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Growth and yield attainment of *Rabi* rice (*Oryza sativa* L.) under precision nitrogen management practice

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Abstract
A field experiment was conducted during *rabi*, 2021-22 on sandy clay loam soils of Agricultural Research Station, Nellore, Andhra Pradesh to study the effect of precision nitrogen management on growth and yield of *rabi* rice. The experiment was laid out in Randomized Block Design with three replications. The experiment consisting of ten treatments *viz*., Control, FP, STBNF, RDN along with 2 LCC based, 2 NDVI based and 2 SPAD based N management with critical levels of LCC (4,5), NDVI (0.7, 0.8) and SPAD (35, 40) and that the variety used was NLR 3354. The experimental results indicated that the precision nitrogen management practices significantly influenced the growth and yield of *rabi* rice and found that the application of nitrogen through LCC-5, NDVI- 0.8 and SPAD-40 were on a par with the farmers practice and soil test based nitrogen fertilization in *rabi* rice.

Keywords: FP-Farmer's practice, STBNF-soil test based N fertilization, RDN-recommended dose of N, LCC-leaf color chart, SPAD-soil plant analysis development, NDVI-normalized difference vegetation index

Introduction

Paddy (*Oryza sativa* L.) is the principal food crop of South East Asian countries and feeds more than half of the global population. Usually, paddy is grown under transplanted submerged condition over a large area. In India, 45.76 m ha of area is occupied by rice crop with 124.36 m t of production and 2717 kg ha^{-1} of productivity. In Andhra Pradesh, 2.32 m ha of area is occupied with 7.8 mt of production and 4437 kg ha^{-1} of productivity. (www.indiastat.com, 2020) [26].

Nitrogen is one of the most important nutrients which greatly influence the growth and yield of rice and it place a major role in production and productivity of rice under transplanted condition, and synthetic nitrogen fertilizer plays a critical role in increasing the yield. However, only 30 to 40% of the applied nitrogen is being utilized by the crop, resulting in significant losses of reactive nitrogen, which not only reduces production but also drains the national budget and pollutes the environment.

Rice being cultivating during *kharif* and *rabi* by adopting different production technologies among them, nitrogen management is one of the established and most important production technics in transplanted rice cultivation. Fertilizers mostly nitrogen is recommended based on the soil and plant analysis but that analysis are tedious, laborious and time taking. To avoid the drudgery of analysis, scientists have developed specialized crop sensor technologies which give spot information on the nitrogen need of a crop based on the leaf optical properties. Chlorophyll or nitrogen content of leaf is closely related to photosynthetic rate and biomass production, and is an indicator of changes in crop nitrogen demand during the crop growth. Keeping these in view the study on growth and yield attainment of *rabi* rice (*Oryza sativa* L.) under precision nitrogen management practice under southern Agro-climatic conditions was formulated with an objective to find out the precision nitrogen management practice for *rabi* rice in sandy clay soils.

Materials and Methods

A field experiment entitled "Precision nitrogen management in *rabi* rice [*Oryza sativa* L.]" was conducted during *rabi*, 2021-22 at Agricultural Research Station, Nellore. It is geographically situated at 14°27' N latitude and 79.59'° E longitude at an altitude of 20 m above MSL in the Southern Argo-climatic zone of South Coastal Andhra Pradesh. The experiment was laid out in Randomized Block Design with three replications. The treatments consisted of ten nitrogen management practices *viz.*, T1: Control (without N) (T_1), Farmer's practice (200 kg N ha^{-1}) (T_2), Soil Test Based N fertilizer application (T_3), Recommended dose of N (120 kg ha^{-1} + FYM @ 5 t ha^{-1}) (T_4), N application at LCC 4 scale (T_5), N application at LCC 5 scale (T_6), N application at NDVI Threshold 0.7 (T_7), N application at NDVI Threshold 0.8 (T_8), N application at SPAD Threshold of 35 (T_9) and N application at SPAD Threshold of 40 (T_{10}). The soil of the experimental field was sandy clay loam, neutral in soil reaction, low in organic carbon (0.46%) and low in available nitrogen (202 kg ha^{-1}), high in available phosphorus (56 kg ha^{-1}) and high in available potassium (425 kg ha^{-1}). The crop was sown at 15.0 cm x 15.0 cm spacing on 26th November in filed No. 24 of ARS, Nellore and variety used was Nellore dhanyarasi (NLR 3354). Recommended package of practices were adopted for experimentation. The data collected pertaining to growth and yield was statistically analyzed by following the analysis of variance suggested by Panse and Sukhatme (1985) [14].

Table 1: Growth parameters at different growth stages and yield of rice as influenced by different nitrogen management practices

Treatments	Plant height				Number of tillers m^{-2}				Leaf area (cm^2)				Leaf area index				Grain yield
	30 DAT	60 DAT	90 DAT	At harvest	30 DAT	60 DAT	90 DAT	At harvest	30 DAT	60 DAT	90 DAT	At harvest	30 DAT	60 DAT	90 DAT	At harvest	
T_1: Control (without N)	37.1	62	64	65	193	257	247	238	325	556	433	386	1.44	2.47	1.93	1.72	2435
T_2: Farmer's practice (200 kg N ha^{-1})	44.1	83	89	90	256	388	378	371	456	1008	814	672	2.03	4.48	3.62	2.99	6313
T_3: Soil Test Based N Fertilization (150 kg N ha^{-1})	43.6	82	86	88	248	378	366	360	449	985	798	646	2.00	4.38	3.55	2.87	6384
T_4: Recommended dose of N (120 kg ha^{-1}) + FYM @ 5 t ha^{-1}	42.5	71	75	76	240	324	318	302	434	796	651	556	1.93	3.54	2.89	2.47	5696
T_5: N application at LCC 4 scale	43.4	73	76	77	244	327	314	296	431	832	676	564	1.92	3.70	3.01	2.51	5769
T_6: N application at LCC 5 scale	44.0	83	86	87	248	360	352	346	442	963	788	639	1.96	4.28	3.50	2.84	6291
T_7: N application at NDVI Threshold 0.7	43.4	72	75	76	244	326	313	301	437	846	668	576	1.94	3.76	2.97	2.56	5776
T_8: N application at NDVI Threshold 0.8	43.4	82	85	86	246	361	353	347	442	954	770	621	1.96	4.24	3.42	2.76	6287
T_9: N application at SPAD Threshold of 35	42.2	64	67	68	238	293	283	267	424	694	571	486	1.88	3.08	2.54	2.16	4806
T_{10}: N application at SPAD Threshold of 40	43.8	81	85	86	245	362	354	348	439	945	762	627	1.95	4.20	3.39	2.79	6279
S.Em±	1.28	2.2	2.3	2.3	7.1	9.9	9.4	9.3	12.4	25.7	20.4	16.9	0.059	0.114	0.091	0.075	168.9
CD (P=0.05)	3.8	6	7	7	21	30	28	28	37	76	61	50	0.18	0.36	0.27	0.22	534

Results and Discussion

Growth and yield of *rabi* rice were significantly influenced by different nitrogen management practices and the experimental results in details were discussed in the following paras and depicted in the table 1.

Growth parameters

Growth of the *rabi* rice *viz*., plant height, number of tillers, leaf area, leaf area index were significantly influenced by the different nitrogen management practices and that the results revealed that the *rabi* rice fertilization of nitrogen in three splits through farmer's practice (T_2) was significantly recorded higher growth and it was on a par with soil test based (T_3), leaf color chart-5 (T_6), normalized difference vegetation index-0.8 (T_8) and soil plant analysis development-40 (T_{10}) at all the stages except at 30 DAT and it might be due to the application of nitrogen was comparatively higher than the recommended dose in case of farmers practice and which might be enhanced the synthesis of carbohydrate that directly or indirectly enhanced the growth by multiplication of new tissues which in turn were responsible for increase in growth parameters *viz*., plant height, tiller number, leaf area, leaf area index and that the results was furnished in table. 1. Sharma (2011) [21], Shantappa *et al.* (2014) [20], Suresh *et al.* (2017b) [24] and Naik *et al.* (2019) [13] found similar finding in case of nitrogen application in *rabi* rice cultivation. Further it is reported that Singh *et al.* (2006) [22], Krishnakumar and Haefele (2013) [9], Jhansi *et al.* (2013) [8], Bhat (2014) [2] and Chamely *et al*. (2015) [3] also reported the similar results. The increase in leaf area and leaf area index might be due to increased nitrogen levels which favoured higher uptake of nutrients by crop, that resulted in rapid enhancement in the cell number and elongation that ultimately lead to increased number and size of the leaves and these results are in close conformity with Gupta *et al*. (2011) [6], Ghosh *et al*. (2013) [5] and Mathukia *et al.* (2014) [11], Fageria (2007) [4], Sarnaik (2010) [18], Sen *et al.* (2011) [19], Haque and Haque (2016) [7] and Reena *et al.* (2017) [17].

Grain Yield

Split application of nitrogen through soil test based nitrogen fertilization was significantly regarded maximum grain yield (kg ha^{-1}) of *rabi* rice which was on a par with farmer's practice (T_2) and with different precision nitrogen management practices *viz*., LCC-5 (T_6), NDVI-0.8 (T_8), SPAD-40 (T_{10}). In terms of per cent saving of nitrogen to a tune of 35 was noticed with precision nitrogen management practices without effecting grain yield and the results were depicted in table. 1. Further it was observed that the higher yields in case of LCC-5, SPAD-40, NDVI-0.8 is might be due to timely and adequate supply of nitrogen as per the crop need that led to better crop root & shoot growth and greater nitrogen use efficiency which ultimately improved growth attributing characters like more number of tillers, leaf area in different parts of plant which resulted in better translocation of photosynthates from source to sink during the crop growth.

Furthermore, no response was observed with increased nitrogen levels in farmer's practice over STBNF, indicating that increase in grain yield was found to be significant up to certain extent. The significantly low yields in case of RDN was due low uptake of N when compared to FP and STBNF indicating that current recommended dose of N at fixed time is not adequate to meet the crop demand as the indigenous soil available N was low which requires an extra 25% N fertilization and these findings are in accordance with the findings of Ghosh *et al*. (2013) [5], Syeda *et al.* (2014) [25], Ali *et al.* (2015) [1], Mohanty *et al.* (2015) [12], Liu *et al*. (2015) [10], Prabhudev *et al.* (2017) [16], Pateel *et al.* (2017) [15] and Suresh *et al.* (2017a) [23].

Conclusion

The study revealed that the application of 30 kg N ha^{-1} as basal and split application of 20 kg N ha^{-1} at 10 days interval, guided either by LCC-5 (T_6) or NDVI-0.8 (T_8) or SPAD-40

(T_{10}), proved to be most promising, feasible and economically viable nitrogen management practice for higher yield in *rabi* rice for the Southern Argo-Climatic Zone of Andhra Pradesh.

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