Influence of Methods of Rice Cultivation on the Yield, Nutrient Availability and Uptake of Nutrients in the Coastal Soils of Karaikal

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Abstract

A field study was done to compare different methods of rice cultivation, and N management and their interactions in the coastal soils of Karaikal. Results showed that line planting was significantly superior as compared to the SRI and ICM methods in terms of grain yield. Among the N management strategies, the LCC method recorded significantly higher yield followed by the blanket and SPAD methods. It is concluded that SRI may not be suitable in this soil.

The population demography indicates that India will cross 1.5 billion by the year 2020 (Duraisamy *et al.*, 2001). Feeding this growing population is a daunting task, requiring at least 300 million tonnes of food grains, an addition of another 90 million tonnes. Among the management practices, the fertilizer management could alone account for 50 per cent of yield gap (Randhawa and Velayutham, 1989), the plant density by about 40 to 45 %, the land preparation, pest, disease and weed management by about 15-20 per cent and the post harvest technologies by about 7-26 % (Duraisamy *et al.*, 2001). Recent advances in the technology development and transfer to the farm level did not produce the anticipated results either due to the incomplete adaptation or inherent problems existing at the farm level. As far as rice crop is concerned, methods of cultivation viz., System of Rice Intensification (SRI) and Integrated Crop Management (ICM) are considered to be very effective and gaining popularity among the farming communities. Though reports suggest that the yield of rice could be enhanced by 2 to 3 times by adopting SRI method of cultivation (Uphoff, 2002) and up to 1.5 Mg/ha by adopting the ICM practices (Balasubramanian *et al.*, 2004) there are also contradictory results which indicate not much of yield enhancement.

Similarly the fertilizer N management in rice system of cultivation is considered to be a complicated process owing to the complex behaviour of Nitrogen under submerged conditions. In this regard the recent developments of fertilizer N prescription by supplying N, based on the real time N concentration in the leaf using Leaf Colour Chart (LCC) and Soil and Plant Analysis Department Meter (SPAD meter). The present investigation was aimed at comparing the different methods of rice cultivation, the tools of N management and their interactions in the coastal soils of Karaikal.

Materials and Methods

A field experiment was conducted on the experimental farm of Pandit Jawarharlal Nehru Collage of Agriculture & Research Institute, Karaikal of the U.T. of Pondicherry. The treatments were the methods of rice cultivation (Var.ADT.43) in the main plot viz., M_1- SRI, M_2- ICM, M_3 – Line planting and M_4 - Random planting (The farmers method of planting). In the sub plots, the various N management tools were super imposed viz., N_1- Control, N_2- the blanket recommendation (120 Kg N/ha), N_3 – LCC - 4, N_4 – LCC – 5, N_5 – SPAD – 35 and N_6 – SPAD – 37. The treatments were replicated twice in a split plot design and the experiment was conducted during *kharif* 2005. The initial soil samples before the crop cultivation and soil samples during crop growth were collected and

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analysed for various properties by adopting standard procedures. The plant samples were also collected at different phenological stages and at harvest for computing the uptake of nutrients.

The experimental soil was sandy clay loam with an apparent specific gravity of 1.33 Mg/m^3 and absolute specific gravity of 2.59 Mg/m^3 and the pore space of 48.06 per cent. The pH and EC in 1:2 soil water suspension was 7.85 and 0.58 dS/m. The organic carbon content was 5.40 g/kg and the CEC was 24.45 cmol (p^+)/kg. The ESP was worked out to be 16.31 per cent. As regards the available nutrient status, the $KMnO_4$- N was 168 kg/ha (low), Olsen – P was 24 kg/ha (high), and NH_4OAc – K was 278 kg/ha (medium).

Results and Discussion

The results of the grain yield had shown that line planting was significantly superior as compared to the SRI and ICM methods, which recorded yields on par with the random method of transplantation. The benefits that are attributed towards the yield increase in SRI method of cultivation by different author were due to the production of different plant type (Laulanié, 1993) linked to phyllochron pattern of plant growth (Moreau, 1987), planting of single seedling, reducing the competition between the multiple seedlings, overcoming the transplantation shock (Uphoff, 2003), square planting which not only facilitates the operation of cono weeder resulting in the incorporation of weeds in to the soil but also favours better aeration, the intermittent irrigation that creates a favourable soil physical, physico-chemical, chemical and biological properties making the plant to grow under non-hypoxic situation and deeper rooting depth (Barison, 2002). However, the present investigation did not produce the anticipated results which might be due to the fact that the SRI management practices lead to more productive phenotype provided there are conducive soil conditions for getting the expression of plant's full genetic potential for tillering, shoot growth and grain filling (Uphoff, 2003). It was further insisted by Uphoff (2003), that SRI will not be proven or disproven by any singly set of results, since its yield, like those with any production method may vary as a result of differences in soil, climate etc. In the present investigation the major constraints which were faced in the SRI method of cultivation was that when the seedlings were grown in mat nursery the germination and establishment was relatively slow due to the fact that the native soil is sodic and the salt raise up by capillarity causing salt injury because of the irrigation water which have high residual sodium carbonate (Sankar, 1999). Furthermore, the enhanced yield in SRI method of cultivation is said to be due to the prolonged tillering phase in the main field there by resulting in more number of tillers. However, if the soil in the main field is not favourable, the survival of very young seedlings and the production of more number of tillers is hampered as revealed from the present investigation. Similar results were also reported by Krupakar Reddy *et al.* (2004), who observed comparable yield between SRI and conventional method of cultivation. It was even reported by Uphoff (2003), while summarizing the result of SRI trials from various countries, that there are certain places where SRI recorded lower yields than conventional methods.

The recent reports form Directorate of Rice Research (DRR, 2006) had also indicated that among the 22 locations where SRI and ICM were compared with conventional method of transplanting, in 11 locations, SRI method had recorded significantly higher yield, in 8 locations SRI and ICM were comparable, in 2 locations ICM was found superior to SRI and in 3 locations viz., Karaikal, Kapurthala and Malan, the standard method of transplanting was found to be significantly superior to SRI and ICM method of cultivation. This clearly indicates that the synergistic effect of different components of SRI could be better utilized only when the soil condition is favourable to support vigorous tillering and root proliferation in terms of its nutrient supply and conditions favouring their uptake. In the present investigations such a soil environment is not available which could compensate the plant density

on par with the line planting method of cultivation by increased tiller number and productive_tillers. Though the ICM method of cultivation is a modified method of SRI, reasons quoted above may also hold good for the significantly lower yield registered by this method than line planting.

Among the N management strategies, the LCC method recorded significantly higher yield followed by the blanket and SPAD methods. Between the LCC values, the LCC 4 itself is sufficient to meet the crop requirement. This result is in line with Porpavai *et al.* (2002), and Budhar (2005). It was further seen that the SPAD method of N supply did not result in higher yield as compared to LCC method, but was comparable to the blanket recommendation. Considering the amount of nitrogenous fertilizers used, (Table 1), which ranged form 180 – 270 kg/ha in LCC method and 30 – 60 kg/ha in SPAD method as against the blanket recommend tion of 120 kg/ha. The N management throu h SPAD measurement is relatively cheaper t practically not possible. However, this metl l was reported to be highly economical by Bal bramanian *et al.* (2000) and Coumaravel (2002

The total uptake of the nutrients as influenced by different methods of rice cultivation and N management strategies revealed that the line planting method of cultivation had resulted in significant uptake of N, P and K by the plants (Table 1). The uptake of nutrients is a function of the nutrient supply form the soil, which is being reflected on the concentration of nutrients in different plant parts and the dry matter accumulation. These two factors are mutually interdependent which means that a healthier crop depends on better nutrient supply and an adequate nutrient availability produces higher dry matter production and thus resulting in heavy nutrient uptake. As seen in the case of grain yield of rice, the line planting method of cultivation was able to produce higher dry matter as well as grain yield due to more number of tillers and productive tillers per unit area and higher panicle weight as compared to SRI and ICM methods of cultivation, which may be the reason for higher uptake of nutrients. Similarly the different N management strategies had produced significantly different uptake values probably due to the higher nutrient availability in the case of N management treatments or through higher dry matter production resulting in increased uptake of P and K. Though, there were lot of variation in the doses of N applied (30 – 270 kg N/ha), the uptake of nutrients seemed to be highly influenced by dry matter production rather than higher nutrient concentrations.

The nutrient availability in the soil was influenced by different treatments and their interactions (Table 1). As regards the available N and K status, the methods of cultivation did not have any significant influence possibly due to the fact that growth and dry matter accumulation in different treatments were according to nutrient supply from the soil and the nutrient depletion is proportional to dry matter accumulation, thereby resulting in almost similar status of available nutrients at harvest stage. Among the N management tools the LCC method had resulted in a positive balance of nutrients at harvest as compared to initial status which might be either due to the higher level of N applied or due to the decreased dry matter production with higher doses of N.

To conclude, the present study had shown that the improved methods of rice cultivation viz., SRI and ICM may not result in higher productivity under all situations. It may also be concluded that the soil should be fertile enough without any limitations so as to support the young seedlings to produce profuse tillering there by resulting in higher production.

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Table 1: Effect of methods of rice cultivation and N management tools on the grian yield, uptake and availability of nutrients

Methods of planting		Total N applied (kg ha^{-1})	Grain yield (kg ha^{-1})	N uptake (kg ha^{-1})	P uptake (kg ha^{-1})	K uptake (kg ha^{-1})	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})
SRI	Control	0	1640	73.04	7.79	52.71	107	13.07	270
	Blanket	120	2091	105.20	11.98	79.03	191	18.03	333
	LCC 4	240	3119	91.86	9.33	58.24	150	18.06	274
	LCC 5	270	2229	86.88	10.32	50.50	176	18.17	283
	SPAD 35	60	2440	76.62	9.81	58.10	157	17.51	305
	SPAD 37	60	2107	87.14	9.18	66.65	133	16.77	288
ICM	Control	0	1904	77.58	10.39	60.00	109	15.59	268
	Blanket	120	2518	100.72	11.32	66.78	134	19.84	282
	LCC 4	210	2189	96.12	7.75	57.67	190	13.31	282
	LCC 5	270	2976	115.98	10.34	79.66	176	17.56	293
	SPAD 35	30	2056	87.42	12.39	69.41	156	13.38	283
	SPAD 37	60	2110	68.08	8.82	49.57	155	16.53	276
Line planting	Control	0	2170	96.32	10.96	98.67	169	15.10	282
	Blanket	120	2712	174.15	19.96	119.75	162	20.27	265
	LCC 4	180	2966	208.68	20.15	140.32	176	19.80	296
	LCC 5	270	2536	103.82	12.75	97.99	169	14.86	272
	SPAD 35	30	2288	132.24	14.49	91.04	161	15.09	257
	SPAD 37	30	2502	142.42	16.32	112.01	154	20.75	227
Random planting	Control	0	1839	48.18	5.00	39.10	160	11.11	277
	Blanket	120	2248	112.41	10.62	68.86	182	12.35	300
	LCC 4	180	2353	107.79	9.73	65.54	162	13.38	279
	LCC 5	270	2675	113.24	9.31	68.28	160	11.05	241
	SPAD 35	30	2137	72.77	7.13	58.05	147	12.63	310
	SPAD 37	30	1690	64.81	7.74	53.85	168	16.34	329
C.D (0.05%) for M			211	11.22	1.34	13.04	NS	1.41	NS
C.D (0.05%) for N			201	5.38	0.77	3.44	10	1.51	12
C.D (0.05%) for M x N			426	16.03	2.21	11.70	27	NS	35
C.D (0.05%) for N x M			403	14.30	1.93	12.39	27	NS	31

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