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Physiological parameters, leaf nitrogen content, nitrogen use efficiencies and grain yield of rice (*oryza sativa* l.) As affected by different sources organic manures in comparison with RDF and INM under site-specific organic farming condition.

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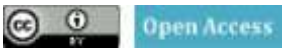

ABSTRACT

Field experiments were carried out at Tamil Nadu Agricultural University, Coimbatore, India during *samba* (August-December) season of 2012 and 2013 to study the effect of different sources of organic manures in comparison with INM and RDF on physiological parameters, leaf nitrogen content and grain yield of rice (*Oryza sativa* L.). The experiment consisted of fourteen treatments which were laid out in Randomized Block Design, replicated thrice and SRI method of planting was adopted during both the years. Among fourteen treatments, four treatments with different organic manures at 100 per cent RDN on equi nutrient basis (farm yard manure, vermi-compost, poultry manure and (Dhaincha) green manure) another six treatments consisted of 50 per cent combination of each manure, one treatment with 1/4th combination of all the manures and one absolute control (without organic or inorganic). These treatments were compared with the recommended dose of fertilizer (RDF) and integrated nutrient management practice (RDF + Dhaincha). The physiological parameters such as LAI, CGR, NAR and SPAD values (leaf nitrogen content) were recorded at critical growth stages of the crop along with grain yield of rice. Different nitrogen use efficiencies such as agronomic efficiency, physiological efficiency apparent nitrogen recovery and harvest index were worked out for the entire cropping period. Higher physiological parameters and grain yield of rice was recorded with the INM practice followed by recommended dose of fertilizers (RDF) treatment. Among the organic treatments, higher grain yield of rice was recorded with 100% RDN through green manure followed by 25% RDN through each organic manures in both the years of study. Similar trend was observed for all the physiological parameters recorded and harvest index of the rice crop.

KEY WORDS

Agronomic efficiency, apparent N recovery and harvest index, CGR , LAI, , NAR, SPAD values, physiological efficiency, Rice grain yield.

INTRODUCTION

Nitrogen is the most limiting nutrient in irrigated rice (*Oryza sativa* L.) production and growers continue to be faced with the challenge of meeting crop N demand particularly in organic production system. The world's arable land resources are finite and there is not much scope for significantly expanding the area of land under cultivation. Hence, most of the increase in agricultural production will have to be obtained through increased productivity from the existing agricultural land. This can be achieved by improved management practices in general and fertilizer management in practices in particular. The problem is compounded by the fact that

majority of the farmers in rainfed area are resources poor with low risk bearing capacity and they generally do not apply recommended dose of fertilizer either organic and inorganic sources. Further, present days, a lot of emphasis is being given by ICAR in identifying organic responsive crops in light of organic agriculture. Keeping these facts in view, the different sources of organic manures in comparison with RDF and INM practices to complete the organic nutrition of rice can be find out. The vermi-compost has been advocated as good organic manure for use in integrated management practices in the field crops particularly on rice. Use of vermi-compost as a biofertilizer and substitute for chemical fertilizer is advised by pioneers of organic farming [1]. Vermi-compost would not only increase organic carbon status of the soils but also increase the soil water holding capacity. Flocculation of soil and availability of all micro and macro nutrients , thus making the soil and crop production sustainable one [2]. Addition of FYM and other organic manures improves the soil physical properties such as soil structure, reduces compaction and crusting of soil. It increases N_2 fixation by micro organisms [3]. Thereafter, the present investigation was undertaken to find out the effects of different sources of organic manures in comparison with RDF and INM practices on physiological parameters, leaf nitrogen content and grain yield rice for promoting site-specific, organic rice farming in Western agro-climatic zone of Coimbatore.

MATERIALS AND METHODS

Field experiments were carried out at Wetland Farms of "O" block at Tamil Nadu Agricultural University, Coimbatore, India during *Samba* (August-December) season of 2012 and 2013. Coimbatore is situated in the Western agro-climatic zone of Tamil Nadu at 11^{o}N latitude and 77^{o}E longitude and at an altitude of 426.7 m above mean sea level. The soil of the experimental field was clay loam in texture belonging to *Typic Haplustalf* with the initial analysis of the soil of the experimental site revealed that the soil was slightly alkaline (pH= 8.0 and 8.1) with low soluble salts (EC= 0.43 and 0.42dSm^{-1}), medium in organic carbon content (0.42 and 0.41%), low in available N (214.0 and 228.0 kg ha^{-1}), low in available P (16.7 and 17.8 kg ha^{-1}) and high in available K (536.0 and 438.0 kg ha^{-1}) during the first and second years respectively.

III. Field experiment:

The field experiment consisted of fourteen treatments which were laid out in Randomized Block Design, replicated thrice and square planting (25 x 25 cm) was adopted during both the years. Among fourteen treatments, four treatments with different organic manures at 100% RDN on equi nutrient basis (farm yard manure, vermi-compost, poultry manure and (Dhaincha) green manure) another six treatments consisted of 50% combination of each organic manure, one treatment with 1/4th combination of all the manures and one absolute control (without organic or inorganic). These treatments were compared with the recommended dose of fertilizer (RDF) and integrated nutrient management practice (RDF + Dhaincha). The rice variety CO (R) 48 with field duration of 135 days was used in the trial. Separate nurseries were raised for conventional (INM and RDF) treatments and organic nursery for organic treatments. For organic and inorganic treatments separate experimental plots were maintained in both the years of study. Transplanting was carried out with 14 days old seedlings. All other package of practices were carried out as per recommendation of [4] for INM and RDF treatments. For organic treatments no herbicide was used, neem seed kernel extract, *Pnchagavyaa* and *Pseudomonos* were used as prophylactic plant protection measures. Irrigation and plant protection measures were followed uniformly in all the plots as per the requirements during both the years of experimentation. On N equivalent basis, required quantities of farmyard manure, decomposed poultry manure, vermi-compost and Dhaincha (*Sesbania aculeata*) green manure were applied in the soil one week before transplanting, whereas the dhaincha (*Sesbania aculeata*) green manure was applied two weeks prior to transplanting. Different sources of organic manures were applied as per treatment schedule. Recommended doses of 150:50:50 kg ha^{-1} of N, P and K in the form of urea, single super phosphate and muriate of potash were applied to the rice crop in respect of treatment T_{13} (RDF Treatment). In INM treatment (T_{14}), 6.25 t ha^{-1} of green manure Dhaincha (*Sesbania aculeata*) was incorporated two weeks prior to transplanting along with the recommended doses of 150:50:50 kg ha^{-1} N, P and K in the form of urea, single super phosphate and muriate of potash were applied to the rice crop. In addition to this, application of 5 kg ha^{-1} of *Azospirillum*, 5 kg ha^{-1} of *Phosphobacteria* and 50 kg ha^{-1} of zinc sulphate were applied as basal prior to transplanting.

IV. Biometric and Yield Observations:

Five plants in each plot were selected at random and tagged. These plants were used for recording biometric observation at different stages of crop growth. The harvested produce from each net plot was threshed, sun dried, winnowed separately and the rice grain yield was recorded at 14% moisture content and expressed in kg·ha^{-1} [5].

4.1. Physiological parameters:

4.1.1. Leaf area index (LAI):

The maximum length and breadth of the third leaf from the top of five tagged plants were measured at active tillering, panicle initiation, flowering and harvest stages and the mean value was multiplied with total number of leaves. The LAI was calculated by using the formula suggested by [6].

$$LAI = \frac{K\ (L \times W) \times \text{number of leaves hill-1}}{\text{Land area occupied by the plant}}$$

Where,

K - Constant factor (0.73 for samba season rice),

L - Maximum length of the third leaf blade from the top (cm), and

W - Maximum width of the leaf blade (cm).

4.1.2. Crop growth rate (CGR):

The CGR indicates an increase in dry matter per unit land area per unit time. It was calculated by using the formula suggested by [7]. It was estimated between active tillering to panicle initiation, panicle initiation to flowering and flowering to harvest stages and expressed in g m-2 day-1.

$$CGR = \frac{W2 - W1}{P\ (t2 - t1)}$$

Where,

W1 and W2 - Whole plant dry weight at time t1 and t2 respectively,

P - Ground area occupied by the plant (m2), and

t1 and t2 - Time interval in days.

*4.1.3. Net assimilation rate (NAR***):**

The NAR is the measure of photosynthetic product that is partitioned to form the plant materials. The NAR during the crop growth period (active tillering to panicle initiation, panicle initiation to flowering and flowering to harvest) was estimated by using the following formula suggested by [8] and expressed in mg cm-2 day-1.

$$NAR = \frac{W_2 - W_1}{t_2 - t_1} \quad \frac{\text{Loge } L_2 - \text{Loge } L_1}{L_2 - L_1}$$

Where, at time t_1 and t_2, respectively,

W_1 and W_2 - Whole plant dry weight at time t_1 and t_2, respectively, and

t_1 and t_2 - Time intervals in days.

4.1.4. Leaf nitrogen content / SPAD values (chlorophyll meter value):

The chlorophyll meter (SPAD 502, Minolta Camera Co., Osara, Japan from Soil Plant Analysis Division section, was used to obtain SPAD values of intact leaves as described by [9]. Observations were recorded flowering stage by taking five observations per leaf around the mid point of each leaf blade, 30 cm apart on upper (dorsal) side of midrib. Readings from five plants i.e. 25 readings, were averaged to represent the mean SPAD values of each plot.

4.1.5. Harvest index (HI):

Harvest Index was calculated by using the following formula as suggested by [7].

$$\text{Harvest index} = \frac{\text{Economic yield (kg ha}^{-1})}{\text{Biological yield (kg ha}^{-1})}$$

4.1.6. Agronomic efficiency (AE):

The agronomic efficiency i.e. the response in yield per unit input as indicated by the following formula [10].

$$\mathbf{AE} = \frac{\text{Grain yield in fertilised plot (kg ha-1)} - \text{Grain yield in unfertilized plot(kg ha-1)}}{\text{Quantity of fertilizer N applied (kg ha-1)}}$$

4.1.7. Physiological efficiency (PE):

The physiological efficiency also known as efficiency of utilization as indicated by kg of grain per kg of absorbed N [10] was computed as follows

$$\mathbf{PE} = \frac{\text{Grain yield in fertilised plot (kg ha-1)} - \text{Grain yield in unfertilized plot(kg ha-1)}}{\text{N uptake in fertilized plot (kg ha-1)} - \text{N uptake in unfertilized plot (kg ha-1)}}$$

4.1.8. Apparent N recovery (ANR):

Apparent N recovery, also known as recovery fraction was computed as per the formula suggested by [11].

$$ANR = \frac{Yt - Yo}{Nt} \times 100$$

Where,

Yt - Uptake of N in particular treatment (kg ha^{-1}),

Y_O - Uptake of N in unfertilized plot (kg ha^{-1}), and

Nt - Quantity of N applied for the treatment (kg ha^{-1}).

4.1.9. Statistical Analysis:

The data on various characters studied during the course of investigation were statistically analysed [12] for randomized block design. Wherever treatment differences were significant ("F" test), critical differences were worked out at five per cent probability level. Treatment differences that were not significant were denoted as "NS".

RESULTS AND DISCUSSION

5.1. Physiological parameters:

5.1.1. Leaf area index:

In general, the leaf area index (LAI) had increased as the crop advances in growth and it reached the maximum at flowering in both the years of study (Table 1). Higher LAI of rice was observed in the INM treatment (4.95 during 2012) flowering stage, whereas, it was on par with recommended NPK fertilizers (T_{13}) (4.82). Similar trend was noticed during 2013 also. Among the organic treatments, 100% RDN through green manure (T_5) recorded higher LAI (4.92 during 2012 and 4.96 during 2013) at flowering stage and it was followed by 25% RDN through each organic manures (T_{12}) (4.78 and 4.82). During the course of investigation, LAI was least in the treatment T_1 (absolute control), the values being 3.34 during 2012 and 3.36 during 2013, respectively flowering stage of the crop.

5.1.2. Crop growth rate:

The crop growth rate (CGR) was significantly influenced in rice as the crop advances during flowering to harvest phase in both the years of study (Table 1).The INM practice (T_{14}) recorded higher crop growth rate (11.42 g m^{-2} day^{-1} during in 2012 and 11.62 g m^{-2} day^{-1} in 2013, respectively) at flowering to harvest phase. However, it was comparable with recommended NPK fertilizers (T_{13}) (8.14 and 8.24)during both the years of study. Among the organic treatments, 100% RDN through green manure (T_5) recorded higher crop growth rate (7.71 during 2012 and 7.91) at flowering to harvest stage respectively and it was followed by 25% RDN through each organic manure (T_{12}) (7.51 and 7.81) . Similar trend was noticed in 2013 too. Lower values of crop growth rate were evident with absolute control (T_1) (5.91 in 2012 and 6.12 in 2013) at flowering to harvest phase, respectively. During the conformity trial also similar nature of results were observed.

5.1.3. Net assimilation rate:

The net assimilation rate (NAR) was influenced in rice as crop advances in growth, particularly during flowering to harvest stage in both the years of study (Table 1). The INM practice(T_{14}) recorded higher values of NAR (1.46 mg cm^{-2} day^{-1} in 2012 and 1.54 mg cm^{-2} day^{-1} in 2013, respectively) at flowering to harvest stage of rice. However, it was comparable with recommended NPK fertilizers (T_{13}) (1.41 and 1.46) during both the years of study. Among the organic treatments, 100% RDN through green manure (T_5) recorded higher values of NAR (1.40 in 2012 and 1.40 in 2013) at flowering to harvest stage, respectively and it was followed by 25% through each organic manure (T_{12}) (1.38). Similar results were observed in 2013 also. The absolute control (T_1) registered lower values of NAR (1.00 during 2012; 1.12, 1.03 and 1.03 during 2013, respectively) at flowering to harvest stage of the crop.

5.1.4. Rice leaf N content (SPAD value):

The treatments imposed had significant influence on leaf nitrogen content (SPAD values) during both the years (Table 1). Data on SPAD values increased as the crop advances till up to flowering in rice at all treatments, during both the years of investigation. The INM practice (T_{14}) recorded higher SPAD values (36.44 and 36.62 in 2012 and 2013, respectively) at flowering and it was on par with recommended NPK fertilizers (T_{13}) (34.64 and 34.82). Among the organic treatments, 100% RDN through green manure (T_5), recorded higher SPAD values (34.03 during 2012 and 34.41 during 2013) at flowering, respectively and it was followed by 100% RDN through each organic manure (T_{12}) (35.53 and 34.13). During the conformity trial also similar nature of results were noticed. The absolute control (T_1) registered lower SPAD values (27.81 and 27.51 in 2012 and in 2013, respectively) at flowering.

5.1.5. Rice grain yield:

The treatments imposed had influenced the rice grain yield in both the years of experimentation (Table 1). The grain yield of rice extended from 3602 to 6235 kg ha^{-1} during 2012 and from 3646 to 6270 kg ha^{-1} during 2013. The INM practice (T_{14}) recorded higher grain yield (6235 and 6270 kg ha^{-1} in 2012 and 2013, respectively). The percentage yield increased under INM ranged from 73.1 in 2012 to 72.0 in 2013 over absolute control. The grain yield under INM practices was comparable with recommended RDF (5603 and 5680 in 2012 and 2013, respectively) and resulted in yield reduction of 11.3 per cent and 11.4 per cent over INM in both the years of study. Among the organic treatments, 100% RDN though green manure (T_5) recorded higher grain yield (5084 and 5140 in 2012 and 2013, respectively) resulted in yield reduction of 22.6% and 22.0% over INM and the percentage yield increase over absolute control ranged from 41.1 in 2012 to 40.9 in 2013, respectively. Next to 100% RDN through green manure, higher grain yield was recorded with 25% RDN through each organic manure (T_{12}) (5004 and 5120 in 2012 and 2013, respectively) resulted in percentage yield increase over absolute control was 38.9 in 2012 and 40.4 in 2013. While comparing all the organic treatments, the percentage yield increase ranged from 8.5 to 41.1 in 2012 and 9.2 to 40.9 in 2013, respectively over absolute control. The RDF treatment recorded higher grain yield (5603 and 5680 in 2012 and 2013, respectively) resulted in percentage yield reduction of 11.3 and 11.4 over INM and percentage yield increase of 9.9 and 10.5 over 100 per cent RDN through green manure treatment. The lower grain yield (3602 in 2012 and 3646 in 2013) was obtained with absolute control (T_1), which did not receive organic manures and recommended NPK fertilizers. The treatments like INM, RDF, 100% RDN through green manure, and 25% RDN through each organic manures resulted in percentage yield increase (73.1 and 72.0, 55.5 and 55.8, 41.1 and 40.9, and 38.9 and 40.4, respectively) over absolute control in both the years of study.

5.2. Harvest index:

The INM practice, recommended NPK fertilizers and each organic manure and its various combinations did not significantly influenced the harvest index during 2012 and 2013 (Table 2). However, harvest index ranged from 0.423 and 0.455 in 2012 and from 0.425 to 0.456 in 2013. Similar trend of rice grain yield was observed in rice straw yield also during both the years of study. Similarly, the harvest index also reflected as that of grain and straw yield of rice trend during both the years of experimentation.

5.3. Nitrogen use efficiencies:

5.3.1. Agronomic efficiency:

The agronomic efficiency (AE) extended from 2.05 to 17.55 in 2012 and from 2.23 and 17.49 in 2013 (Table 2). The INM treatment (T_{14}) resulted higher AE of 17.55 and 17.49 in 2012 and 2013, respectively. The next best was observed with recommended NPK fertilizers (T_{13}) (13.34 in 2012 and 13.56 in 2013), 100% RDN through green manure (T_5) (9.88 in 2012 and 9.96 in 2013) and 25% RDN through each organic manure (T_{12}) (9.35 in 2012 and 9.83 in 2013). The application of 50% RDN through FYM and vermi-compost (T_6) recorded the least agronomic efficiency of 2.05 and 2.23 during 2012 and 2013, respectively.

5.3.2. Physiological efficiency:

The physiological efficiency (PE) extended from 20.26 to 60.81 in 2012 and from 23.03 to 60.46 in 2013 (Table 2). The INM treatment (T_{14}) resulted higher PE of 60.81 in 2012 and 60.46 in 2013, respectively. The next best was observed with recommended NPK fertilizers (T_{13}) (52.66 in 2012 and 51.62 in 2013), 100% RDN through green manure (T_5) (41.98 and 40.60 during 2012 and 2013, respectively) and 25% RDN through each organic manure (T_{12}) (41.36 and 43.01 during 2012 and 2013, respectively). Lower PE was registered with (T_6) 50 per cent RDN each through FYM and vermi-compost (20.26 and 23.03 during 2012 and 2013, respectively).

5.4. Apparent N recovery:

The INM treatment (T_{14}) recorded higher apparent nitrogen recovery (ANR) (28.87 and 29.00 per cent during 2012 and 2013, respectively) (Table 2). This was followed by recommended NPK fertilizers (T_{13}) (25.33%

in 2012 and 26.27% in 2013), 100% RDN through green manure(T_5) (23.53% in 2012 and 24.53% in 2013), and 25% RDN through each organic manure(T_{12})(22.60% in 2012 and 22.80% in 2013, respectively. Lower apparent nitrogen recovery was recorded in T_6 *viz.*, application of 50% RDN through FYM and vermi-compost (10.13 and 9.67%) in both the years, respectively.The results of present investigation involving INM practice, organic manures and recommended NPK fertilizers showed marked impact on the physiological parameters and yield of rice. In the present study, 100% RDN through green manure (T_5) incorporation (*Sesbania acculeata*) might have released the $N - NH_4^+$ N into the soil solution on decomposition, which is ready usable by rice plants. Similar results were observed by [13] and [14]. [15] reported that green manures, particularly the legumes like *Sesbania aculeata* and *Sesbania rostrata* which are comparatively high in N and low in C:N ratio behave almost like chemical fertilizers in respect to the improvement in growth and yield attributes of rice. [16] reported that plant height, LAI, RGR, CGR, number of tillers m^{-2} and DMP of rice increased upon green manuring. Application of green manures along with organic compost gave higher LAI than chemical fertilizers alone [17]. Green manure substituted about 100 per cent of N requirement of rice crop [18]. [19] reported that *Sesbania aculeata* was a better green manure than any other green manures. In the present study, green manure application gave higher LAI, CGR, number of tillers m^{-2} than other organic sources compared, in both the years of experimentation. The INM practice recorded higher SPAD values (rice leaf N concentration) and it was comparable with recommended NPK fertilizers and 100% RDN through green manure at flowering stage of rice. This might be due higher nutrients supplied through the INM treatment and 100% RDN through green manure application, to the growing tissues which led to the synthesis of more chlorophyll. This is in accordance with the results obtained by [20]. In addition, prolific root also might have sustained the leaf N concentration at a higher level throughout the crop growth period. The crop growth rate (CGR) and net assimilation rate (NAR) was higher with the INM practice. The INM treatment improved the soil environment which encouraged prolific root system resulting in better absorption of water and nutrients from lower layers and thus resulted in increased growth rate. [21] and [22] were also in line with the current findings. The INM practice recorded higher growth parameters was also observed for yield attributes. This might be due to higher concentration of macro and micronutrients in the INM practice, recommended NPK fertilizers and 100% RDN through green manure, when compared to other treatments. Physiologically, proper partitioning might have occurred from source to sink, as a result improved the yield attributes. Similar results were reported by [23]. [24] observed that the enhanced and continuous supply of nutrients by the enriched organics led to better tiller production, enhanced panicle length and filled grain of rice.

Table 1: Effect of organic manures, RDF and INM on physiological parameters such as LAI at flowering , CGR (g m^{-2} day^{-1}) at (flowering -harvest), NAR (mg $cm^{-2}day^{-1}$) at (flowering-harvest) and SPAD values (leaf nitrogen content) at flowering and grain yield of rice.

Treatments	*Samba* 2012					*Samba* 2013				
	LAI at flowering	CGR at F-H	NAR at F-H	SPAD values at flowering	Grain yield (kg ha^{-1})	LAI at flowering	CGR at F-H	NAR at F-H	SPAD values at flowering	Grain yield (kg ha^{-1})
T_1 : Absolute control	3.34	5.91	1.00	27.81	3602	3.36	6.12	1.03	27.51	3646
T_2 : 100% RDN through FYM	4.28	6.71	1.31	29.81	4164	4.40	7.12	1.33	31.42	4190
T_3 : 100% RDN through VC	4.52	6.92	1.33	30.62	4296	4.64	7.21	1.35	33.22	4380
T_4 : 100% RDN through PM	4.59	7.12	1.35	32.22	4377	4.66	7.41	1.34	33.41	4550
T_5 : 100% RD through GM	4.92	7.71	1.40	34.03	5084	4.96	7.91	1.40	34.41	5140
T_6 : 50% RDN each of through FYM + VC	4.32	6.51	1.29	28.63	3910	4.38	6.91	1.30	29.04	3980
T_7 : 50% RDN each of through FYM + PM	4.34	7.23	1.36	32.43	4721	4.41	7.52	1.35	33.62	4833
T_8 : 50% RDN each of through FYM + GM	4.36	6.83	1.32	30.02	4236	4.42	7.23	1.34	32.72	4316
T_9 : 50% RDN each of through VC + PM	4.48	7.32	1.36	33.23	4923	4.50	7.62	1.36	34.04	4986
T_{10} : 50% RDN each of through VC + GM	4.52	6.72	1.30	29.21	4079	4.54	7.04	1.32	30.04	4140
T_{11} : 50% RDN each of through PM + GM	4.56	7.02	1.34	31.82	4322	4.60	7.32	1.34	32.23	4430

T_{12} : 25% RDN each of through FYM + VC + PM + GM	4.78		7.51	1.38	33.53	5004	4.82	7.81	1.38	34.13	5120
T_{13} : RDF (150 : 50 : 50) NPK kg ha^{-1}	4.82		8.14	1.41	34.64	5603	4.85	8.24	1.46	34.82	5680
T_{14} : INM Practice (RDF + GM @ 6.25 t ha^{-1})	4.95		11.42	1.46	36.44	6235	4.97	11.62	1.54	36.82	6270
SEd	0.42		0.73	0.12	2.93	425	0.41	0.73	0.13	3.13	432
CD (p=0.05)	0.87		1.56	0.25	6.16	874	0.86	1.56	0.27	6.26	889

Table 2: Agronomic efficiency, physiological efficiency, apparent N recovery (%) and harvest index of rice

	Samba 2012				*Samba* 2013			
Treatments	Agronomic Efficiency	Physiological Efficiency	Apparent N recovery (%)	Harvest Index	Agronomic Efficiency	Physiological Efficiency	Apparent N recovery (%)	Harvest Index
T_1 : Absolute control	-	-	-	0.423	-	-	-	0.425
T_2 : 100% RDN through FYM	3.75	29.12	12.87	0.434	3.63	28.63	12.67	0.436
T_3 : 100% RDN through VC	4.63	30.04	15.40	0.436	4.89	31.91	15.33	0.438
T_4 : 100% RDN through PM	5.17	28.18	18.33	0.438	6.03	31.83	18.93	0.441
T_5 : 100% RDN through GM	9.88	41.98	23.53	0.441	9.96	40.60	24.53	0.443
T_6 : 50% RDN each of through FYM + VC	2.05	20.26	10.13	0.433	2.23	23.03	9.67	0.435
T_7 : 50% RDN each of through FYM + PM	7.46	38.19	19.53	0.439	7.91	39.30	20.13	0.440
T_8 : 50% RDN each of through FYM + GM	4.23	29.76	14.20	0.435	4.47	31.90	14.00	0.437
T_9 : 50% RDN each of through VC + PM	8.81	41.28	21.33	0.440	8.93	41.87	21.33	0.442
T_{10} : 50% RDN each of through VC + GM	3.18	27.57	11.53	0.434	3.29	30.12	10.93	0.435
T_{11} : 50% RDN each of through PM + GM	4.80	28.35	16.93	0.437	5.23	29.04	18.00	0.439
T_{12} : 25% RDN each of through FYM + VC + PM + GM	9.35	41.36	22.60	0.440	9.83	43.01	22.80	0.442
T_{13} : RDF (150 : 50 : 50) NPK kg ha^{-1}	13.34	52.66	25.33	0.441	13.56	51.62	26.27	0.443
T_{14} : INM Practice (RDF + GM	17.55	60.81	28.87	0.455	17.49	60.46	29.00	0.456

@ 6.25 t ha^{-1})

Data not statistically analysed

Conclusion:

From this study, From this study, it was concluded that, higher physiological parameters and grain yield of rice was recorded with the INM practice followed by recommended dose of fertilizers (RDF) treatment. Among the organic treatments, higher higher grain yield of rice was recorded with 100% RDN through green manure followed by 25% RDN through each organic manures in both the years of study. The different sources of organic manures particularly the composted poultry manure at the rate of 5 t/ha application had increased the rice yield as well as the rice fallow pulse (blackgram) yield in the rice-blackgram cropping sequence [25]. For organic rice production, application of 100% RDN through green manure for realizing better physiological parameters and grain yield followed by 25% RDN through each organic manures (farmyard manure, vermi-compost, poultry manure and green manure) for rice-greengram cropping system. These site-specific organic nutrient management practices are seems to be better agronomic package to the organic rice growers. Green manures have a good potential to maintain soil fertility, supplement nutrient supply to rice crop and could contribute to greater food security [26], which found to be optimum for enhancing rice production for promoting organic rice farming in Western agro-climatic zone of Coimbatore.

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