emergent
Life Sciences Research

Research Article

Comparative assessment of liquid organic formulations in association with vermicompost on growth attributes and grain yield of Tulaipanji rice (*Oryza sativa* L.)

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Received: 30 December 2024
Accepted: 17 February 2025
Online: 18 February 2025

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Emer Life Sci Res (2025) 11(1): 1-7

E-ISSN: 2395-6658
P-ISSN: 2395-664X

DOI: http://doi.org/10.31783/ELSR.2025.1110107

Abstract

An experiment has been conducted during kharif 2022 and 2023 to see the comparative performance of some liquid organic formulation on growth attributes and grain yield of Tulaipanji. The experiment was fitted out in randomized complete block design, with seven treatments and replicated thrice. Treatment comprising of vermicompost @ 3t ha^{-1} in combination of Sanjivak, Jivamrut, Amrit Pani, Panchgavya and vermicompost tea 20% foliar spray (FS) at 45 days after transplanting (DAT) which was compared with recommended dose (N: P: K= 50:25:25 kg ha^{-1}) and absolute control. Results revealed that during the initial stages of crop growth i.e. 30 DAT, chemically fertilized plot recorded highest plant height (81.85 cm), dry matter accumulation (197.40 g m^{-2}) leaf area index (1.47), chlorophyll index (221.77) and number of tiller m-2 (495.97). Thereafter in the subsequent stages of rice growth, combined application of vermicompost 3 t ha^{-1} and foliar spray of panchgavya 20 % at 45 DAT recorded ominously maximum plant height, dry matter, leaf area and tillers which ultimately helped in producing 0.30 and 0.99 tone more grain yield ha^{-1} as compared to sole application of chemical (100 % RDF) and absolute control plot. Rests of the organic treatments were performed better in terms of growth attributes as well in grain yield over 100 % RDF. Present experimental finding clearly reflects the superiority of vermicompost in combination with panchgavya for sustainable aromatic rice production.

Keywords chlorophyll, dry matter, jivamrut, panchgavya, sanjivak, tulaipanji

Introduction

Rice (*Oryza sativa* L.) is the most vibrant staple food for more than half of the world's population and it plays an important role in upholding food security. The demand for aromatic rice has vividly increased over the past two decades due to a change in consumer's preference for better quality of rice. West Bengal has an extremely rich genetic diversity in aromatic rice. Among them the medium-grained, aromatic cultivar Tulaipanji is particularly well-liked in the domestic market due to its superior qualities and potentiality for international trade. Farmers are losing interest on cultivation of local aromatic rice varieties due to poor agronomic performance, low yields, and sensitivity to environmental factors.

Tulaipanji is adapted in a small pocket of the Uttar Dinajpur district of West Bengal, India. Farmers in the two Dinajpur districts of West Bengal typically grow it with no or little input [1]. Soil and climatic condition of terai region of West Bengal is ideal for growing many aromatic rice as reported by Sinha et al., 2009 [2]. Since inorganic fertilizers tend to lose aroma and other qualitative characteristics, hence farmers were avoiding using of chemical fertilizer. Integrated nitrogen management through organic and inorganic sources was also found beneficial for aromatic rice production [3]. Organic nutrient management is one of many management techniques that is extremely important since it plays a part in the development and growth of the crop as well as the preservation of the soil's health and the quality of the output [4-5]. Liquid organic formulations have largely been overlooked in mainstream scientific literature, with most of the existing knowledge about them concentrated in biodynamic farming resources [6]. Traditional liquid fertilizer in India is known as panchagavya and other Indian liquid manures, like jivamrut and beejamrut, are reportedly used as plant growth promoters rather than as sources of nutrients [7]. These fermented products are used as plant growth promoters and are made by farmers from resources available easily. Therefore, a healthy balance of organic and inorganic nutrient sources is necessary for sustainable rice farming, which can guarantee the production of high-quality food. In this context, a study was undertaken to evaluate the comparative assessment of some organic formulations in association with vermicompost on growth attributes and grain yield of Tulaipanji rice (*Oryza sativa* L.).

Methodology

A field experiment was conducted at the Instructional Farm of Uttar Banga Krishi Viswavidyalaya in Cooch Behar, West Bengal (Terai Zone) during the *kharif* seasons of 2022 and 2023. The farm is located at 26019′86′′ N latitude and 89023′53′′ E longitude, at an elevation of 43 m above mean sea level (MSL) and the land topography is medium low-land. The field was slightly acidic in reaction (pH 6.02), sandy loam in texture having high in organic carbon (0.585 %), low in available nitrogen (181.88 kg ha^{-1}), medium in available phosphorus (18.46 kg ha^{-1}) and high in available potassium (149. 65 kg ha^{-1}). The experiment fitted out in randomized complete block design (RCBD), with seven treatments replicated thrice. Treatments consisted of T1: Vermicompost 3 t ha^{-1}+ Sanjivak 20 % FS at 45 DAT; T2: VC 3 t ha^{-1}+ Jivamrut 20 % FS at 45 DAT; T3: VC 3 t ha^{-1}+ Amritpani 20 % FS at 45 DAT; T4: VC 3 t ha^{-1}+ Panchgavya 20 % FS at 45 DAT; T5: VC 3 t ha^{-1}+ vermicompost tea 20 % FS at 45 DAT; T6: 100 % RDF (N: P: K=50:25:25 kg ha^{-1}) and T7: Absolute control. Tulaipanji was transplanted at a spacing of 25 × 20 cm and having a plot size of 5 m x 4 m. Vermicompost was incorporated into soil 15 days earlier to final land preparations. Standard crop management techniques were followed. Agronomic parameters like dry matter accumulation (g m^{-2}), leaf area index, chlorophyll index and number of tiller m^{-2} at 30 days' interval commencement from 30 days after transplanting (DAT) to 120 DAT. Crop was harvested 7 days after physiological maturity and after proper drying threshing was done to get grain yield in net plot area and then transformed to the t ha^{-1}. All the data collected were subjected statistical analysis using SPSS software version-20.

Results and Discussion

Growth attributes

Plant height (cm)

The plant height of Tulaipanji was measured at various growth stages, ranging from 30 to 120 days after transplanting, and the results are presented in Table 1. Overall, the plant height consistently increased until maturity, regardless of the treatments; however, the highest rate of growth was observed between 30 and 60 days after transplanting. At 30 DAT, significantly tallest plant (81.45 cm) was observed in T6 (100 % RDF) over T1, T2, T3, T5 and T7, while T4 was statistically equal. This was due to better availability of plant nutrients during initial stages of crop growth through

Table 1. Performance of some liquid organic formulation on plant height (cm) and dry matter accumulation at different growth stages of tulaipanji rice (Pooled data over the year)

Treatments	Plant height (cm)				Dry matter accumulation (g m^{-2})			
	30 DAT	60 DAT	90 DAT	120 DAT	30 DAT	60 DAT	90 DAT	120 DAT
T1	76.62	105.89	127.22	146.00	170.63	413.73	725.73	876.70
T2	76.19	100.22	125.55	142.39	168.10	403.33	714.67	866.40
T3	73.82	97.78	122.66	139.72	148.50	374.60	696.20	834.10
T4	77.31	107.77	130.99	150.20	169.97	441.53	738.00	882.33
T5	73.75	98.77	124.78	140.83	148.83	388.60	703.73	841.37
T6	81.45	96.88	121.89	137.55	197.40	358.80	678.67	821.00
T7	69.53	94.78	116.55	132.72	116.93	337.33	584.80	741.77
S.Em. (±)	**1.37**	**1.99**	**1.87**	**1.78**	**13.13**	**19.64**	**16.38**	**16.97**
CD (P=0.05%)	**4.28**	**6.19**	**5.84**	**5.55**	**40.91**	**61.20**	**51.02**	**52.88**

incorporation of 100% recommended dose by inorganic form. From 60 DAT onwards, application of VC 3 t ha-1+ Panchgavya 20 % FS at 45 DAT (T4) performed better and recorded significantly taller plant (107.77, 130.99 and 150.20 cm at 60, 90 and 120 days after transplanting, respectively) as compared to 100% RDF (T6) might be due addition of comparatively higher amount of plant nutrients and steady release of nutrients from vermicompost throughout the growth period as well as bio enhancing effect of panchgavya which helped in cell enlargement and thereby plant height. Noticeable effect of panchgavya on plant height was also reported earlier by Avudaithai et al., [8] and Nagar et al., [9]. Combined application of neem cake, veremicompost, phosphocompost and poultry manure improved plant height in groundnut as reported by Patra and Sinha [10]. Absolute control treatment (T7) recorded significantly shortest plant (69.53, 94.78, 116.55 and 132.72 at 30, 60, 90 and 120 DAT respectively) in all the stages of recording observations due to in sufficient availability of essential nutrient elements for growth.

Dry matter accumulation (g m^{-2})

Dry matter production represents growth and metabolic ability of a plant, which lastly affects the monetary yield. Accretion of dry matter, beside with its real allocating to economically substantial plant parts; holds the important for yield stability. Dry matter accumulation, as affected by liquid organic formulations, was assessed at various growth stages and is presented in Table 1. Initially (30 DAT) treatment having 100 % RDF produced higher dry matter (197.40 g m^{-2}) compared to organically treated plot due to taller plant and larger leaf area achieved by quicker nutrient release ability of inorganic fertilizer. Afterwards, treatment receiving VC 3 t ha^{-1}+ Panchgavya 20 % FS at 45 DAT (T4) proved better in production of dry matter and recorded significantly higher dry matter (441.53, 738 and 882.33 g m^{-2} respectively at 60, 90 and 120 days after transplanting) as compared to treatment with 100 % RDF (T6). All the treatment having vermicompost and liquid organic formulation (T1, T2, T3, T4 and T5) were failed to achieve level of significance. Higher dry matter production was ascribed by balanced supply of necessary amounts of nutrients and also addition of plant growth promoters through vermicompost and Panchgavya which facilitated hasty cell division and expansion. The results corroborate with the earlier findings of Gowtham Chand et al., [11] and Bharadwaj et al., [12]. It is quite obvious that treatment without any fertilizer (T7) was least performer and produced significantly lowest dry matter of 116.93, 337.33, 584.80 and 741.77 g m^{-2} respectively at 30, 60, 90 and 120 days after transplanting.

Leaf area index

It is an important index as leaf surfaces are the principal limit of energy and mass conversation, practices such as canopy interference, transpiration and photosynthesis are unswervingly proportional to it. Leaf area index was measured on 4 instances at 30 days' interval starting from 30 days after transplanting to 120 days after transplanting and presented in Table 2.

Table 2. Performance of some liquid organic formulation on leaf area index and chlorophyll index at different growth stages of tulaipanji rice (Pooled data over the year)

Treatments	Leaf area Index				Chlorophyll index			
	30 DAT	60 DAT	90 DAT	120 DAT	30 DAT	60 DAT	90 DAT	120 DAT
T1	1.38	2.51	3.80	2.88	212.89	176.00	108.22	71.77
T2	1.44	2.48	3.79	2.78	198.33	171.44	98.88	67.44
T3	1.32	2.40	3.72	2.69	203.44	164.55	91.88	62.33
T4	1.44	2.56	3.84	2.96	210.78	178.00	109.66	75.00
T5	1.34	2.43	3.76	2.81	199.89	167.22	94.22	65.22
T6	1.47	2.35	3.71	2.76	221.77	162.78	90.77	62.11
T7	1.04	2.16	3.09	2.33	190.11	157.89	87.44	48.00
S.Em. (±)	**0.05**	**0.03**	**0.05**	**0.10**	**5.81**	**3.19**	**3.22**	**2.93**
CD (P=0.05%)	**0.15**	**0.08**	**0.16**	**0.30**	**18.10**	**9.95**	**10.05**	**9.13**

In general leaf area index increased with the progression of crop growth found maximum at 90 days after transplanting and thereafter dropped towards ripening due to senescence of lower leaves as well as shrinking of leaf area. As like of plant height and dry matter accumulation 100 % RDF was also gave higher leaf area index of 1.47 at 30 DAT, though it was statistically similar with T1, T2, T4 and T5. Leaf area index varied from 2.16 & 2.56, 3.09 & 3.84 and 2.33 & 2.96 at 60, 90 and 120 days after transplanting due to differential nutrient management strategies. At 90 days after transplanting application of VC 3 t ha^{-1}+ Panchgavya 20 % FS at 45 DAT (T4) recorded higher leaf area index of 3.84 which was closely followed by T1 (3.80), T2 (3.79), T5 (3.76), T3 (3.72) and T6 (3.71). Comparatively higher leaf area with organics might be due to sufficient supply as well as better movement of nutrients during crop development stage, which hurried the metabolic and physiological activity of the plant and put up more growth by assimilating added quantities of nutrients and speed up photosynthesis process and thereby larger leaf area. Many researchers [13-16] also reported improved leaf area with organic sources of nutrients in green gram, chickpea and several vegetables.

Chlorophyll index

Chlorophyll (Chl) is a vital photosynthetic stain of the plant, which plays a significant role by catching the solar radiation and transforming it into plant food. Weakening in total leaf chlorophyll content lessens the quantity of sunlight that can be captivated which in turn restricts the efficacy of analogous photosynthetic methods hence dropping primary photosynthetic production. Chlorophyll index was found highest during 30 days after transplanting, thereafter decline with the advancement of crop growth irrespective of treatments (Table 2). At 30 DAT, highest chlorophyll index of 221.77 was achieved with 100 % RDF (T6) which was statistically at par with T1 (212.89) and T4 (210.78). Higher chlorophyll index was mainly due to higher greenness value and better brightness index achieved through readily availability of nutrients from inorganic fertilizer. Thereafter, T4 (VC 3 t ha^{-1}+ Panchgavya 20 % FS at 45 DAT) recorded significantly higher chlorophyll of index 178, 109.66 & 75 at 60, 90 and 120 DAT over T3, T5, T6 and T7. Substantial enhancement of chlorophyll content was also reported by Kumawat et al., [17] in groundnut with foliar application of panchgavya and neem leaf extract. All the organically amended plots showed dominancy over 100 % RDF in the later stages of crop growth (60 DAT onwards) might be due to consistent release of nutrients at desired level.

Number of tillers m^{-2}

Tiller represents to the production of side shoots and is an important agronomic yield deciding characteristic of rice. This permits them to arise multiple stems (tillers) beginning from the mother plant. It controls the extent of plant branching and besides oversees the position of panicle branching. Tillering endorses the expansion of profuse branching and innumerable seed heads and subsequently controls monetary yield of rice. Frequency of tiller production is connected with the numerous elements like available nutrients element, soil moisture, weed rivalry and disease invasions. Hence, it is indispensable to increase the tiller number to achieve the maximum grain yield. Number of tiller sq. m-2 was calculated at 30, 60, 90 and 120 days after transplanting and presented in Figure 1.

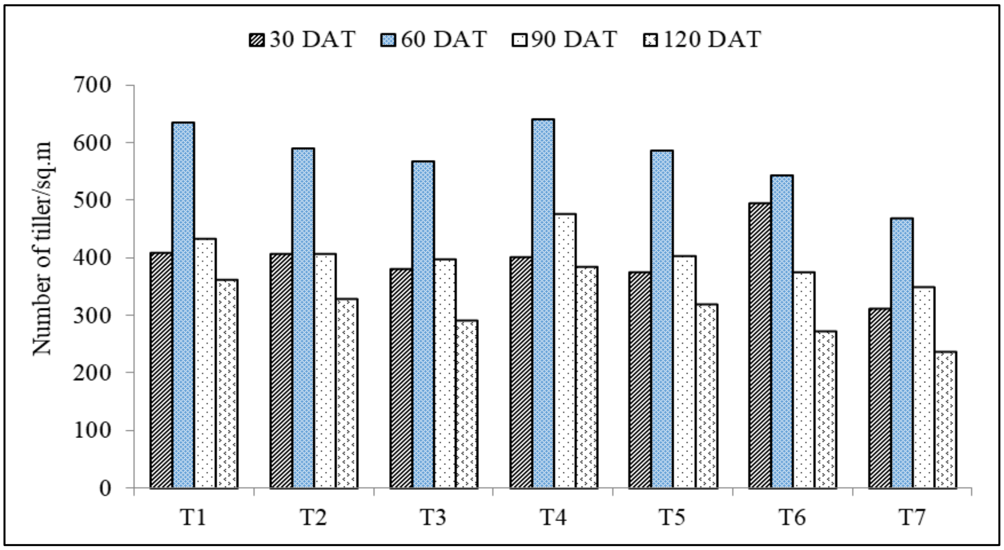

Figure 1. Effect of liquid organic formulations on number of tillers at different growth stages

At 30 DAT, maximum number of tiller (495.97 m^{-2}) was found inT6 (100 % RDF), which was statistically superior over rest of the treatments. In general maximum number of tillers was found at 60 DAT and afterward reduced towards maturity due to death of side tillers irrespective of treatments. At maximum tillering stage (60 DAT) tiller number varied from 468.80 to 642.13 m^{-2}. From 60 DAT onwards treatment receiving 3 t ha^{-1} vermicompost and panchgavya 20 % FS at 45 DAT (T4) produced significantly maximum number of tillers m^{-2} (642.13, 477.73 and 384.33 at 60, 90 and 120 DAT respectively) which was closely followed by 3 t ha^{-1} vermicompost and sanjivak 20 % FS at 45 DAT (T1). All organically amended plots showed dominance over 100 % chemically treated plot might be due to synchronous and balanced supply of nutrients throughout crop growth period along with bio enhancing effect of liquid organic formulations which exerted profound role on tiller production. Patra et al., [18] were also reported superiority of vermicompost in tiller production over FYM and inorganic fertilizers. Plot without inputs (T7) registered significantly lowest tillers m^{-2}. (311.07, 468.80, 348.87 and 237.67 at 30, 60, 90 and 120 DAT) in all the stages of observing record.

Grain yield (t ha^{-1})

Grain yield is influenced by various yield attributes, such as panicle length, number of panicles, grains per panicle, and test weight. The data on grain yield shown in Figure 2, demonstrate significant variation among the different nutrient management techniques. Treatment receiving VC 3 t ha-1+ Panchgavya 20 % FS at 45 DAT (T4) expressively produced highest grain yield of 2.10 and 2.18 t ha-1 respectively during 2022 and 2023 which was followed by T1 with 2.04 & 2.03 t ha^{-1}, T2 with 1.98 & 1.92 t ha^{-1} and T5 with 1.84 & 1.96 t ha^{-1}. In general, organically amended plot performed better in terms of grain yield as compared to 100 % RDF. The favorable response to organic treatments is due to the balanced nutrient supply and their positive effect on soil physical and biological properties, leading to better growth, improved yield attributes, and, ultimately, higher grain yield. Sustainable

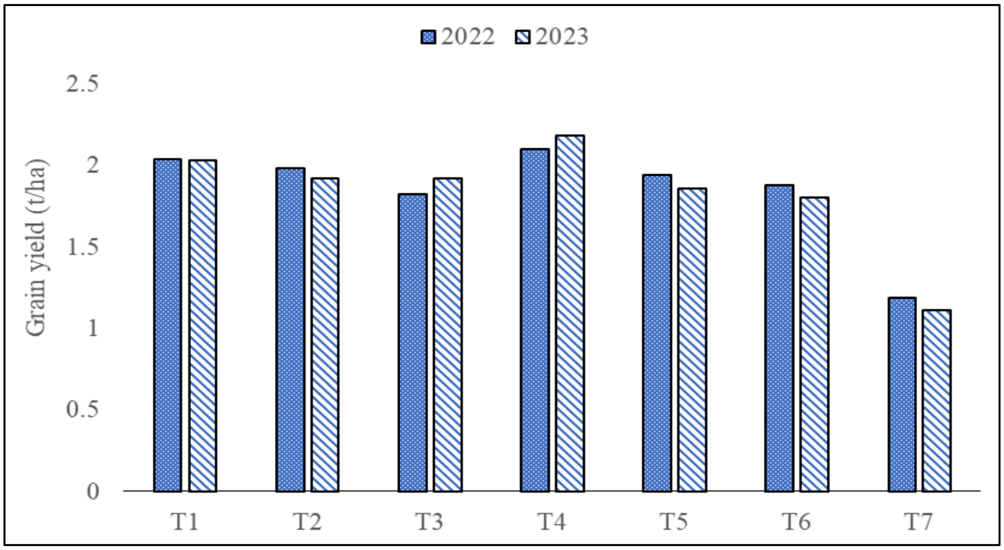

Figure 2. Grain yield of tulaipanji as influenced by liquid organic formulations

grain yield of aromatic rice with the use of organic sources of nutrients were also found by many researchers [18-20]. Combined application of various organic sources of nutrient were found beneficial in increasing yield of buck wheat [21] and groundnut [10]. Absolute control plot produced lowest grain yield of 1.19 and 1.11 t ha^{-1} respectively during 2022 and 2023.

Conclusion

Integration of vermicompost @ 3 t ha^{-1} along with foliar application of 20% Panchgavya, at 45 days after transplanting is found promising organic nutrient management approach for improving the growth and yield of Tulaipanji rice whit out disturbing the quality of soil and environment.

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