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Growth and physiological characters of rice (*Oryza sativa*) as influenced by integrated nutrient management under SRI in Cauvery Deltaic Zone of Tamil Nadu

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ABSTRACT

Growth and physiological characteristic of crop plants ultimately decides the crop productivity. Field experiments were conducted at experimental farm, Faculty of Agriculture, Annamalai University, to study the effect of integrated nutrient management under SRI on rice (Oryza sativa L). Experiments were laid out in split plot design with two main plot treatments (SRI and conventional system of cultivation) and twelve sub plots treatments (integrated nutrient management practices) and replicated thrice. Enhanced growth and physiological attributes were noticed under system of rice intensification method of rice cultivation i.e. 35-60 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 in respect of growth and physiological characters of rice. It was closely followed by application of 75 % fertilizer N + 25 % organic N through FYM. Lower values of growth and physiological attributes were registered by LCC based N applied treatment at all the crop growth stages.

Key words: FYM, growth, INM, IPNS, LCC, 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). 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). 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. 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 using different organic sources (FYM, press mud, green manure, poultry manure) combined with RDF of

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NPK fertilizers plus biofertilizers on a deep clay soil in Cauvery deltaic zone of Tamil Nadu for enhancing growth and physiological attributes of rice.

MATERIALS AND METHODS

Field experiments were conducted for two consecutive years in kharif season 2013 and 2015 at Experimental Farm, Annamalai University, Annamalai Nagar Tamil Nadu. 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, neutral reaction (pH 7.4,7.5) organic carbon content 4.6and 5.8 g kg^{-1}, CEC of 20.7 and 21.4 c mol (P+) kg^{-1}, low available N (227 and 230 kg ha^{-1}), medium available P (1.9and 21.3 kg ha^{-1}), high available K (281 and 276 kg ha^{-1}); DTPA extractable Fe, Zn, Mn and Cu soil content of 21.2,2.1,3.7,1.1 and 20.8,2.7,3.7,0.9 mg kg^{-1}, respectively at first and second year experimental soils. Experiment was laid in split plot design with two methods of cultivation (SRI and CSC) as main plot treatments and twelve sub plot treatments viz., three inorganic alone applied treatments (100 % RDF, STCR based RDF, LCC based N (Recommended dose of fertilizer P&K without basal N), nine integrated nutrient management treatments (STCR based IPNS, 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 different organic manures viz., farmyard manure (FYM), green manure (GM), press mud (PM), poultry manure (POM) as sub plot treatments, and replicated thrice. The rice variety used was CO-43 which matures normally in 135 days. The total nutrients supplied through organic sources and 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 superphosphate, 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 and physiological 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, panicle initiation and at harvest). Leaf area index (LAI) was worked out without removing the leaves as proposed by Palaniswamy and Gomez (1974). Plant samples were collected and dried in an oven at 65°C - 70°C to constant weight and the dry weight was recorded. For collecting root samples, whole hill with root was collected from each sampling plot separately. Root length and dry weight were recorded and the root volume was measured by water displacement method (Karthikeyan, 1999). A chlorophyll meter was used to obtain SPAD values of intact leaves as described by Peng *et al.* (1993). All the data were statistically analysed and 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

Growth and physiological attributes of rice

Plant height

Plant height increased with advancement of crop growth from tillering and it reached maximum at harvest (Table 1). The number of elongated internodes and sum of length of elongated internodes accounts for a larger fraction of plant height. Taller plants were **P.**

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) which 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. 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) recorded the highest plant height of 68.4,110.8 and 117.2 cm at tillering, flowering and at harvest, respectively. It was significantly superior over all other treatments. Treatment T_5 (75 % fertilizer N + 25 % organic N through FYM) recorded the second highest plant height. This could be attributed due to fertilizer dose and constant supply of additional amount of nutrients throughout the crop growth by the addition of FYM and stimulatory effect of inoculated bio-fertilizers. These results corroborates with the findings of Virdia and Metha (2009). Treatment T_3 LCC based N (RDF P and K) registered the lowest plant height at all growth stages.

Table 1: Effect of INM and cultivation methods on plant height (cm) and number of tillers m^{-2} of rice at various growth stages (mean of 2 years)

Treatments	Tillering		Flowering		Harvest		Active Tillering	
	SRI	CSC	SRI	CSC	SRI	CSC	SRI	CSC
T_1	49.9	45.4	91.3	84.8	101.8	89.1	484	381
T_2	52.1	47.4	93.3	83.0	101.6	90.6	490	386
T_3	34.3	31.4	75.4	69.0	87.8	75.1	304	239
T_4	68.4	60.7	110.8	98.3	117.2	104.4	603	475
T_5	62.4	55.4	104.8	93.0	111.8	99.1	583	459
T_6	61.0	54.2	103.4	91.8	110.6	97.9	535	422
T_7	54.4	49.1	96.0	86.7	105.5	92.8	500	394
T_8	56.4	50.9	98.1	88.5	107.3	94.6	513	403
T_9	44.9	40.8	86.3	78.4	97.2	84.5	431	339
T_{10}	43.5	39.5	84.8	77.1	95.9	83.2	421	331
T_{11}	40.2	36.5	81.5	74.1	92.9	80.2	362	285
T_{12}	41.9	38.1	83.3	75.7	94.5	81.8	364	287
	M	S M x S	M S	M x S	M S	M xS	M	S M x S
SEd±	0.75	1.43 2.08	1.36 1.46	2.40	1.73 1.20	2.37	9.06	7.53 13.6
CD (P=0.05)	3.23	2.88 NS	5.84 2.95	NS	7.44 2.43	NS	39.0	15.2 41.3

Number of tillers

Comparatively higher number of tillers m^{-2} was noticed in SRI over conventional system (Table 1). 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. 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. Treatment T_4 (STCR based IPNS) recorded maximum number of tillers (539 m^{-2}) and it was significantly superior over all other treatments. Treatment T_3 (LCC based N (RDF P and K) registered minimum number of tillers. Among treatments, T_4 (STCR based IPNS) under SRI registered maximum number of tillers, while T_3 under conventional system of cultivation registered the minimum number of tillers m^{-2} (Table 1). Manuring favored the tiller production irrespective of cultivation methods and nutrient management practices. 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. Findings of the present study are in line with those of Singh (2013).

Table 2: Effect of INM and cultivation methods on Leaf area index, Crop growth rate (g m^{-2} day^{-1}) and SPAD values of riceat various growth stages (mean of 2 years)

Treatments	Leaf area index				Crop growth rate				SPAD values			
	Tillering		Flowering		Tillering to PI		PI to Flowering		Tillering		Flowering	
	SRI	CSC	SRI	CSC	SRI	CSC	SRI	CSC	SRI	CSC	SRI	CSC
T_1	3.01	2.39	7.54	5.99	8.39	7.62	16.99	15.05	32.4	31.1	29.6	28.4
T_2	3.03	2.41	7.61	6.04	8.43	7.66	17.18	15.22	32.5	31.2	29.7	28.6
T_3	1.95	1.55	4.90	3.89	6.39	5.84	8.62	7.57	26.6	25.6	23.7	22.8
T_4	3.53	2.80	8.85	7.03	9.62	8.53	20.03	17.24	36.8	35.3	34.4	33.1
T_5	3.45	2.74	8.66	6.87	9.42	8.36	19.75	17.16	35.8	34.4	33.4	32.2
T_6	3.25	2.58	8.15	6.47	8.99	7.98	18.95	16.46	34.2	32.9	31.8	30.6
T_7	3.06	2.43	7.68	6.10	8.48	7.66	17.66	15.65	32.6	31.3	30.0	28.9
T_8	3.11	2.47	7.79	6.18	8.53	7.70	17.73	15.72	32.6	31.3	30.2	29.1
T_9	2.81	2.23	7.05	5.60	8.08	7.34	16.15	14.29	30.8	29.6	28.0	26.9
T_{10}	2.79	2.21	7.00	5.55	8.02	7.29	15.74	13.92	30.0	28.9	27.1	26.1
T_{11}	2.57	2.04	6.44	5.11	7.56	6.87	14.78	13.04	28.3	27.2	25.4	24.4
T_{12}	2.59	2.05	6.49	5.15	7.60	6.91	14.87	13.12	28.4	27.3	25.5	24.5
	M S M x S		M S M x S		M S M x S		M S M x S		M S M x S		M S M x S	
SEd±	0.75 1.43 2.08		1.36 1.46 2.40		0.07 0.07 0.12		0.15 0.21 0.32		0.19 0.469 0.664		0.174 0.501 0.701	
CD (P=0.05)	3.23 2.88 NS		5.84 2.95 NS		0.32 0.15 0.35		0.63 0.42 0.79		0.82 0.946 NS		0.749 1.010 NS	

Leaf area index: Leaf area index (LAI) increased with advancement of crop growth and it reached maximum at flowering stage (Table 2). Conspicuously higher LAI was recorded in SRI (M_1) system (2.93 and 7.35) compared to conventional system of cultivation (2.33 and 5.83) at tillering and flowering stages, respectively. This might be ascribed to planting younger seedlings resulted better root growth and activity (Sridevi and Chellamuthu 2015). STCR based IPNS treatment (T_4) achieved maximum values of LAI (3.53 and 8.85) at tillering and flowering stages, respectively and it was on par with T_5 (3.45 and 8.66). This might be due to higher root activity and healthier soil system led to more number of tillers which in turn increased LAI of rice. While the treatment (T_3) receiving LCC based N (RDF P and K) registered minimum values of LAI (1.95 and 4.90) at tillering and flowering stages, respectively.

Table 3: Effect of INM and cultivation methods on root length, root dry weight and root volume of rice at various growth stages (mean of 2 years)

Treatments	*Root Length*						*Root volume*						*Root dry weight*					
	Tillering		Flowering		Harvest		Tillering		Flowering		Harvest		Tillering		Flowering		Harvest	
	SRI	CSC	SRI	CSC	SRI	CSC	SRI	CSC	SRI	CSC	SRI	CSC	SRI	CSC	SRI	CSC	SRI	CSC
T_1	18.0	17.7	27.1	23.5	25.9	23.9	15.8	14.3	26.4	22.6	24.4	20.3	1.96	1.38	3.53	3.02	3.71	3.07
T_2	18.5	18.0	27.6	23.9	26.4	26.2	16.0	14.6	26.8	22.9	24.6	20.2	1.97	1.39	3.56	3.04	3.74	3.09
T_3	15.2	15.0	22.0	20.4	22.7	20.4	12.4	10.0	19.0	14.3	16.5	13.7	1.53	1.01	2.11	1.80	2.27	1.88
T_4	22.5	20.0	31.8	27.1	30.6	27.1	19.8	17.5	32.1	25.9	30.7	25.4	2.33	1.67	4.07	3.48	4.05	3.35
T_5	20.3	19.5	30.4	25.9	29.2	25.9	19.3	16.6	30.9	25.7	30.1	24.9	2.27	1.63	3.98	3.40	3.96	3.28
T_6	20.0	19.3	30.0	25.6	28.8	25.6	18.8	16.5	29.2	25.0	28.7	23.7	2.15	1.53	3.81	3.26	3.80	3.14
T_7	18.9	18.3	28.1	24.3	26.9	24.3	16.2	14.7	27.4	23.4	24.8	20.5	1.99	1.41	3.57	3.05	3.76	3.11
T_8	19.3	18.7	28.6	24.7	27.4	24.7	17.3	15.6	27.8	23.7	27.4	22.7	2.00	1.42	3.62	3.09	3.79	3.13
T_9	17.0	16.8	26.7	23.1	25.5	23.1	15.7	14.2	24.9	21.2	23.1	19.1	1.82	1.27	3.36	2.88	3.56	2.94
T_{10}	16.7	16.6	25.5	22.1	24.3	22.1	14.6	13.3	24.3	20.7	22.5	18.6	1.80	1.25	3.34	2.85	3.52	2.92
T_{11}	16.0	16.0	24.7	21.3	23.5	21.3	14.1	12.8	22.3	19.1	20.7	17.1	1.67	1.12	3.12	2.67	3.32	2.74
T_{12}	16.3	16.3	25.1	21.7	23.9	21.7	14.2	12.9	22.7	19.4	21.0	17.3	1.69	1.14	3.15	2.70	3.35	2.77
	M S Mx S		M S M xS		M S Mx S		M S Mx S		M S Mx S		M S Mx S		M S M xS		M S M xS		M S MxS	
SEd±	0.04 0.14 0.18		0.27 0.18 0.36		0.18 0.17 0.29		0.16 0.20 0.31		0.38 0.32 0.58		0.31 0.28 0.49		0.04 0.01 0.05		0.04 0.03 0.06		0.04 0.03 0.06	
CD (P=0.05)	0.18 0.28 0.39		1.16 0.34 1.19		0.76 0.34 0.82		0.69 0.40 0.82		1.63 0.65 1.74		1.34 0.57 1.45		0.18 0.03 0.18		0.16 0.07 0.17		0.19 0.06 0.20	

This might be due to no initial fertilization given which in turn unable to supply of required nutrients as and when to meet the growth of rice plant. Among the interactions, the treatment

M_1T_4 (STCR based IPNS) under SRI method of cultivation registered the highest LAI values (3.53 and 8.85) while the treatment M_2T_3 (LCC based N (RDF P and K) under conventional system of cultivation accounted for the lowest LAI (1.55 and 3.89) at tillering and flowering stages, respectively.

Crop growth rate (CGR g m^{-2} day^{-1})

It was detectably increased with the advancement of crop growth and reached maximum at panicle initiation to flowering stage under SRI and CSC (Table 2). Significantly higher CGR values were recorded in SRI (8.29 and 16.54 g m^{-2} day^{-1}) compared to conventional system of cultivation (7.48 and 14.54 g m^{-2} day^{-1} g m^{-2} day^{-1}) at all stages respectively. The maximum mean values (9.62 and 20.03 g m^{-2} day^{-1}) of CGR were obtained from STCR based IPNS treatment irrespective of stages. The treatment T_3 (LCC based N (RDF P and K) registered minimum values (6.39 and 5.34 g m^{-2} day^{-1}) at all growth stages. It might be due to maximum tillers at vegetative growth facilitated by proper nutrient supply and sustained with less tiller mortality under wider spacing made plants less dense with vigorous root growth in SRI. (Sri Ranjitha and Reddy 2014).Significant interaction was found between cultivation methods and nutrient management. Among interactions, treatment M_1T_4 (STCR based IPNS) under SRI registered the highest CGR values (20.03 g m^{-2} day^{-1}) at panicle initiation (PI) to flowering stage while treatment T_3 (LCC based N (RDF P and K) under conventional system of cultivation noted (M_1T_3) lowest CGR (5.84 g m^{-2} day^{-1}) at tillering to panicle initiation stage.

Leaf N content (SPAD values)

The SPAD reading is a measure of total chlorophyll content indicating the greenness of leaves influencing the physiological functions as well as provides an idea about leaf nitrogen content as nitrogen is an essential constituent of chlorophyll. SPAD values decreased with advancement of crop growth irrespective of treatments (Table 2). However, SRI showed higher SPAD values (31.8 and 29.1) compared to conventional system of cultivation (30.5 and 28.0) at tillering and flowering stages. This might be due to increased photosynthetic activity and prolific root growth of rice plants which in turn enhanced the chlorophyll content of leaves under stress free environment throughout the crop duration. Application of STCR based IPNS through fertilizer + FYM + bio fertilizers (T_4) registered higher SPAD values of 36.8,35.3 and 34.4,33.1 at tillering and flowering stages, respectively and it was on par with application of 75 % RDN through fertilizer + 25 % N through FYM (T_5) and T_6 (75 % RDN through fertilizer + 25 % N through GM). This might be due to supply of nutrients from applied inorganic fertilizer N and added FYM with biofertilizers.

Table 4: Effect of INM and cultivation methods on dry matter (kg ha^{-1}) of rice at various growth stages (mean of 2 years)

Treatments	Tillering			Flowering			Harvest		
	SRI	CSC		SRI	CSC		SRI	CSC	
T_1	1965	1840		8717	8162		11787	11230	
T_2	2008	1880		8807	8246		11961	11394	
T_3	1368	1280		5032	4712		8526	8604	
T_4	2428	2273		10146	9500		15201	14095	
T_5	2353	2204		9998	9361		14753	13688	
T_6	2211	2070		9522	8916		13736	12766	
T_7	2031	1902		8996	8423		12263	11607	
T_8	2077	1945		9053	8477		12335	11657	
T_9	1828	1712		8219	7696		10728	10231	
T_{10}	1758	1646		8015	7505		10424	9948	
T_{11}	1598	1496		7454	6979		9547	9101	
T_{12}	1621	1518		7511	7033		9613	9162	
	M	S	M x S	M	S	M x S	M	S	M xS
SEd±	13.2	32.9	46.5	39.6	98.5	139.1	45.2	142.9	198.8
CD (P=0.05)	56.9	66.4	NS	170.2	198.5	NS	194.7	288.1	424.1

Root characteristics (Length, volume and dry weight)

Significantly higher values of root length, root volume and root dry weight were recorded in SRI (18.2,27.3, 26.3 cm, 16.2,26.2,24.5 cc $hill^{-1}$ and 1.69,3.15,3.35 g $hill^{-1}$) compared to conventional system of cultivation (17.7,23.6,23.8 cm, 14.4,22.0,20.3 cc $hill^{-1}$ and 1.35,2.93,2.95 g $hill^{-1}$) at tillering, flowering and harvest, respectively (Table 3). This might 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 in SRI. (Sathya *et al.*2013). Treatment T_4 (STCR based IPNS) recorded the higher values of root length, root volume and root dry weight (22.5, 31.8, 30.6 cm ,19.8,32.1,30.7 cc $hill^{-1}$ and 2.33,4.07,4.05 g $hill^{-1}$ at tillering, flowering and harvest, respectively. It was significantly superior over all (LCC based N (RDF P and K) registered the lowest values of these root characteristics at all growth stages. Root length density was higher with inorganic and organic fertilizer application than control as reported by Sathya *et al.* (2013). Among interactions, treatment T_4 (STCR based IPNS) under SRI system (M_1T_4) registered the highest values of root characters while T_3 (LCC based N (RDF P and K) under conventional system (M_2T_3) recorded the lowest root length, root volume and root dry weight at all crop stages.

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

In general, it increased gradually with advancement of growth and reached maximum at maturity. Significantly higher DMP were recorded in SRI (1937, 8456 and 11740 kg ha^{-1}) compared to conventional system (1813, 7918 and 11124 kg ha^{-1}) at tillering, flowering and harvest, respectively. This might be ascribed due to greater tiller number with larger root volume, more LAI (Sridevi and Chellamuthu 2015). Relatively higher DMP were recorded with T_4 (STCR based IPNS) (2428, 10146 and 15201 kg ha^{-1}) at tillering, flowering and harvest, respectively and it was on par with $T_{5,}$ whereas LCC based N (RDF P and K) registered lower values of DMP (1368, 5032 and 8526 kg ha^{-1}). 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 (Priyanka Gautam *et al.* 2013). Interactions were non significant at tillering and flowering stages whereas it was significant at harvest. However, treatment M_1T_4 (STCR based IPNS) under SRI registered the highest dry matter (15201 kg ha^{-1}) at harvest while treatment M_1T_3 accounted for the lowest DMP (8526 kg ha^{-1}).

The results revealed that the combination of inorganic and organic nutrient sources i.e. STCR based IPNS practices and or inorganics integrated with organics like FYM or green manure application can be beneficial in enhancing growth and physiological attributes of rice both under system of rice intensification and conventional system of cultivating rice in lowlands in deep clay soil of Cauvery Deltaic zone of Tamil Nadu. Practicing STCR based IPNS will be a better choice for the farmers of this particular zone by which enhanced and sustainable rice production could be achieved.

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