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Integrated Nutrient Management Practices on Growth and Yield of Direct Seeded Low Land Rice

R. Umashankar, C. Babu, P. Suresh Kumar and R. Prakash
Department of Meteorology, Tamil Nadu Agricultural University, Coimbatore-641 003, India

Abstract: Two field experiments were conducted in the experimental farm, Department of Agronomy, Annamalai University, Annamalai Nagar, India on clay loam soils during Samba (August-January) 1998-99 and Kuruvai (July-October) 1999 seasons to study the impact of integrated nutrient management practices on the growth and grain yield of rice. The experiments were laid out in split plot design with three replications. Main plot consisted of nine different nutrient source combinations whereas; in sub plot seed treatments were taken. The experimental results revealed that enriched FYM+neem cake blended urea +K in combination with seed soaking of Penshibao and *Azospirillum* produced taller plants, increased number of tillers m^{-2}, higher leaf area index and maximum dry matter production as compared to all other treatment combinations. Increased growth parameters also favorably increased the grain and straw yield of rice. Magnitude of increase of grain yield was 29.0 and 34.6% during Samba and Kuruvai seasons, respectively over control (Conventional NPK+water soaking).

Key words: Direct seeded rice, nutrient sources, seed soaking, grain yield

INTRODUCTION

Rice is the most important staple food for 65% of the population in India and foremost food of the developing world. Direct seeded rice culture is becoming an increasingly popular alternative to transplanting in India and it is cultivated nearly one-third of the total rice area of the country, in spite of many constrains. Transplanting being a labour intensive and costly process, direct seedling is becoming popular even in the non-traditional rice growing areas. Introduction of early maturing varieties and availability of selective herbicides encouraged many farmers to switch over from transplanting to direct seeding[1].

Rice crop revises a heavy fertilization for better growth and yield. Nitrogen is by far the most important yield-raising nutrient. The low use efficiency of nitrogen and higher losses due to volatilization, leaching, denitrification alarmed application of heavy doses of nitrogen. Hence, application of appropriate quantity of nitrogen without causing much loss, using slow releasing nitrogenous fertilizers is therefore one of the important agronomic techniques to increase the nitrogen uptake and in turn grain yield of rice.

In view of cost escalation in respect of inorganic fertilizers, there is a need to utilize organic manures, crop residues, organic wastes etc. to a large extent. In a tropical country like India, addition of organic manures to soil is crucial for maintaining the soil fertility and also for successful crop production. Bio-fertilizers are another important natural source for augmenting the nutrient supplies to plants. By virtue of fixing atmospheric N by *Azosprillium* and acid by solubilisation of applied and native soil phosphate by *Phosphobacteria*, they are accepted as key compounds of the integrated plant nutrient supply system[2].

Soaking the seeds in water is a very common practice in rice. However, seed soaking in *Azospirillum* had influenced the rice yield[3]. Penshibao is a new micronutrient rich chemical, having growth promoting property and its effects were proved in many crops. But, there is no research report on organic manures in combination with seed soaking chemicals on rice production, thus the present study was made.

MATERIALS AND METHODS

The experiments were conducted at Annamalai University farm, Annamalai Nagar during Samba (August-January) 1998-99 and Kuruvai (July-October) 1999 seasons. The experimental farm is geographically located at 11°24' N latitude, 74°41' E longitude and at an altitude of 5.79 m above mean sea level. The soil of the experimental field was moderately drained clay loam with

Corresponding Author: R. Umashankar, S/o K. Rajagopal, 1-B, Katchimada Street, Kanchipuram. 631 502, Tamil Nadu, India
Tel: 0914112224220 E-mail: suriep@yahoo.com

a pH of 7.3 in both the seasons. The soil was low in available N (238.0 and 236.2 kg ha^{-1}), medium in P_2O_5 (23.5 and 23.7 kg ha−1) and high in available K_2O (318.7 and 0386.2 kg ha^{-1}) during Samba and Kuruvai seasons, respectively. Rice cultivars CO 43 (short duration) during Samba and PY 5 (medium duration) during Kuruvai were chosen for the study. The experiments were laid out in split plot design with three replications. The treatment details are furnished below:

Main plot

M_1: FYM+NPK
M_2: Enriched FYM+NPK
M_3: FYM+Neem cake blended urea+PK
M_4: FYM+Gypsum blended urea+PK
M_5: FYM+Tar coated urea+PK
M_6: Enriched FYM+Neem cake blended urea+K
M_7: Enriched FYM+Gypsum blended urea+K
M_8: Enriched FYM+Tar coated urea+K
M_9: Conventional NPK

Sub plot

S_1: Water soaking
S_2: Seed treatment with *Azospirillum*
S_3: Seed soaking with Penshibao+*Azospirillum.*

The FYM was applied basally @ 12.5 t ha^{-1}. In fertilizer application treatments, nitrogen, phosphorus and potassium were supplied through urea, super phosphate and muriate of potash, respectively @ 120:38:38 kg ha^{-1} for short duration and 150:50:50 kg ha^{-1} for medium duration varieties. Basally half dose of nitrogen, full dose of P_2O_5 and half dose of K_2O were given. The remaining N and K_2O were top dressed in two equal splits at maximum tillering and panicle initiation stages. The slow release nitrogenous fertilizers viz., neem cake blended urea, gypsum blended urea, tar coated urea were applied according to the treatment schedule. The treatment plots of enriched FYM were applied with enriched FYM prepared already by mixing the entire dose of super phosphate and the recommended FYM. It was applied basally to the respective treatments.

For recording various observations, a sample consist of five plants were selected at random and tagged. Growth parameters viz., plant height, number of tillers m^{-2}, Leaf Area Index (LAI) and dry matter production (DMP) were measured. Plant height was recorded from the surface of the soil to the tip of the top most leaf at harvest. The number of tillers m^{-2} were counted and recorded at maximum tillering stage. LAI was estimated at panicle initiation stage by using the formula[4].

$$LA = L \times W \times K$$

Where:
LA = Leaf area (cm^2)
L = Length of the leaf (cm)
W = Maximum width of the leaf (cm)
K = Adjuscent factor 0.75[5]
Third leaf was selected as index leaf.

$$LAI = \frac{\text{Total leaf area of a known population}}{\text{Leaf area occupied by the given plant population}}$$

A plant sample at harvest was taken, dried in hot air oven at 80±5°C for 48 h, oven dry weight was recorded and computed to t ha^{-1}. Number of panicles m^{-2} was counted at the time of harvest. Matured crop was harvested from the net plot area and the grains were hand threshed, winnowed and sun dried. The dried grains were weighed plot wise and recorded. The grain yield $plot^{-1}$ was computed to t ha^{-1}. Straw yield was calculated after threshing the grains, the straw was sun dried plot-wise, weighed and computed to t ha^{-1}. The data subjected to statistical analysis[6].

RESULTS AND DISCUSSION

Growth characters: Growth parameters of rice were significantly influenced by the INM treatments (Table 1). Among the main plot treatments, enriched FYM+neem cake blended urea +K produced the tallest plants (101.6 and 97.4 cm) during Samba and Kuruvai seasons, respectively. Similarly, higher number of tillers m^{-2} (345.5 and 358.1), increased LAI (7.57 and 7.76) and maximum DMP (13.6 and 14.6 t ha^{-1}) were recorded with the same treatment during Samba and Kuruvai seasons, respectively over other treatment combinations. Enriched FYM+gypsum blended urea +K was the next best with regard to above growth parameters. Conventional NPK produced the least growth parameters. Increased availability of applied phosphorus to the crop as a result of increased solubility of phosphorus in the presence of organic acids in the enriched FYM and slow and gradual release of nitrogen from the neem cake blended urea might have exerted a beneficial effect on the growth characters. Neem cake blended urea could be attributed to the slow nitrification of applied urea and reduction in nitrogen losses caused by hydrolysis and denitrification resulting in gradual release of available nitrogen and also its greater availability to the crop. The results observed in this investigation are in consonance with the findings of Mani

Table 1: Effect of integrated nutrient management on growth and yield parameters of direct seeded rice

	Plant height (cm) at harvest		Number of tillers m^{-2} at maximum tillering stage		LAI at panicle initiation stage		DMP (t ha^{-1}) at harvest		Grain yield (t ha^{-1})		Straw yield (t ha^{-1})	
Treatments	Samba	Kuruvai	Samba	Kuruvai	Samba	Kuruvai	Samba	Kuruvai	Samba	Kuruvai	Samba	Kuruvai
Nutrient sources												
M_1	91.3	87.45	307.9	321.6	4.14	4.45	6.07	6.55	4.14	4.45	6.07	6.55
M_2	94.9	90.9	320.4	333.4	4.70	5.02	6.72	7.25	4.70	5.02	6.72	7.25
M_3	97.3	93.2	329.8	342.9	4.98	5.34	7.09	7.65	4.98	5.34	7.09	7.65
M_4	95.5	91.5	323.6	337.0	4.72	5.06	6.77	7.30	4.72	5.06	6.77	7.30
M_5	93.2	89.2	314.0	327.5	4.43	4.74	6.38	6.88	4.43	4.74	6.38	6.88
M_6	101.6	97.4	345.5	358.1	5.55	5.95	7.78	8.38	5.55	5.95	7.78	8.38
M_7	99.8	95.5	339.3	352.1	5.28	5.66	7.46	8.05	5.28	5.66	7.46	8.05
M_8	97.9	93.8	333.2	346.2	5.00	5.36	7.12	7.68	5.00	5.36	7.12	7.68
M_9	89.6	85.8	301.9	315.8	3.86	4.14	5.76	6.21	3.86	4.14	5.76	6.21
SEd	0.48	0.46	2.67	2.58	0.09	0.09	0.08	0.09	0.09	0.09	0.08	0.09
CD (p=0.05)	0.97	0.94	5.35	5.14	0.18	0.19	0.17	0.18	0.18	0.19	0.17	0.18
Seed treatments												
S_1	94.4	90.4	319.2	332.7	4.49	4.82	7.01	7.57	4.49	4.82	7.01	7.57
S_2	95.6	91.5	323.7	337.2	4.76	5.09	6.81	7.34	4.76	5.09	6.81	7.34
S_3	97.0	93.1	328.9	341.5	4.97	5.33	6.56	7.07	4.97	5.33	6.56	7.07
SEd	0.25	0.25	1.95	1.87	0.05	0.05	0.06	0.06	0.05	0.05	0.06	0.06
CD (p=0.05)	0.51	0.58	3.92	3.75	0.11	0.11	0.12	0.12	0.11	0.11	0.12	0.12

and Palaniappan[7]. Bains *et al.*[8] observed that plant height and number of tillers m^{-2} were increased in neem cake blended urea. Increase in LAI[9] and DMP in rice[10,11] due to neem cake blended urea was earlier reported.

Among the sub plot treatments, seed soaking with Penshibao with *Azospirillum* recorded significantly higher plant height (97.0 and 93.1 cm), more number of tillers m^{-2} (328.4 and 341.5), increased LAI (7.40 and 7.56) and maximum DMP (12.8 and 13.1 t ha^{-1}) during Kuruvai and Samba seasons, respectively over other treatments. This treatment was followed by *Azospirillum* seed treatment. The lowest growth parameters were recorded with seed soaking in water. This might be due to the synergistic and cumulative effect of micronutrient rich Penshibao and nitrogen fixing *Azospirillum* on crop establishment and seedling vigour. The favourable growth attributes might have augmented the CGR of direct seeded rice and this could be the reason for better growth performance of the direct seeded rice in terms of plant height, tiller number m^{-2} and DMP. The beneficial effect of *Azospirillum* could be also due to secretion of growth promoting substances as stated by Prasad and Singh[12].

The interaction effects of between fortified organic and inorganic and seed soaking were found to be significant. Enriched FYM+neem cake blended urea +K and seed soaking with Penshibao and *Azospirillum* resulted in production of the tallest plants. In the same manner other growth parameters (number of tillers m^{-2}, LAI and DMP) were also maximum with the above combination. The least value was observed in conventional NPK and water soaking. These results are in conformity with the report of Syed and Sree Ramulu[13].

Grain and straw yield: All the treatments exerted a distinct effect on the grain and straw yields of rice. In respect to main treatments, the effects of the treatment were similar to those observed in growth parameters. Application of enriched FYM+neem cake blended urea +K registered the highest grain yield (5.55 and 5.95 t ha^{-1}) and straw yield (7.78 and 8.38 t ha^{-1}) during Samba and Kuruvai seasons, respectively. This was followed by the application of enriched FYM+gypsum blended urea +K. The least grain yield was recorded in conventional NPK application. This could be attributed to the gradual release of available N due to the effect of alkaloids present in the neem cake. Discussions made in previous section will holds good here also. The results of the study are in line with the findings of Muneshwar and Singh[14], Natarajan[15].

Among the seed soaking treatments, *Azospirillum* and Penshibao treated seeds produced the maximum grain yield (4.97 and 5.33 t ha^{-1}) and straw yield (7.01 and 7.57 t ha^{-1}) during the Samba and Kuruvai seasons, respectively. The least yields were recorded with control (water soaking). The results have evidently proved the advantage of combination of Penshibao and bio-fertilizer. Enhanced N fixation by *Azospirillum* and availability of micronutrients such as zinc and boron from Penshibao might have provided congenial seed-soil interface promoting growth and development of crop. Consequently their additive effects contributed to better utilization of available and applied nutrients which in turn resulted in higher grain yield of rice. The results of the present study corroborate with the reports of Babu[16].

The interaction effect between fortified organic and in organics and seed soaking were found significant. The

highest grain yield (5.78 and 6.20 t ha^{-1}) and straw yield (7.99 and 8.65 t ha^{-1}) were obtained during Samba and Kuruvai seasons, respectively with enriched FYM+neem cake blended urea +K along with seed soaking of Penshibao and *Azospirillum*. The least grain and straw yields were recorded with conventional NPK with water soaking treatment. This could be due to the favourable effect of sustained release of N and availability of both macro and micronutrients at seed soil interface, which results in increased seedling vigour and growth attributes. Manifestation of good growth parameters naturally will lead to increased yield. The results of the present study are in line with the report of Palaniappan *et al.*[17].

Thus from the present investigation, it can be concluded that application of enriched FYM+neem cake treated urea +K along with seed soaking of Penshibao and *Azospirillum* produced better growth and yield attributes which in turn increased the grain straw yields of wet seeded direct seeded rice.

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