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Influence of integrated application of nitrogen sources on growth attributes of rice under system of rice intensification

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Abstract

Growth characteristic of crop plants ultimately decides the crop productivity. In low land rice production growth attributes can be enhanced through integrated nutrient management (INM) and effective cultivation practices. In this view to enhance the crop productivity by influencing better growth of rice plants in low lands, an experiment was conducted at experimental farm, Faculty of Agriculture, Annamalai University, Tamil Nadu, India. Experiment was laid out in split plot design with two main plot treatments (SRI and conventional system of cultivation) and seven sub plots treatments (integrated nutrient management practices) and replicated thrice. Growth attributes viz., plant height, number of tillers, DMP, root length, root volume and root dry weight hill^{-1} values were recorded at tillering, flowering stages and at harvest. Enhanced growth attributes were noticed under system of rice intensification method of rice cultivation i.e. more than 35 percent increases over conventional system of rice cultivation. Among the integrated nutrient management practices, the application of STCR based IPNS (combined application of NPK fertilizer along with 12.5 t ha^{-1} FYM and bio-fertilizers viz., Azospirillum and PSB as soil treatment) proved its superiority over other treatments significantly. It was closely followed by application of 75% fertilizer N + 25% organic N through EFYM. Lower values of growth attributes were registered by 100% RDF applied treatment at all the crop growth stages. From the experimental results, it may be concluded that STCR based IPNS or 75 percent N through inorganic and 25 percent N through EFYM or FYM could be the better options for enhancing growth attributes of low land rice crop for improving its sustainable productivity.

Keywords: EFYM, growth, INM, IPNS, rice, SRI, STCR

Introduction

Rice (*Oryza sativa*. L) is the most important source of calories for millions of people and, like all crops, its growth and yield is enabled by taking up water and nutrients from the soil through its root system. Yield can be constrained by many abiotic and biotic factors, including drought, nutrient deficiencies, and pathogen infections. The growth characters, yield components and rice yield can significantly influenced by addition of organics alone or fertilizer alone or combined application of inorganic and organics. In this context, India would need to produce 380 Mt of food grains to feed the population of 13 billion by 2025 (Subba Rao *et al*., 2015) [16]. The yield of rice plants cannot be achieved without having better growth of crop plants at effective stages i.e. tillering, panicle initiation which in turn helps the plants to be productive. Rice production depends on several factors viz., climate, physical condition of the soil, soil fertility, and water management, sowing date, cultivar, seed rate, weed control and fertilization and proper nitrogen management is the prerequisite to hasten the plant growth and development. Making accurate N recommendation for higher N demanding crops like rice is becoming more important as concern growth about the high cost of this input and nitrate pollution and increase profitability by improving crop production. Integrated nutrient management involves maintenance of soil fertility, sustainability of crop production and the beneficial effect of integrated plant nutrient supply(IPNS) in low land rice has been well reported by several workers (Kumar *et al*., 2014) [6]. SRI has been promoted for more than a decade as a set of agronomic management practices for rice cultivation that enhances growth and yield of rice based cropping systems, reduces water requirement, raises input productivity, is accessible to small holders and is more favorable for the environment than conventional practice with its continuous flooding of paddies and heavy reliance on inorganic fertilization (Nayak *et al*., 2018) [8]. Efficient natural resource management and nutrients could be better utilized under SRI along with integration of nutrient sources to realize the maximum rice crop productivity through enhancing growth and physiological aspects of low land rice. Hence, an attempt was made to develop an effective integrated nutrient management practice under SRI and conventional system of cultivation using different organic sources (FYM, EFYM, green manure,) combined with RDF of NPK fertilizers plus biofertilizers on a deep clay soil in Cauvery deltaic zone of Tamil Nadu for enhancing growth attributes of rice.

Materials and methods

Field experiment was conducted in kharif season during 2014-2015 at Experimental Farm, Annamalai University, Annamalai Nagar Tamil Nadu, India. The experimental site is situated at 11°24' N latitude and 74°44' E longitude at an altitude of + 5.79 m above mean sea level in the southern part of India. Temperature and relative humidity during the experiment ranged from 28.5 to 38.5 ºC and 78.0 to 96.0%, respectively. Soil of the experimental farm is classified as Typic Haplusterts (clay) having holding capacity of 36.8 per cent, neutral in reaction (pH 7.4) organic carbon content 6.1 g kg^{-1}, CEC of 22.5 c mol (P+) kg $^{-1}$, low available N (232 kg ha^{-1}), medium available P (20.8 kg ha^{-1}), high available K (279 kg ha^{-1}); DTPA extractable Fe, Zn, Mn and Cu soil content of 20.4,2.4,3.4 and 1.2 mg kg^{-1}, respectively. Experiment was laid in split plot design with two methods of cultivation (SRI and CSC) as main plot treatments and seven sub plot treatments viz., 100% RDF, six integrated nutrient management treatments (STCR based IPNS(144:64:60 npk kg ha^{-1} + FYM 12.5 t ha^{-1} + Biofertilizer @ 2 kg ha^{-1}), based on 100% RDF two levels of fertilizer nitrogen (75and 50 per cent) in combination with two levels of N (25 and 50 per cent) through organic manures *viz.*, Farmyard manure (FYM), Enriched farm yard manure(EFYM) and 50% Green manure (GM) as sub plot treatments, and replicated thrice. The rice variety used was CO-43 which matures normally in 135 days, the total nutrients were supplied through organic sources inorganic fertilizers were given at the rate of 150-50-50 kg N, P, and K ha^{-1}, and 8 kg Zn ha^{-1} through urea, single super phosphate, muriate of potash, and zinc sulfate, respectively. Nitrogen was given in three equal splits at basal, maximum tillering, and panicle initiation stages, while P, K, and Zn were given as basal doses. For SRI-organic treatments, the N dose was adjusted to the recommended level based on the moisture content and total N concentration of the organic sources. In the SRI plots (both organic and inorganic), 10–12-day-old seedlings were transplanted, while 30-day-old seedlings were transplanted for CSC.CSC plots were kept flooded whenever required to maintain a layer of 5–6-cm depth of water during the vegetative stage. SRI plots were kept saturated, but with no standing water during the vegetative stage. After panicle initiation, both SRI and CSC plots were maintained with 2–3-cm depth of water and all the plots were drained 15 days before harvest. Weeding in SRI plots (both organic and inorganic) was done four times by Cono-weeder to incorporate weeds into the soil at 10, 20, 30, and 40 days after transplanting (DAT), while the CSC plots were hand weeded twice at 25 and 40 DAT. The growth attributes were recorded as per the standard procedure i.e. Five plants in each plot were selected at random and tagged. These plants were used to record biometric observations at different stages of crop growth (tillering, flowering and at harvest). Plant height was measured and expressed in cm. Plant samples were collected and dried in an oven at 65°C - 70°C to constant weight and the dry weight was recorded. The average dry weight of five hills was taken as dry matter production per hill and is expressed in kg ha^{-1}. Root studies undergone and whole hill with root was collected from each sampling plot separately by digging and the dugout plants were placed in big buckets, made into slurry with excess water to remove soil from the roots by washing and draining till no soil was found with roots and then stored in plastic bags. The root samples were brought to lab, again washed, and cleaned to remove debris. Then root length (without much loss of roots as for as possible and root length was measured from the base to the tip of the longest root and expressed in cm), root volume [after measuring the root length, the roots were separated from the plants and the root volume was measured by water displacement method (Karthikeyan, 1999) [5]. The root volume $hill^{-1}$ was measured and expressed in cubic centimeter (cc)) and dry weight (After measuring the root volume, the roots were dried in shade and then oven dried at 80 ± 5°C till the attainment of constant weight and expressed in g $hill^{-1}$). All the data were statistically analyzed by analysis of variance (ANOVA) as applicable to a completely randomized block design (Gomez and Gomez, 1984) [3]. The significance of the treatment effect was determined by F tests, and to determine the significance of the difference between the means of the treatments, least significant difference (LSD) was calculated at the 5% probability level.

Results and discussion

Plant height (cm)

Plant height increased with advancement of crop growth from tillering and it reached maximum at harvest. The data pertaining to plant height at tillering, flowering and harvest are given in table 1. The results revealed that SRI method of cultivation registered taller plants 62.9, 100.4, 107.9 cm compared to conventional system (55.2, 9.39, 100.9 cm) at all stages, respectively. Plant height is an indicator of varietal nature; it differed with varieties and on field management practices. The number of elongated internodes and sum of length of elongated internodes accounts for a larger fraction of plant height. In common, plant height was found to increase with age of the crop. In the present study taller plants were observed constantly at all growth stages with SRI method of cultivation compared to CSC. This might be ascribed due to planting of young seedlings (Kalyan Jana *et al*., 2015) [4] had higher vitality and more root growth which stimulated cell division causing more stem elongation, lesser intra-hill competition through wider spacing with favorable soil environment during stem elongation stage. This is in agreement with the findings of (Mishra and Salokhe, 2010) [7] who reported that number of functional leaves, leaf area and total number of tillers $hill^{-1}$ were higher at wider spacing which increased the photosynthetic rates and higher root oxidizing activity leading to taller plants. Amongst integrated nutrient management options treatment T_4 (STCR based IPNS i.e. combined application of fertilizer along with 12.5 t ha^{-1} FYM and bio-fertilizers *viz*., *Azospirillum* and *PSB* as soil treatment) (T_2) (68.3, 110.6, 116.7 cm), which was on par with T_5 (75% fertilizer N+ 25% organic N through EFYM) and T_3 (75% fertilizer N+25% organic N through FYM) followed by T_4, T_6 and T_1 (on par). This could be attributed due to fertilizer dose and constant supply of additional amount of nutrients throughout the crop growth period by the addition of FYM (Priyanka Gautam, 2013) [9] which contains both macro and micronutrients and stimulatory effect of inoculated bio-fertilizers (Weijebhandara *et al*., 2008 and Roy *et al*., 2013) [19, 10] attributed greater root development, photosynthetic activity, and greater response of crop to available nutrients. These results corroborates with the findings of Virdia and Mehta (2009) [18] who reported that enhancement in growth with increase in fertility was owing to rapid conversion of synthesized photosynthates into protein to form more protoplasm, thus increasing number and size of cell which might have increased the plant height. Whereas the shortest plants were recorded in treatment received 50% fertilizer N + 50% organic N through GM (42.3, 82.6, 93.2 cm) at all stages of crop growth, respectively. This might have put forth mainly by crop raised 50% inorganic N, which is very much required for growth and development of rice plant during starting period of growth to achieve the physiological niche. But in the later stages might be due to delayed decomposing of green manure and slow availability of N to rice plants shortened the height of plants. Interactions among methods of cultivation and integrated nutrient management options did not affected the plant height significantly at all stages of data recorded.

Number of tillers m^{-2}

Tillering character differs in each and every rice cultivars. Data concerned to number of tillers m^{-2} observed under different nutrient management practices of rice at tillering under SRI and conventional system are presented in table 2. At all stages, comparatively higher number of tillers m^{-2} was noticed in SRI (547 m^{-2}) over conventional system (453 m^{-2}). This might be attributed due to planting of younger seedlings before starting of rapid tillering and rooting which would begin in fourth phyllochron stage and effective utilization of space, more foraging area for root system**,** use of sunlight etc. in square planting DRR (2011) [2] compared to conventional system of cultivation in both experiments. Further, enhanced availability of resources for the individual culms under wider spacing might have prolonged the duration of tiller production resulted in profuse tillering, and low density planting increased the number of tillers (Zaman *et al*., 2015) [20]. Whereas rice under conventional system, acknowledged for lesser tillers m^{-2} due to mutual competition between tillers (less space with more dense) and increased tiller mortality. Also cluster planting resulted in more primary tillers at early stage and lesser tillers at the subsequent stages. Among sub plot treatments, T_2 (STCR based IPNS) recorded maximum number of tillers (577 m^{-2}) it was comparable with T_5 (75% fertilizer N + 25% organic N through EFYM) and followed by T_3, T_4, T_6 (being on par with each other) and T_1.The treatment T_7 (application of 50% fertilizer N + 50% organic N through GM) registered minimum number of tillers (392 m^{-2}). Interaction effects were found to be significant. Among interactions, treatment T_2 (STCR based IPNS) under SRI registered the highest number of tillers (620 m^{-2}) while treatment T_7 under conventional system registered the lowest number of tillers (362 m^{-2}).Manuring favored the tiller production irrespective of cultivation methods and nutrient management practices. Application of STCR based IPNS (combined application of fertilizer along with 12.5 t ha^{-1} FYM and bio-fertilizers *viz*., *Azospirillum* and *PSB* as soil treatment) exerted conscientious upshot on number of tillers $hill^{-1}$ at tillering stage of the experiment, significantly. This would have attributed by addition of organic manure (FYM) in large quantity resulted in improved soil function as well as augmented availability of nutrients and enhanced nutrient uptake and stimulatory effects of microbial population through addition of bio-fertilizers might have influenced the synergistic effects on the production of more tillers $hill^{-1}$. Findings of the present study are in line with those of Singh (2013) [13].

Root characteristics (Length, volume and dry weight)

Root length was significantly influenced by cultivation methods and integrated nutrient management practices. In general root length steadily increased from initial tillering to flowering stage and then slightly declined at harvest. Data related to root parameters are presented in table 3, 4 and 5. The nutrient management practices caused significant difference in root characteristics at all growth stages under SRI and conventional system of cultivation. The data pertaining to root length, root volume and root dry weight at tillering, flowering and harvest are presented in table 6, 7 and 8, respectively. Significantly higher values of root length, root volume and root dry weight were recorded in SRI (20.6, 30.2, 28.9 cm, 18.46, 29.76, 28.48 cc $hill^{-1}$ and 1.73, 3.87, 3.91 g $hill^{-1}$) compared to conventional system of cultivation (18.1, 26.5, 25.4 cm, 16.21, 26.13, 25.0 cc $hill^{-1}$ and 1.52, 3.40, 3.44 g $hill^{-1}$) at tillering, flowering and harvest respectively. Roots, the absorbing part of plants; their growth is evident by index of plant vigor and productivity. Root characters (length, distribution and especially root volume) help in revealing the crop water use and nutrient uptake pattern. In general, root characters *viz.*, root length, root volume and root dry matter showed a gradual increase up to flowering and declined later. SRI method of cultivation recorded better root characteristics at all stages of crop growth in the study, which could be attributed by wider spacing and less plant population per unit area which resulted in increased root volume, root length and root dry weight with abundant availability of nutrients, light intensity and water availability thereby enabled the plant to extract nutrient efficiently from larger soil volume. All these beneficial factors were deficient in conventional system under continuous submergence, which has closer spacing and poor root characters. Similar findings were reported by Sathya *et al*. (2013) [11]. Sri Ranjitha and Reddy (2014) [14] and Singh *et al*. (2014) [12] also found that rice plants under SRI had about 10 times more root mass, five times more root length density, and seven times more root volume in the top 30 cm of soil profile, compared with roots in the plots of flooded rice due to larger and healthier root system with SRI might be due to production of phytohormones. Among sub plot treatments, T_2 (STCR based IPNS) recorded higher root length, root volume and dry weight (21.8, 30.8, 29.6 cm, 19.14, 31.05, 29.73 cc $hill^{-1}$ and 1.77, 3.86, 3.84 g $hill^{-1}$) and it was on par with 75% N through fertilizer + 25% N through EFYM (T_5) and 75% N through fertilizer + 25% N through FYM (T_3) followed by T_4, T_6 (being on par with each other) and T_1 and the lower root length was registered in T_7 (50% fertilizer N + 50% organic N through GM (15.8, 24.1, 22.9 cm, 13.83, 22.92, 21.23 cc $hill^{-1}$ and 1.32, 3.16, 3.33 cc $hill^{-1}$) at all stages, respectively. The enhanced root characters in the present study owing to improved enzymatic activity and translocation of some amount of decayed root in the vicinity of rhizosphere by means of greater population of microorganisms by the application STCR based IPNS. These results are in consonance with conclusions of Chen *et al*. (2013) [1] and Thiruneelakandan and Subbulakshmi (2014) [17] opined that enrichment of soil atmosphere with organic manure addition possibly encouraged root proliferation. Further, Zaman *et al*. (2015) [20] emphasized that soil micro flora released growth promoting phytohormones like auxins, cytokinins and gibberellic acid etc. which stimulated the root growth i.e. mean root length and weight density were longer and deeper with compost application as soil depth increased. Further, root length density was higher with inorganic and organic fertilizer application than control. Interaction effects found to be non significant at all growth stages.

Dry matter production (kg ha^{-1})

Dry matter production of a crop reflects its competence to use available resources such as solar radiation, moisture, nutrients and other factors of existing environmental conditions and, it is the product of growth factors such as plant height, number of tillers, LAI and efficiencies of the crop to confine available resources. In general, it increased gradually with advancement of growth and reached maximum at maturity. In this study, the total dry matter (kg ha^{-1}) steadily increased with the advancement of crop growth. Significant variations were noticed among crop cultivation methods, and nutrient management practices at tillering, flowering and harvest stages of rice are presented in table 9. Methods of cultivation did not substantially alter the dry matter production at tillering. However, significant variations were found at flowering and harvest (Table 6). The maximum mean dry matter was produced by SRI 9562.1 and13519.5 kg ha^{-1} compared to CSC 8394.0 and 11867.1 kg ha^{-1} at flowering and harvest, respectively. This might be ascribed due to greater tiller number with larger root volume, more LAI. This is in confirmation with the findings of Sridevi and Chellamuthu (2015) [15] who found that dry matter accumulation was higher with SRI, because the root volume and dry matter production were dependent on each other and synergistic effects between growth of root and shoot, each enabling other to grow larger and functions better which in turn might have enhanced prolific root growth. The highest dry matter production was observed with application of STCR based IPNS (T_2) (2416.3, 9788.2, 14410.1 kg ha^{-1}), which was on par with T_5 and T_3 followed by T_4, T_6 and T_1 where T_4 and T_6 were on par with each other. Whereas the lowest mean values of DMP were recorded in treatment received 50% fertilizer N +50% organic N through GM (1706.4, 7542.9, 9620.9 kg ha^{-1}) at all stages of crop growth, respectively. This might be due to greater root development and increased availability of nutrients in adequate amount at different growth stages through associative biological nitrogen fixation (BNF) in rhizosphere, solubilization of immobilized nutrients through bacterial inoculation that improved above ground parts especially DMP. These results are in accordance with the findings of Kumar *et al*. (2010b) who observed maximum dry matter production with 100% NPK + 20 t ha^{-1} FYM + 10 kg ha^{-1} BGA and Priyanka Guatam *et al*. (2013) [9] reported that combined application of inorganic and organic sources improved the growth parameters of rice viz., plant height, DMP and LAI. Interactions found to be non significant at tillering and flowering stages whereas it was significant at harvest. However, treatment T_2 (STCR based IPNS) under SRI registered the highest dry matter (15348 kg ha^{-1}) at harvest while treatment T_7 under conventional system accounted for the lowest DMP (8995 kg ha^{-1}). Interaction effects were found to be non significant at all growth periods.

Table 1: Effect of integrated nutrient management on plant height (cm) of rice

Stages	**Tillering**			**Flowering**			**Harvest**		
Treatments /Cultivation methods	**SRI**		**CSC**	**SRI**		**CSC**	**SRI**		**CSC**
T_1 - 100% RDF	51.7		45.4	94.5		82.9	105.1		92.3
T_2 - STCR Based IPNS	72.8		63.9	117.8		103.4	124.3		109.1
T_3 -75% fertilizer N + 25% organic N (FYM)	71.3		62.6	115.4		101.3	121.8		106.9
T_4 -50% fertilizer N + 50% organic N (EFYM)	64.3		56.4	108.8		95.5	116.3		102.1
T_5 -75% fertilizer N + 25% organic N (EFYM)	72.0		63.2	116.7		102.4	123.1		108.1
T_6 - 75% fertilzer N + 25% organic N (GM)	63.3		55.6	107.2		94.1	114.5		100.6
T_7 - 50% fertilizer N + 50% organic N (GM)	45.1		39.6	88.0		77.2	99.3		87.2
	M	S	M x S	M	S	M x S	M	S	M xS
SEd±	1.03	1.36	2.06	1.75	1.46	2.59	1.88	1.20	2.46
CD (P=0.05)	4.44	2.81	NS	7.54	3.01	NS	8.10	2.48	NS

Table 2: Effect of integrated nutrient management on number of tillers m^{-2} at active tillering stage in rice

Stages	**Active Tillering**		
Treatments /Cultivation methods	**SRI**		**CSC**
T_1 - 100% RDF	484		370
T_2 - STCR Based IPNS	620		533
T_3 -75% fertilizer N + 25% organic N (FYM)	614		415
T_4 -50% fertilizer N + 50% organic N (EFYM)	545		478
T_5 -75% fertilizer N + 25% organic N (EFYM)	607		530
T_6 - 75% fertilzer N + 25% organic N (GM)	537		471
T_7 - 50% fertilizer N + 50% organic N (GM)	422		362
	M	S	M x S
SEd±	12.40	9.65	17.70
CD (P=0.05)	53.34	19.93	55.97

Table 3: Effect of integrated nutrient management on root length (cm) of rice

Stages	**Tillering**		**Flowering**		**Harvest**	
Treatments /Cultivation methods	**SRI**	**CSC**	**SRI**	**CSC**	**SRI**	**CSC**
T_1 - 100% RDF	18.1	15.9	27.2	23.9	26.0	22.8
T_2 - STCR Based IPNS	23.2	20.4	32.8	28.8	31.6	27.7
T_3 -75% fertilizer N + 25% organic N (FYM)	22.7	19.9	32.1	28.2	30.9	27.1
T_4 -50% fertilizer N + 50% organic N (EFYM)	20.4	17.9	30.7	26.9	29.4	25.8
T_5 -75% fertilizer N + 25% organic N (EFYM)	23.0	20.2	32.5	28.5	31.2	27.4
T_6 - 75% fertilzer N + 25% organic N (GM)	20.1	17.7	30.2	26.5	29.0	25.4

T_7 - 50% fertilizer N + 50% organic N (GM)	16.8		14.8	25.7		22.5	24.4		21.4
	M	S	M x S	M	S	M x S	M	S	M xS
SEd±	0.34	0.32	0.53	0.49	0.35	0.67	0.47	0.35	0.66
CD (P=0.05)	1.45	0.65	NS	2.13	0.72	NS	2.040	0.71	NS

Table 4: Effect of integrated nutrient management on root volume (cc hill^{-1}) of rice

Stages	Tillering			Flowering			Harvest		
Treatments /Cultivation methods	**SRI**		**CSC**	**SRI**		**CSC**	**SRI**		**CSC**
T_1 - 100% RDF	15.83		13.89	26.52		23.28	24.54		21.55
T_2 - STCR Based IPNS	20.39		17.90	33.07		29.03	31.66		27.80
T_3 -75% fertilizer N + 25% organic N (FYM)	19.97		17.53	32.39		28.43	31.01		27.22
T_4 -50% fertilizer N + 50% organic N (EFYM)	19.21		16.87	29.82		26.18	29.32		25.74
T_5 -75% fertilizer N + 25% organic N (EFYM)	20.18		17.72	32.74		28.74	31.35		27.52
T_6 - 75% fertilzer N + 25% organic N (GM)	18.93		16.62	29.38		25.79	28.89		25.36
T_7 - 50% fertilizer N + 50% organic N (GM)	14.73		12.93	24.41		21.43	22.61		19.84
	M	S	M x S	M	S	M x S	M	S	M xS
SEd±	0.30	0.29	0.48	0.49	0.42	0.73	0.47	0.45	0.75
CD (P=0.05)	1.30	0.59	NS	2.10	0.86	NS	2.01	0.93	NS

Table 5: Effect of integrated nutrient management on root dry weight (g hill^{-1}) of rice

Stages	Tillering			Flowering			Harvest		
Treatments /Cultivation methods	**SRI**		**CSC**	**SRI**		**CSC**	**SRI**		**CSC**
T_1 - 100% RDF	1.55		1.36	3.55		3.12	3.73		3.27
T_2 - STCR Based IPNS	1.93		1.69	4.20		3.69	4.18		3.67
T_3 -75% fertilizer N + 25% organic N (FYM)	1.89		1.66	4.11		3.61	4.09		3.59
T_4 -50% fertilizer N + 50% organic N (EFYM)	1.75		1.53	3.90		3.42	3.89		3.41
T_5 -75% fertilizer N + 25% organic N (EFYM)	1.91		1.67	4.16		3.65	4.14		3.63
T_6 - 75% fertilzer N + 25% organic N (GM)	1.72		1.51	3.84		3.37	3.83		3.36
T_7 - 50% fertilizer N + 50% organic N (GM)	1.40		1.23	3.36		2.95	3.55		3.11
	M	S	M x S	M	S	M x S	M	S	M xS
SEd±	0.03	0.03	0.04	0.06	0.04	0.08	0.06	0.03	0.08
CD (P=0.05)	0.13	0.06	NS	0.27	0.08	NS	0.28	0.06	NS

Table 6: Effect of integrated nutrient management on dry matter production (kg ha^{-1}) of rice

Stages	Tillering			Flowering			Harvest		
Treatments /Cultivation methods	**SRI**		**CSC**	**SRI**		**CSC**	**SRI**		**CSC**
T_1 - 100% RDF	2011		1794	8714		7650	11571		10152
T_2 - STCR Based IPNS	2554		2279	10425		9151	15348		13473
T_3 -75% fertilizer N + 25% organic N (FYM)	2501		2232	10210		8963	15031		13195
T_4 -50% fertilizer N + 50% organic N (EFYM)	2303		2054	9687		8503	13723		12047
T_5 -75% fertilizer N + 25% organic N (EFYM)	2529		2256	10322		9061	15195		13339
T_6 - 75% fertilzer N + 25% organic N (GM)	2269		2024	9544		8378	13521		11869
T_7 - 50% fertilizer N + 50% organic N (GM)	1804		1610	8034		7052	10247		8995
	M	S	M x S	M	S	M x S	M	S	M xS
SEd±	2011	1794	8714	7650	11571	10152	2011	1794	8714
CD (P=0.05)	2554	2279	10425	9151	15348	13473	2554	2279	10425

Conclusion

Use of integrated plant nutrient supply system resulted in saving of inorganic sources application for production through enhanced growth. The results revealed that the combination of inorganic and organic nutrient sources i.e. STCR based IPNS practices and or inorganic integrated with organics like EFYM or FYM application can be beneficial in enhancing growth attributes of rice both under system of rice intensification and conventional system of cultivating rice in lowlands. And it can be concluded that application STCR based IPNS will be a better choice for the farmers by which enhanced and sustainable rice production could be achieved under SRI. Practicing STCR based fertilizer application needs to be popularized among farmers to achieve higher productivity. It is also advocated that trends observed in this study may hold true for broad generalization in the larger parts of Cauvery deltaic zone of Tamil Nadu that would serve as key factor for effective nutrient management for sustainable rice production.

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