 50% RDF+ FYM @ 12.5 t ha ⁻¹ + 3% Panchagavya foliar spray @ AT, PI and 50% flowering	3574	6489
T7 - 50% RDF+ Vermicompost @ 5 t ha ⁻¹ + 3 % Panchagavya foliar spray @ AT, PI and 50% flowering	4576	7270
T8 - 50% RDF+ Green leaf manure @ 6.25 t ha ⁻¹ + 3% Panchagavya foliar spray @ AT, PI and 50% flowering	3902	6739
T9- 50% RDF+ Pressmud @ 6 t ha ⁻¹ + 3% Panchagavya foliar spray @ AT, PI and 50% flowering	4267	7005
S.E.D	78.70	103.03
CD (P=0.05)	169.62	221.94

Table 2: Effect of integrated nutrient management on economics of transplanted rice

Treatments	Cost of cultivation (Rs. ha ⁻¹)	Gross returns (Rs. ha ⁻¹)	Net returns (Rs. ha ⁻¹)	BCR
T1 - Control (no NPK)	39570	47852	8282	1.20
T2 - 75% RDF+ FYM @ 12.5 t ha ⁻¹ + 3% Panchagavya foliar spray @ AT, PI and 50% flowering	53881	117998	64117	2.18
T3 -75% RDF+ Vermicompost @ 5 t ha ⁻¹ + 3% Panchagavya foliar spray @ AT, PI and 50% flowering	57318	134962	77644	2.35
T4 - 75% RDF+ Green leaf manure @ 6.25 t ha ⁻¹ + 3% Panchagavya foliar spray @ AT, PI and 50% flowering	54698	124692	69994	2.27
T5 - 75% RDF+ Presmud @ 6 t ha ⁻¹ + 3 % Panchagavya foliar spray @ AT, PI and 50% flowering	56818	130092	73274	2.28
T6 - 50% RDF+ FYM @ 12.5 t ha ⁻¹ + 3% Panchagavya foliar spray @ AT, PI and 50% flowering	55047	90288	35241	1.64
T7 -50% RDF+ Vermicompost @ 5 t ha ⁻¹ + 3 % Panchagavya foliar spray @ AT, PI and 50% flowering	61922	114448	49526	1.79
T8 - 50% RDF+ Green leaf manure @ 6.25 t ha ⁻¹ + 3% Panchagavya foliar spray @ AT, PI and 50% flowering	56682	97192	40510	1.71
T9- 50% RDF+ Pressmud @ 6 t ha ⁻¹ + 3% Panchagavya foliar spray @ AT, PI and 50% flowering	60922	104826	43904	1.72

Table 3: Effect of integrated nutrient management on post-harvest soil available nutrients status of rice

Treatments	Post-harvest soil nutrient (kg ha ⁻¹)		
	N	P	K
T1 – Control (no NPK)	222.56	15.19	251.17
T2 - 75% RDF+ FYM @ 12.5 t ha ⁻¹ + 3% Panchagavya foliar spray @ AT, PI and 50% flowering	238.12	22.33	264.62
T3 - 75% RDF+ Vermicompost @ 5 t ha ⁻¹ + 3% Panchagavya foliar spray @ AT, PI and 50% flowering	242.00	24.08	270.28
T4 - 75% RDF+ Green leaf manure @ 6.25 t ha ⁻¹ + 3% Panchagavya foliar spray @ AT, PI and 50% flowering	239.45	22.91	266.50
T5 - 75% RDF+ Presmud @ 6 t ha ⁻¹ + 3 % Panchagavya foliar spray @ AT, PI and 50% flowering	240.73	23.50	268.41
T6 - 50% RDF+ FYM @ 12.5 t ha ⁻¹ + 3% Panchagavya foliar spray @ AT, PI and 50% flowering	231.94	20.03	257.18
T7 - 50% RDF+ Vermicompost @ 5 t ha ⁻¹ + 3 % Panchagavya foliar spray @ AT, PI and 50% flowering	236.85	21.75	262.73
T8 - 50% RDF+ Green leaf manure @ 6.25 t ha ⁻¹ + 3% Panchagavya foliar spray @ AT, PI and 50% flowering	233.30	20.60	260.90
T9- 50% RDF+ Pressmud @ 6 t ha ⁻¹ + 3% Panchagavya foliar spray @ AT, PI and 50% flowering	234.57	21.17	0.32
S.E.D	0.60	0.23	0.81
CD (P=0.05)	1.26	0.56	1.81

Conclusion

The integrated application of RDF, organic manures and foliar spray of panchagavya in rice cultivation significantly improved yield, economic standard and post-harvest nutrient status. The synergistic interaction of these inputs led to improved soil fertility, nutrient availability, and crop growth, resulting in higher grain and straw yields.

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