



Evaluation of Bio Complementary Organic Nutrient Management Practices on Growth of Rice in Rice Blackgram Cropping Sequence

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INTRODUCTION

Organic farming has assumed importance as an offshoot of environmental concerns in the Western world. The almost total dependence on chemical fertilizers, pesticides, herbicides and growth regulators for enhancing crop productivity, gradually culminated into a situation which necessitated reconsidering the alternative for chemical agriculture gradually developed in the Western world. Energy crisis, higher fertilizer cost, sustainability in agri-production system and ecological stability are the important issues which renewed the interest of farmers and research workers in non-chemical sources of plant nutrients like bio-fertilizers, farmyard manure, green manure, composts etc. Awareness about crop quality and soil health increased the attention of people towards organic farming (Sharma *et al.*, 2008). The organic manures are available in the form of green and dry plant residues, fresh animal wastes, decomposed materials from plants and animal (Palaniappan *et al.*, 1995). Inclusion of a pulse crop in the cropping system is more beneficial than cereals after growing cereals (Kumpawat, 2001). Khatik and Dikshit (2001) indicated that the application of organic manures helped to sustain crop productivity besides maintaining the soil health. Use of manures and biologically active preparations of animal and plant organic was most commonly used by those farmers who aimed for sustainable production in Tamil Nadu (Somasundaram, 2002). Rice-rice-blackgram cropping sequence plays a significant role in food security of India in general and particularly in Tamil Nadu in particular. Hence, suitable organic farming practices have to be evaluated for rice based cropping system to assess the stability in production. Balanced use of nutrients through organic sources like farmyard manure, vermicompost, green manuring, neem cake and bio-fertilizers are prerequisites to sustain soil fertility, to produce maximum crop yield with optimum input level (Dahiphale *et al.*, 2003). At present very scanty information is available on organic farming practices of rice-blackgram cropping sequence to have a sustainable production levels. Therefore, experiments were conducted to develop suitable organic package with different combinations of organic manures for rice-blackgram cropping sequence.

MATERIAL AND METHODS

Field experiments were conducted at farmer's holding at Thoppur village, Thirupparankundram block of Madurai district during *samba* seasons of 2016 and 2017. The geographical location of the experimental field has the reference to is 9.9N latitude, 78°E longitude at an altitude of 101 m above MSL. The average annual rainfall is 874.5 mm. The mean maximum and minimum monthly temperature vary from 37.4°C and 21.6°C, respectively. The soil was sandy loam, slightly alkaline (pH 8.1), low in available nitrogen (262 kg ha⁻¹), medium in P (18.2 kg P₂O₅ ha⁻¹) and high in K (576 kg K₂O ha⁻¹), medium in organic matter content (0.62%). The experiment was laid out in a randomized complete block design with three replications. A total of twelve treatments which includes eleven organic manure combinations and one with blanket recommendation (i.e., inorganic NPK fertilisers). *viz.*, T₁ : Green manure @ 6.25 t ha⁻¹ + neem cake @ 250 kg ha⁻¹, T₂ : Enriched FYM (EFYM) @ 1.0 t ha⁻¹, T₃ : Green manure @ 6.25 t ha⁻¹ + tamarind seed powder @ 100 kg ha⁻¹ + neem cake @ 250 kg ha⁻¹, T₄ : E FYM @ 1.0 t ha⁻¹ + tamarind seed powder @ 100 kg ha⁻¹ + neem cake @ 250 kg ha⁻¹, T₅ : Split application of vermicompost @ 4 t ha⁻¹ (as basal, AT, PI and F) + neem cake @ 250 kg ha⁻¹, T₆ : T₃ + Panchagavya @ 3% as foliar spray twice (PI & F), T₇ : T₄ + Panchagavya @ 3% as foliar spray twice (PI & F), T₈ : T₅ + Panchagavya @ 3% as foliar spray twice (PI & F), T₉ : Green manure @ 6.25 t ha⁻¹ + split application of vermicompost in four equal splits @ 4 t ha⁻¹ (as basal, AT, PI & F) + Panchagavya @ 3%

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ABSTRACT

Field experiments were conducted to develop the suitable organic farming package for rice-blackgram crop sequence. Treatments consisting green manure recorded significantly high number of tillers and highest plant height, dry matter production, root length, root volume and root dry weight over rest of the treatments. The recommended practice also recorded relatively, more number of tillers, leaves hill⁻¹, higher plant height, dry matter production, root length, root volume and root dry weight which is on par with the aforesaid treatment. Therefore the application of green manure @ 6.25 t ha⁻¹ + split application of vermicompost @ 4 t ha⁻¹ in four equal splits (basal, AT, PI & F) + Panchagavya @ 3% as foliar spray twice (AT & PI) can be recommended for adoption in organic cultivation of rice- black gram crop sequence grown organically.

KEYWORDS

Complimentary, Crop sequence, Panchagavya, Vermicompost, Rice

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as foliar spray twice at AT& PI, T₁₀: Organic farmers practice (Multi varietal seed technique +herbal pest repellent spray, T₁₁: Absolute Control (FYM 12.5 t ha⁻¹) along with T₁₂: Control – State recommendation (FYM @ 12.5 t ha⁻¹+ Recommended NPK). The crops were raised under irrigated condition with recommended package of practices. The growth parameters were recorded from the net plot and computed to kg / ha at 14% moisture.

The pre-season green manuring of *Tephrosia purpurea* (L.) Pers. (Kolinji) was incorporated at 51 DAS during 2016 and at 49 DAS during 2017, to neutralize the fertility variation of the experimented field before transplanting of rice. The treatments were imposed only to rice crop and rice fallow blackgram was raised as residual crop. Based on the treatments, required quantities of organic manures were incorporated in the soil one week before transplanting of rice. The P and K were not applied. The rice variety, Co (R) 48 was raised during *samba* 2016 and Co (R) 51 during *samba* 2017 while in summer 2017 and 2018, blackgram variety VBN 6 was raised. The plant protection was done through neem seed kernel extract, Panchagavya and *Pseudomonas fluorescens* culture for organic manure treatments. The recommended NPK fertilizer (control) treatment received full dose of NPK through inorganic fertilizers and plant protection through insecticides. Weeding was done manually.

The growth parameters such as plant height, no of tillers, no of leaves per hill, root length, root volume, root dry weight and dry matter production was recorded in three stages namely active tillering, panicle initiation and flowering and yield was recorded at the time of harvest. The data for the characters studied under various treatments were analyzed statistically using the Agres Software Version 3.01 (1994).

Table 1 : Effect of organic manures on plant height (cm) and number of tillers of rice at different growth stages

Treatments	Samba 2016						Samba 2017					
	Plant height (cm)			Number of tillers/plant			Plant height (cm)			Number of tillers		
	AT	PI	F	AT	PI	F	AT	PI	F	AT	PI	F
T ₁	40.5	52.9	96.8	8.8	16.7	38.6	36.7	51.2	90.5	9.1	15.5	36.7
T ₂	37.3	44.3	84.4	6.7	10.2	33.5	36.7	40.9	78.5	6.8	13.9	31.6
T ₃	41.2	53.2	97.5	11.1	16.7	39.0	39.9	52.5	94.8	9.3	16.6	37.0
T ₄	37.1	45.5	86.3	7.3	10.0	36.3	39.4	42.7	77.9	7.4	14.2	34.7
T ₅	39.4	49.4	91.7	8.7	11.0	37.9	39.8	44.0	88.7	8.9	15.4	35.4
T ₆	40.9	54.3	99.4	8.8	17.1	39.5	42.6	52.1	95.9	11.6	16.8	37.2
T ₇	38.0	46.9	88.7	7.0	10.2	37.5	39.5	43.4	87.3	7.6	14.9	35.3
T ₈	37.9	49.3	91.0	8.5	10.2	37.6	38.4	43.2	86.4	7.9	14.8	35.1
T ₉	43.3	60.9	113.6	11.1	17.4	29.8	43.7	56.7	106.4	11.7	17.5	28.6
T ₁₀	33.3	42.9	81.7	5.2	9.9	32.4	32.0	39.8	72.8	6.2	11.7	31.0
T ₁₁	37.0	40.0	71.8	6.0	9.9	30.9	33.2	38.8	68.3	5.4	9.6	29.2
T ₁₂	45.3	58.6	108.2	12.7	17.2	40.6	43.9	54.6	101.0	12.4	17.0	38.7
SEd	2.49	2.59	3.52	0.43	0.73	1.03	1.85	2.00	3.21	0.52	0.69	0.98
CD (P=0.05)	5.16	5.37	7.29	0.89	1.51	2.13	3.83	4.16	6.66	1.08	1.44	2.02

*AT- Active tillering, PI – Panicle Initiation, F- Flowering

Number of tillers

During *samba* 2016 and 2017, the number of tillers produced was more with green manure @ 6.25 t ha⁻¹ + split application of vermicompost in four equal splits @ 4 t ha⁻¹ as basal, at active

Results and Discussion

Plant height

The plant height was maximum at flowering stage. During *samba* 2016 and 2017, the taller plant height was recorded with green manure @ 6.25 t ha⁻¹ + split application of vermicompost in four equal splits @ 4 t ha⁻¹ as basal, at active tillering, panicle initiation and flowering stages + Panchagavya @ 3% as foliar spray twice at panicle initiation (43.3 and 43.7 cm) and flowering (60.9 and 56.7 cm) stages (T₉), respectively. However it was comparable with T₁, T₃, T₆, T₁₂ at active tillering stage and with T₁₂ during flowering and panicle stage. State recommendation (T₁₂) was found to be the next best in enhancing the plant height during active tillering (45.3 and 43.9 cm), panicle initiation (58.6 and 54.6 cm) and flowering (108.2 and 101.0 cm) stages, respectively in both the years. The absolute control (T₁₁) treatment registered shorter plants (37.0, 40.0 and 71.8 cm during *samba* 2016; 33.2, 38.8 and 68.3 cm during *samba* 2017, respectively) at all the three stages of crop growth (Table 1).

Plant height was highly influenced by green manure incorporation @ 6.25 t ha⁻¹ along with split application of vermicompost in four equal splits @ 4 t ha⁻¹ as basal, at active tillering, panicle initiation and flowering stages and Panchagavya @ 3% as foliar spray twice at active tillering and panicle initiation stages (T₉) had 14.5, 34.3 and 36.8 per cent during *samba* 2016 and 24.0, 31.6 and 35.8 per cent during *samba* 2017 over control respectively at active tillering, panicle initiation and flowering stages. This might be due to organic manures in association with micro-organisms help in synthesis of certain phytohormones and vitamins which promote the growth and development of crops. Findings of Singh and Shivay (2013) strongly support the results obtained from the present study.

tillering, panicle initiation and flowering stages + Panchagavya 3% as foliar spray twice at active tillering and panicle initiation stages (T₉) at active tillering (11.1 and 11.7), panicle initiation (17.4 and 17.5) and flowering (41.8 and 39.6)

stages respectively, which was however on par with State recommendation (T_{12}) and green manure @ 6.25 t ha^{-1} + tamarind seed powder @ 100 kg ha^{-1} + neemcake @ 250 kg ha^{-1} + Panchagavya @ 3% as foliar spray twice at (PI & F) (T_6). State recommendation of NPK fertilizers (T_{12}) recorded significantly higher number of tillers (12.7, 17.2 and 40.6 in *samba* 2016; 12.4, 17.0 and 38.7 in *samba* 2017, respectively) at active tillering, panicle initiation and flowering stages. Absolute control (T_{11}) produced minimum number of tillers (6.0, 9.9 and 30.9 in *samba* 2016; 5.4, 9.6 and 29.2 in *samba* 2017, respectively) at active tillering, panicle initiation and flowering stages (Table 1).

This might be due to enhanced microbial action and consequent plant nutrient supply, polysaccharides and other organic compounds release during decomposition of organic matter that led to increased number of tillers. Hugar *et al.* (2009) also confirmed the above findings. Panchagavya is also known to contain beneficial micro organisms such as *Azospirillum*, *Azotobactor*, *Phosphobacteria* and *Pseudomonas* besides *Lactobacillus* which promotes the plant growth parameters (Yadav and Lourduraj, 2006).

Dry matter production

During both the years of study, the DMP increased steadily with advancement of age, attaining its peak at flowering stage in all the treatments. In *samba* 2016 and 2017, green manure @ 6.25 t ha^{-1} + split application of vermicompost in four equal splits @ 4 t ha^{-1} as basal, at active tillering, panicle initiation and

flowering stages+ Panchagavya @ 3% as foliar spray twice at active tillering and panicle initiation stages (T_9) application recorded higher DMP (1159, 5066 and 9188 kg ha^{-1} ; 998, 4715 and 8604 kg ha^{-1}) at active tillering, panicle initiation and flowering stages, respectively). However it was comparable with state recommendation (T_{12}) and T_9 , T_5 , T_6 at active tillering stage.

The lower dry matter production at all the stages of crop growth period was associated in absolute control (T_{11}) (607, 2346 and 5954 kg ha^{-1} ; 602, 2141 and 5632 kg ha^{-1} respectively). The increased dry matter production than control to the tune of 47.6, 53.7 and 35.2 per cent during *samba* 2016 and 39.7, 54.6 and 34.5 per cent during *samba* 2017, respectively at active tillering, panicle initiation and flowering stages which could be attributed to the continuous slow release of nutrients, which might have enabled the leaf area duration to extend, thereby providing an opportunity for plants to increase the photosynthetic rate which could have led to higher production of biomass thereby, good accumulation of dry matter. Similar results were obtained by Amanullah *et al.*, (2006). Besides these, growth regulatory substances such as Indole acetic acid, gibberellic acid, cytokinin and essential plant nutrients present in Panchagavya (Perumal *et al.*, 2006) might result in improved dry matter accumulation in rice. This was significantly inferior to the dry matter produced with the multi varietal seed technique+ herbal pest repellent spray (T_{10}) during both the years of study (Fig. 1 and 2).

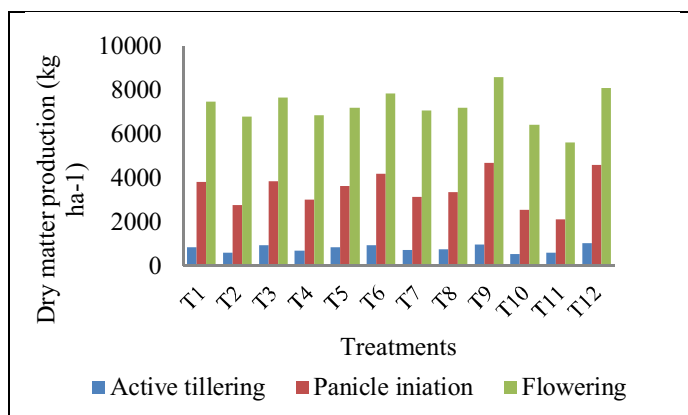


Fig. 1: Effect of organic manures on dry matter production (kg ha^{-1}) of rice at different growth stages (Samba 2016)

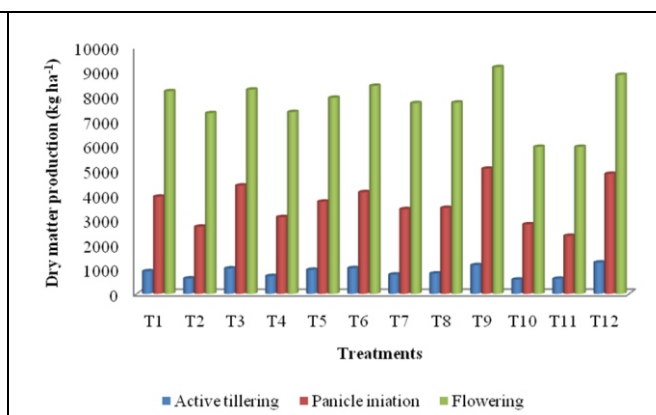


Fig. 2: Effect of organic manures on dry matter production (kg ha^{-1}) of rice at different growth stages (Samba 2016)

Root length

It was found that the root length was significantly influenced by the application of organic manures in both the years throughout the crop growth. During *samba* 2016 and 2017, green manure @ 6.25 t ha^{-1} + split application of vermicompost in four equal splits @ 4 t ha^{-1} as basal, at active tillering, panicle initiation and flowering stages+ Panchagavya @ 3% as foliar spray twice at active tillering and panicle initiation stages (T_9) recorded significantly longer root length (21.8, 36.9 and 35.9 cm; 22.5, 36.5 and 34.3 cm, respectively) at active tillering, panicle initiation and flowering stages and which was however on par with state recommendation (T_{12}) at panicle initiation stage (during *samba* 2017). The decreased root

length (15.5, 21.1 and 20.1 cm in *samba* 2016; 15.8, 22.1 and 22.9 cm in *samba* 2017, respectively) at all the three stages was observed in absolute control (T_{11}) which was comparable with multi varietal seed technique+ herbal pest repellent spray (T_{10}) at flowering stage of *samba* 2017 (Table 2).

Root volume

The root volume increased significantly in the treatment T_9 , viz., green manure @ 6.25 t ha^{-1} + split application of vermicompost in four equal splits @ 4 t ha^{-1} as basal, at active tillering, panicle initiation and flowering stages+ Panchagavya @ 3% as foliar spray twice at active tillering and panicle initiation stages (17.6, 28.2 and $25.7 \text{ cc hill}^{-1}$ in *samba*

Table 2: Effect of organic manures on root length (cm) and root volume (cc hill⁻¹) of rice at different growth stages

Treatments	Samba 2016						Samba 2017					
	Root length (cm)			Root volume (cc hill ⁻¹)			Root length (cm)			Root volume (cc hill ⁻¹)		
	AT	PI	F	AT	PI	F	AT	PI	F	AT	PI	F
T ₁	18.9	30.3	29.6	16.1	26.0	24.4	18.9	30.1	29.3	17.6	25.1	24.4
T ₂	17.9	28.5	26.6	14.5	22.2	21.8	17.8	27.1	26.2	15.4	21.7	23.0
T ₃	19.1	31.5	30.4	16.2	26.1	24.8	19.3	31.3	29.3	18.3	25.6	25.5
T ₄	18.0	28.5	27.0	15.0	23.7	22.5	18.0	28.6	26.3	16.2	21.8	23.2
T ₅	18.7	29.1	28.6	15.8	25.1	23.8	18.7	29.1	27.6	17.6	24.7	24.1
T ₆	19.3	31.9	30.9	16.7	26.7	25.0	19.4	31.6	29.4	18.8	26.0	25.9
T ₇	18.2	28.7	28.2	15.7	24.1	21.2	18.4	28.7	28.0	16.9	23.0	23.2
T ₈	18.4	28.8	28.4	15.8	24.8	23.1	18.6	29.0	28.3	17.1	24.4	23.3
T ₉	21.8	36.9	35.9	17.6	28.2	25.7	22.5	36.5	34.3	19.7	26.5	27.8
T ₁₀	17.2	24.3	23.2	14.1	20.8	20.6	17.1	24.1	22.0	14.3	21.4	20.5
T ₁₁	15.5	21.1	20.1	13.2	17.3	16.6	15.8	22.1	22.9	13.7	16.7	17.4
T ₁₂	20.2	34.3	31.0	17.0	28.0	25.3	19.5	34.9	32.4	19.2	26.3	26.9
SEd	0.44	0.99	0.76	0.47	0.70	0.76	0.62	0.79	0.68	0.49	0.53	0.54
CD (P=0.05)	0.92	1.99	1.57	0.97	1.46	1.58	1.30	1.63	1.41	1.01	1.09	1.12

*AT- Active tillering, PI – Panicle Initiation, F- Flowering

2016; 19.7, 26.5 and 27.8 cc hill⁻¹ in *samba* 2017, respectively) at active tillering, panicle initiation and flowering stages. However it was on par with state recommendation (T₁₂) and green manure @ 6.25 t ha⁻¹ + tamarind seed powder @ 100 kg ha⁻¹ + Neem cake @ 250 kg ha⁻¹ + Panchagavya @ 3% as foliar spray twice at (PI & F) (T₆). In both the years of study, lower root volume was registered (13.2, 17.3 and 16.6 cc hill⁻¹ in *samba* 2016; 13.7, 16.7 and 17.4 cc hill⁻¹ in *samba* 2017, respectively) in absolute control (T₁₁) at all the stages of crop growth and it was on par with multi varietal seed technique+ herbal pest repellent spray (T₁₀) at active tillering stage during both the years of study (Table 2). Similar trend was observed with respect to root dry weight also (Table 3).

Table 3: Effect of organic manures on root dry weight (g hill⁻¹) of rice at different growth stages

Treatments	Samba 2016			Samba 2017		
	AT	PI	F	AT	PI	F
T ₁	1.57	3.17	3.21	1.56	3.07	3.03
T ₂	1.33	2.53	2.56	1.31	2.49	2.46
T ₃	2.03	3.22	3.35	1.62	3.21	3.16
T ₄	1.36	2.73	2.72	1.41	2.64	2.61
T ₅	1.57	3.17	3.19	1.53	3.05	3.02
T ₆	2.07	3.82	3.55	2.05	3.96	3.67
T ₇	1.42	2.98	2.98	1.46	2.70	2.72
T ₈	1.55	3.16	3.15	1.52	2.84	2.85
T ₉	2.19	4.17	3.94	2.15	4.45	4.18
T ₁₀	1.18	2.36	2.40	1.30	2.42	2.32
T ₁₁	1.15	2.29	2.29	1.20	2.05	2.25
T ₁₂	2.07	3.97	3.74	2.08	3.97	3.71
SEd	0.12	0.28	0.28	0.14	0.28	0.28
CD (P=0.05)	0.25	0.59	0.59	0.29	0.57	0.58

*AT- Active tillering, PI – Panicle Initiation, F- Flowering

The root characters are healthier index for vigorous rice plant since it supports the above ground plant parts. The root length, volume and dry weight were greatly influenced by the

application of organic manures. Green manure @ 6.25 t ha⁻¹ + split application of vermicompost in four equal splits @ 4 t ha⁻¹ as basal, at active tillering, panicle initiation and flowering stages + Panchagavya 3% as foliar spray twice at active tillering and panicle initiation stages (T₉) increased the root length, root volume and root dry weight over control with 44.0, 35.4 and 41.9 per cent during *samba* 2016 and 33.2, 37.4 and 46.2 per cent during *samba* 2017, respectively at AT, PTK flowering stages. This might be due to improvement in physicochemical properties of soil favoured by organic manures addition. Improvement in soil aeration and moisture content helps in better nutrient utilization. Reduction in bulk density might have increased root proliferation in organic manures applied plots.

Thus all the growth characteristics such as plant height, number of tillers m⁻², dry matter production and root characteristics were significantly enhanced by organic manure applications. However, application of green manure @ 6.25 t ha⁻¹ + split application of vermicompost in four equal splits @ 4 t ha⁻¹ as basal, at active tillering, panicle initiation and flowering stages + Panchagavya @ 3% as foliar spray twice at active tillering and panicle initiation stages recorded higher values on all the rice growth parameters. The superiority of this treatment is mainly because of improved soil microbial conditions, better nutrient availability in soil coupled with improved chlorophyll content in the leaves. Singh and Agarwal (2001) observed that the increase in leaf number as well as size due to enough nutrition can be explained in terms of possible increase in nutrient absorption capacity of plant as a result of better root development and increased translocation of carbohydrates from source to growing points.

CONCLUSION

From the above discussion it is clear that organic sources of nutrients have a significant influence on overall growth in rice. Green manure @ 6.25 t ha⁻¹ + split application of

vermicompost in four equal splits @ 4 t ha⁻¹ as basal, at active tillering, panicle initiation and flowering stages + Panchagavya@3% as foliar spray twice at active tillering and

panicle initiation stages acquired better growth characteristics besides improving the soil fertility with economic viability for sustainable organic rice production.

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