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Assessing the Impact of Integrated Nutrient Management Practices on Growth and Yield Performance of Direct Seeded Rice in Dystrudepts of Nagaland

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ABSTRACT

Background: Indian agriculture continues to be a gamble with monsoon, Direct seeded rice (DSR) can prove to be a promising method technically and economically, which is an achievable alternative to transplanted rice. On the other hand, the soil has become dilapidated of late due to ill-agricultural practices. Therefore, soil fertility and productivity restoration are in dire need, which can be done through integrated nutrient management.

Methods: The investigation was conducted to assess the impact of integrated nutrient management on the growth and yield performance of direct seeded rice in dyrtrudepts of Nagaland at the experimental farm of the School of Agricultural Sciences (SAS), Medziphema Campus, Nagaland University, during *kharif* season of 2019 and 2020. A randomized block design with three replications and twelve treatments was applied for the trial.

Result: Application of 100% RDF + 2 t FYM ha^{-1} + PSB (T_5) significantly increased the growth parameters, yield attributes, and yield of direct seeded rice which was at parity with T_4 (100% RDF + 2 t FYM ha^{-1}) in both the years of cultivation. Therefore, the integrated use of nutrients favored the growth and yield characteristics of direct-seeded rice.

Key words: FYM, Growth parameter, INM, PSB, Yield.

INTRODUCTION

Rice (*Oryza sativa* L.) is a cereal grain that belongs to the family of *Poaceae* and is recognized as a supreme commodity to mankind. Rice plays a pivotal role in Indian agriculture and is the staple food for more than 70 per cent of the population. Since Indian agriculture continues to be a gamble in monsoon, water scarcity for agricultural production has become a significant problem. Therefore, the direct seeding technique is a viable option to reduce unproductive water flows and is gaining acceptance by the growers day by day because of its low input. The DSR method does not require more labor and squeezes water consumption and production cost. Thus, DSR is a promising method technically and economically, which is an achievable alternative to transplanted rice.

On the other hand, soil is rightfully called the “soul of infinite life”; however, this soul has become dilapidated of late due to ill-agricultural practices being adapted to feed the ever-increasing mouths. Our agriculture’s sustainability and climate adaptability depends on what we put into our fields and what leaches from our field and gets added to our water and air. The needle is pointing at imbalanced nutrient management practices, which have ill effects on soil health deterioration. It is needed to feed our ever-increasing mouths, but this has to be done without further deteriorating our soils, climate or for that matter, human health. The path forward can start with balanced, integrated nutrient management and slowly pave the way towards adapting organic or bio-fertilizers as an alternative to chemical fertilizers (Choudhary *et al*., 2020). Soil health is deteriorating due to the excessive use of chemical fertilizers. Therefore, it is in dire need of soil fertility and productivity, which can only be done through judicious use of chemical fertilizers along with organics (Khan *et al*., 2009). Keeping in view of the above facts, the present investigation entitled, “Assessing the impact of Integrated Nutrient Management practices on growth and yield performance of Direct Seeded Rice in dystrudepts of Nagaland” was carried out for studying the growth and yield parameters of direct seeded rice.

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MATERIALS AND METHODS

The investigation was conducted at the experimental farm of the School of Agricultural Sciences (SAS), Medziphema

Campus, Nagaland University, during *kharif* season of 2019 and 2020. Geographically, the experiment site is situated at 20°45′4″ N latitude and 93°53′0″ E longitude at of 310 m above mean sea level. The soils of the experimental site are dominated by the soil order of Inceptisol with low base saturation with a "Udic" soil moisture regime; therefore, it was laid down in "Dystrudepts" great groups. A well-drained and sandy clay loam texture characterized the soil of the experimental plot.

The field experiment was laid out in randomized block design with three replications and twelve treatments with a plot size of 3 m × 2 m, each maintaining 20 cm × 10 cm spacing. The treatment details are T_1: Control, T_2: RDF (120 kg N ha^{-1} + 40 kg P_2O_5 ha^{-1} + 30 kg k_2O ha^{-1}), T_3: 100% RDF +PSB, T_4: 100% RDF + 2 t FYM ha^{-1}, T_5: 100% RDF + 2 t FYM ha^{-1} + PSB, T_6: 75% RDF + PSB, T_7: 75% RDF + 2 t FYM ha^{-1}, T_8: 75 % RDF + 2 t FYM ha^{-1} + PSB, T_9: 50% RDF + PSB, T_{10}: 50% RDF + 2 t FYM ha^{-1}, T_{11}: 50% RDF + 2 t FYM ha^{-1} + PSB, T_{12}: 109 kg N ha^{-1} + 30 kg P_2O_5 ha^{-1} + 46 kg K_2O ha^{-1} (SSNM).

Land preparation was carried out and well-decomposed FYM was broadcasted in the required plots @ 2 tones ha^{-1} one month before sowing. The calculated amount of fertilizer doses was applied to each plot. Seed treatment of phosphorus solubilizing bio-fertilizer (PSB) at the rate of 200 g per 10 kg seeds as per the treatments was done before sowing. The rice cultivar (Kuntsaire) was broadcasted in each plot @ 80 kg ha^{-1}.

Growth parameters such as plant height, number of leaves $plant^{-1}$, and number of tillers $plant^{-1}$ of five random plants were selected from each plot and tagged for recording. The plant height was measured in centimeters (cm) from the ground level to the tip of the plants. The number of leaves $plant^{-1}$ and tillers $plant^{-1}$ was recorded from the tagged plants. Dry matter accumulation was recorded by selecting five random plants from each plot. The samples were sun dried followed by hot air oven dried at 65-70°C and the average dry weight was recorded. The crop growth rate (CGR) at different growth stages was calculated by using the dry matter accumulation (g) of plants for each plot at successive growth.

Yield attributes such as panicle length, number of panicles $plant^{-1}$, and number of grains $panicle^{-1}$ were recorded from the tagged plants of each plot at the time of harvest. After threshing and cleaning, the grain and straw yield were obtained from their respective plots.

RESULTS AND DISCUSSION

Growth attributes

Table 1 clearly indicated that the growth parameters *viz*. plant height, number of leaves $plant^{-1}$, number of tillers $plant^{-1}$ and dry matter accumulation$plant^{-1}$ responded significantly to the combined application of nutrients during both the years of investigation. T_5 (100 % RDF + FYM @ 2 tones ha^{-1} + PSB) treatment recorded the highest growth attributes which is found to be at parity with T_4 (100% RDF + FYM @ 2 tones ha^{-1}) and is superior than the rest of the treatments. On the other hand, significantly lowest value of growth attributes was prominently noticed in the control treatment (T_1) as there was no external source of nutrients.

Treatment with higher level of fertilizers combined with organic manure and PSB attained higher plant height which could be the indication of adequate nutrient supply which resulted in better elongation of internodes, good establishment of roots and vegetative growth throughout the crop cycle (Geetha *et al*., 2020). The FYM application also enhanced the expansion of algal cells as well as the uptake of nutrients besides facilitating as substrate for the PSB thus increased the plant height. The results were in conformity with Nanda *et al*. (2015). Likewise, the number of leaves $plant^{-1}$ also increased with the combined application of higher levels of RDF along with FYM and PSB when compared with other treatments. Singh *et al*. (2021) also reported that more leaves was produced in the treatments where an adequate amount of major nutrients was applied, which resulted in prolific root growth for supply of nutrient and water and hence brought about greater accumulation of photosynthates which enhanced the crop growth. In the case of the number of tillers $plant^{-1}$, the increase in plant height must have enhanced the photosynthetic area for photosynthesis in plants, which in turn helped in formation of new tillers. The tiller production at higher levels of nutrients may be due to better crop nutrition, which has also been reported by Bajpai *et al*. (2022). The dry matter accumulation is considered to be the reliable index of crop growth which might have increased due to the cumulative effect of an increase in different growth characteristics like plant height, number of tiller $plant^{-1}$ and number of leaves $plant^{-1}$. These findings are in conformity with Kumari *et al*. (2019) and Shinde *et al*. (2017). The crop growth rate was significantly influenced due to integrated nutrient management at 30-60 DAS, where a similar pattern of CGR was also observed by Laila *et al*. (2022) but no significant result was noted after 60 days.

Yield and yield attributes

Significant variations were noticed in yield attributing characters where nutrients were applied in integrated manners. Integrated nutrient management practices significantly boosted the panicle length, number of panicles $plant^{-1}$, number of grains $panicle^{-1}$, grain and straw yield in both the years (Table 2) where maximum value was recorded in treatment T_5 receiving the highest value of nutrients in combination with FYM and PSB, which is found to be at par with treatment T_4 (100% RDF + FYM @ 2 tones ha^{-1}) which is significantly superior from the rest of the treatments. The lowest value of grain yield (22.16 q ha^{-1}) and straw yield (40.88 q ha^{-1}) was recorded in control treatment (T_1).

The significant increase in panicle length could be due to the plant's higher absorption of different fertilizer, which favored producing longer panicles where similar

Table 1: Effect of integrated nutrient management on plant height, number of leaves plant^{-1}, number of tillers plant^{-1}, dry matter accumulation plant^{-1} and crop growth rate of direct seeded rice.

Treatments	Plant height (cm)	No. of leaves plant^{-1}	No. of tillers plant^{-1}	Dry matter accumulation plant^{-1} (g)	CGR (g m^{-2} day^{-1})	
	90 DAS	90 DAS	90 DAS	90 DAS	30-60 DAS	60-90 DAS
	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled
T_1: Control	92.79	29.06	4.46	23.78	17.57	19.64
T_2: RDF (120 kg N ha^{-1} + 40 kg P_2O_5 + 30 kg K_2O)	115.28	39.26	7.01	33.64	28.69	23.66
T_3: 100% RDF + PSB	117.72	40.47	7.33	34.72	30.12	23.88
T_4: 100% RDF + FYM @ 2 t ha^{-1}	127.71	44.81	8.28	39.00	33.98	26.61
T_5: 100% RDF + FYM @ 2 t ha^{-1} + PSB	130.13	45.93	8.59	40.06	35.39	26.81
T_6: 75% RDF + PSB	107.87	35.79	6.07	30.38	24.41	22.97
T_7: 75% RDF + FYM @ 2 t ha^{-1}	110.41	37.00	6.40	31.50	25.86	23.22
T_8: 75% RDF + FYM @ 2 t ha^{-1} + PSB	112.77	38.07	6.69	32.53	27.23	23.43
T_9: 50% RDF + PSB	100.43	32.24	5.10	26.99	20.06	22.12
T_{10}: 50% RDF + FYM @ 2 t ha^{-1}	103.09	33.50	5.43	28.11	21.61	22.28
T_{11}: 50% RDF + FYM @ 2 t ha^{-1} + PSB	105.39	34.62	5.74	29.17	22.55	22.95
T_{12}: SSNM (109 kg N ha^{-1} + 30 kg P_2O_5 + 46 kg K_2O)	120.11	41.64	7.62	35.80	31.50	24.14
SEm±	1.82	0.76	0.15	0.72	0.58	1.80
CD (P=0.05)	5.17	2.15	0.42	2.05	1.66	NS

RDF- Recommended dose fertilizer; FYM- Farm yard manure; PSB- Phosphate solubilizing bacteria.

Table 2: Effect of integrated nutrient management on panicle length, no. of panicles plant^{-1}, no. of grains panicle^{-1} of direct seeded rice.

Treatments	Panicle length (cm)	No. of panicles Plant^{-1}	No. of grains panicle^{-1}	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Harvest index
	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled
T_1: Control	22.01	3.94	193.78	22.16	40.88	35.31
T_2: RDF (120 kg N ha^{-1} + 40 kg P_2O_5 + 30 kg K_2O)	24.48	5.60	229.53	32.65	52.32	38.44
T_3: 100% RDF + PSB	24.71	5.78	233.37	33.82	53.39	38.78
T_4: 100% RDF + FYM @ 2 t ha^{-1}	25.84	6.51	250.69	38.06	59.15	39.16
T_5: 100% RDF + FYM @ 2 t ha^{-1} + PSB	26.08	6.69	254.47	39.15	60.15	39.42
T_6: 75% RDF + PSB	23.73	5.07	218.04	29.24	49.09	37.32
T_7: 75% RDF + FYM @ 2 t ha^{-1}	24.01	5.26	221.23	30.47	50.23	37.76
T_8: 75% RDF + FYM @ 2 t ha^{-1} + PSB	24.22	5.41	225.66	31.45	51.17	38.07
T_9: 50% RDF + PSB	22.91	4.51	207.43	25.70	45.79	35.93
T_{10}: 50% RDF + FYM @ 2 t ha^{-1}	23.24	4.71	210.49	26.98	46.95	36.53
T_{11}: 50% RDF + FYM @ 2 t ha^{-1} + PSB	23.47	4.88	214.19	28.01	47.94	36.87
T_{12}: SSNM (109 kg N ha^{-1} + 30 kg P_2O_5 + 46 kg K_2O)	24.94	5.95	237.15	34.93	54.42	39.09
SEm±	0.21	0.12	3.18	0.69	1.08	1.00
CD (P=0.05)	0.59	0.35	9.08	1.97	3.08	NS

RDF- Recommended dose fertilizer; FYM- Farm yard manure; PSB- Phosphate solubilizing bacteria.

results were reported by Mondal *et al*. (2015). According to Bajpai *et al*. (2022), the early emergence of primary and secondary tillers at the vegetative stage being supported with adequate proper nutrient supply and translocation of food materials towards reproductive parts contributed to a higher number of panicle plant^{-1}. Continuous and even distribution of nutrients at peak demand resulted in more grains panicle^{-1}, which attributed to better translocation of carbohydrates from source to sink (Shalini *et al*., 2017).

Behera and Pany (2021) opined that the increase in yield might be due to the higher availability of nutrients and optimum soil properties in the plots receiving inorganic and organic fertilizers. Neti *et al*. (2022) documented that INM boosted the vegetative growth of the plants, which increased the straw yield, thereby resulted in better productivity. However, the harvest index did not respond to any of the treatments.

CONCLUSION

Based on the study, it was evident that integrated nutrient management positively had significant impact on enhancing the growth parameters, yield attributes, and yield of direct-seeded rice. The application of 100% RDF + FYM @ 2 t ha^{-1} + PSB (T_5) was recorded to perform the best therefore, it is recommended to integrate the use of organic manures in addition to chemical fertilizers to meet the nutrient needs of the direct seeded rice.

Conflict of interest

All authors declare that they have no conflict of interest.

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