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COMBINED EFFECT OF INTEGRATED NUTRIENT MANAGEMENT AND SITE SPECIFIC NITROGEN MANAGEMENT USING LEAF COLOUR CHART IN RAINFED RICE

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ABSTRACT

A field experiment was conducted to assess the effect of combined application of integrated nutrient management (INM) and site specific nitrogen management (SSNM) on rainfed kharif paddy on farmer's field of Sonitpur district of Assam during 2011 and 2012. The results revealed that effective utilization of Leaf Colour Chart (LCC) in rainfed rice is only possible when crop do get sufficient rainfall in its critical growing periods. During 2011, significant increases in yield and yield attributes were recorded under combined application of INM and SSNM in comparison to INM alone due to sufficient rainfall in critical periods whereas deficit rainfall in critical growth stages during 2012 resulted in no significant differences between INM and INM+SSNM .Yield and yield attributes recorded in the treatment INM+SSNM with zero basal N were significantly better than chemical fertilizers alone and INM with basal N application. Highest N uptake (178kg ha^{-1}) was recorded in INM+SSNM followed by INM (168.6 kg ha^{-1}) and lowest in control (139 kg ha^{-1}). However, fertilizer N saving was found to be equal in INM and INM+SSNM (25% each) in comparison to chemical fertilizers alone. Nitrogen use efficiency was better when INM was coupled with SSNM. Aapparent N recovery (%AR_N), Agronomic Efficiency of N (AE_N in kg ha^{-1}) and Production Efficiency (PE_N in kg grain /kg N absorbed) were found to be higher in INM+SSNM plots (39.87, 13.8 34.62, respectively) in comparison to INM and state recommendations of chemical fertilizers.

***Keyword*:** INM, SSNM, LCC, agronomic efficiency, yield, rice

INTRODUCTION

Rainfed rice is being grown under more complex and unpredictable environment than most other crops. Poor nutrient and rainwater management are the major constraints of rainfed rice cultivation. (Jayanthi *et al.,* 2007). Among the three major nutrients, nitrogen (N) is the most limiting in rice soil hence accounts for major input for higher productivity of rice. Integrated Nutrient Management (INM) is proved to be beneficial in rainfed rice based cropping sequence in terms of soil quality and crop yield (Gogoi 2011). INM jointly uses all possible opportunities of nutrient management by the different sources of nutrient such as fertilizers, organics and biological to meet the demand of the plant. In addition to the nutrient value, the application of organic sources to complement fertilizer N rates results in higher crop yields, reduced de-nitrification and leaching loss of N with co benefit of improved soil health (Mohanty *et al.,* 2013). Despite the fact that in INM system, N use efficiency is better than conventional nutrient management, appropriate diagnosis of N in rice leaves to decide about top dressing the fertilizer N may strengthen the INM approach in terms of N management (Jayanthi *et al.,*2007). Here lies the possibility of combination of INM with SSNM using Leaf Colour Chart (LCC) in Rainfed rice. The Leaf Colour Chart (LCC) is an easy to use and inexpensive diagnostic tool for monitoring the relative greenness of a rice leaf as an indicator of the plant N status (Alam *et al.,* 2005). Keeping these points in view an On Farm Trial (OFT) was conducted in rainfed kharif rice to find out combined effect of bio-fertilizer based INM and SSNM in terms of yield and yield attributes, soil properties and N use efficiency.

MATERIALS AND METHODS

The experiment was conducted at farmers' field of Koroioni Bengali village in Sonitpur district of Assam during *kharif* season of 2011 and 2012 using HYV paddy *Ranjit* with four treatment combinations *viz*. T_1 :control (no fertilizer), T_2: state recommendation of chemical fertilizers (SR) @ N:P_2O_5:K_2O 60:20:40, T3: bio-fertilizer based INM using PSB+ *Azospirillum* + rock phosphate as seedling root deep treatment + full doses of K + 75% of recommended N

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(INM) and T_4 : T3+ N management through LCC (INM+SSNM) having five replications (number. of farmers) of each treatment in RBD. The plot size was 132 m^2 per treatment comprising total area of 2640 m^2 .The plots were selected in the adjacent farmers' fields considering homogeneity in soil characteristics. The soil of the experiment site was low in available N (262 kg ha^{-1}) medium in available P (17.4 kg ha^{-1}) and available K (267.2 kg ha^{-1}) and strongly acidic in reaction (5.1). Soil properties from each treatment after harvest of rice have also been determined following standard protocols (Jackson 1973) to see the effect of treatments on soil fertility. The crop was transplanted on 27th June in each year..The crop availed less water in 2012 in tillering and panicle initiation stages in comparison to 2011.

At 14 days after transplanting 10 healthy plants in the field where plant distribution was uniform, were randomly selected. Topmost, fully expanded and healthy leaf of each of the 10 pants were compared. Middle part of the leaf was placed on the top of the LCC colour strips for comparison. Readings were taken at 8 AM at 10 days interval until first heading. If six (6) or more of 10 leaves showed readings below critical LCC value four (4) N was applied @ 15 kg ha^{-1}. Three splits of LCC N were found to be sufficient with INM in both the seasons when no N was applied as basal. The plant samples after harvest were dried in oven at 65 – 70^{0}C to constant weight and the dry weight was recorded. The average of five hills was taken as the dry matter production per hill and is expressed in quintals per hector.Nitrogen in plants was estimated by the micro-Kjeldahl method. A mixture of HNO_3, H_2SO_4 and $HClO_4$ in the ratio of 9:4:1 was used for sample digestion for P and K estimations. Phosphorus was estimated spectrophotometrically while K was estimated flame phototometrically. Nitrogen, phosphorus and potassium uptake were computed mathematically using the information of total nutrient content in plant and corresponding dry matter production Apparent N recovery (%AR_N,), Agronomic Efficiency of N (AE_N in kg ha^{-1}) and Production Efficiency (PE_N in kg grain /kg N absorbed) were also calculated following standard formula.

RESULTS AND DISCUSSION

Yield attributes and yield

Perusal of data (Table 1) reveals that all the treatments resulted significantly higher yield attributes and economic yield in comparison to control in both the seasons. Treatments T3 and T4 performed significantly better in comparison to chemical fertilizers alone. On the other hand, in 2012 performance of both T3 and T4 treatments were found at par except significant increase in grains per panicle in T4 but not reflected in significant yield increase. This may be due to rainfall deficit at the time of split application of N fertilizers using LCC, although the final yield was recorded to be better in 2012 due to sufficiency of water in the month of September and October in comparison to 2011. Conversely, significant increase in all yields attributes and yields have been recorded in INM+SSNM in comparison to INM alone in 2011. This result clearly states that in rainfed rice effective utilization of LCC is possible only when crop do get sufficient rainfall in its critical growing periods. Jayanthi (2007) also reported that yield and yield components of rainfed rice were significantly and favourably influenced when N was applied up to reproductive phase (panicle initiation to 10% flowering) under LCC guided N management. In our study, no basal N was applied in T4 (INM+SSNM) and the result indicates that yield and yield parameters appeared to be better than chemical fertilizer alone and INM where basal N was applied. Jayanthi (2007) reported that a basal application of N @ 20 kg ha^{-1} though increased the growth parameters, the yield and yield parameters were not influenced by basal dose of N.

Table 1: Effect of INM with SSNM using LCC on kharif rice Var. Ranjit (2011 & 2012)

	Control		Chemical Fertilizer		INM		NIM+SSNM		CD (0.05)	
	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011
Effective tillers/plant	8.6	8.6	11.8	12.2	13.8	13.2	14.2	15.2	1.83	1.28
Plant height (cm)	112.4	111.9	122.8	125.6	133.7	143.8	136.1	146.6	6.13	5.34
Panicle length (cm)	19.79	21	23.53	24.1	26.7	26.2	27.5	28.6	1.22	1.69
Grains/panicle	148.6	144.8	227.8	221.6	237	226.4	242.2	240.4	3.91	2.91
Test weight (g)	14.16	15.8	17.5	17	18.1	18	18.2	18.3	0.394	0.31
Yield (t ha^{-1})	4.8	4.6	5.4	5	6.1	5.3	6.2	5.9	0.231	0.17

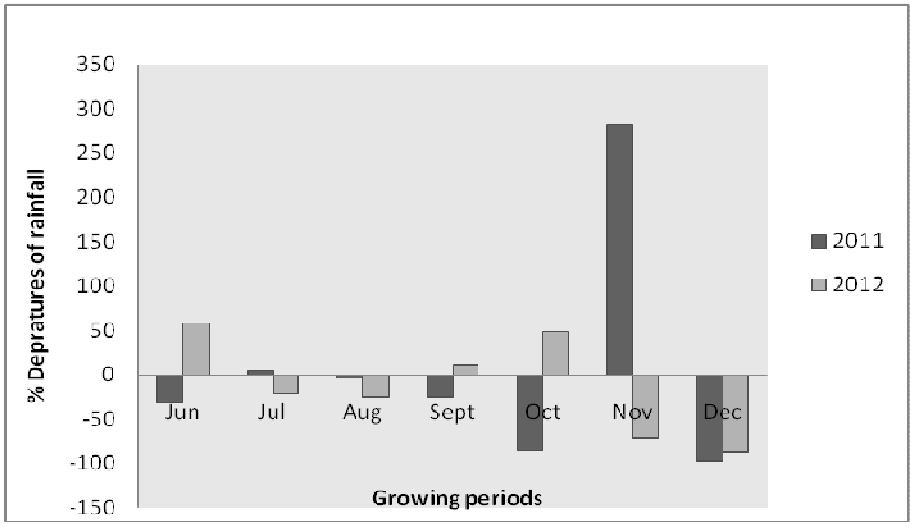

Fig 1: Per cent depratures of rainfall during the growing periods (Source: IMD)

Uptake of Nutrients

The highest N uptake (178kg ha^{-1}) was recorded in INM+SSNM followed by INM (168.6 kg ha^{-1}) and lowest in control (139 kg ha^{-1}). Similar trend of uptake of other nutrients (P and K) was also observed amongst the treatments (Table 2). Highest N (grain): N (straw) ratio was rescored in INM+SSNM (0.791) treatment.Highest P (grain): P (straw) ratio was rescored in INM+SSNM (1.254) and lowest in state recommended dose of chemical fertilizers (1.243). Similarly highest K (grain): K (straw) ratio was also recorded in INM+SSNM (0.087) treatments. Nutrient removal is a function of climate, soil properties, amount and method of fertilizer application and the variety of rice where cultural practices and morphological variations account for variations in nutrient uptake by crops. In addition to this dry matter production and yield also govern the nutrient uptake pattern. Quite higher yield accounted for higher nutrient removal from the soil as reflected from our findings.

Table 2: Effect of Nutrient management on uptake of nutrients (kg ha^{-1}) by rice crop (2 years data)

Nutrient management	Nitrogen		Phosphorus		Potassium	
	Grain	Straw	Grain	Straw	Grain	Straw
Control	61.1	77.9	31.5	25.3	16.9	197.0
SR	67.6	86.2	34.8	28.0	18.7	218.0
INM	74.1	94.5	38.2	30.7	20.5	239.0
INM+SSNM	78.6	99.4	40.5	32.3	21.8	251.6

**SR= State Recommendation*

Efficiency Indices

Apparent N recovery (%AR_N,), Agronomic Efficiency of N (AE_N in kg ha^{-1}) and Production Efficiency (PE_N in kg grain /kg N absorbed) were calculated to be higher in T4 (INM+SSNM) plots (39.87, 13.8 34.62, respectively) in comparison to T3 (INM) and T2 (SR) (Table 3). Although fertilizer N saving was found to be equal in T3 and T4 (25% each) in comparison to chemical fertilizers (T2), N use efficiency was better when INM was coupled with SSNM. Nitrogen use efficiency (NUE) is dependent to a large extent on the synchronization between crop nitrogen demand and the available N supply. INM helped in improving NUE. Rama Lakshmi *et al.,* (2012) also reported that the nitrogen use efficiency with application of 75 % chemical fertilizers + vermicompost @ 2.5 t $ha^{-1}$was better than other combinations closely followed by 50 % RDF + 50 % Prathista organics. Lowest production efficiency was recorded with 100 % chemical fertilizers alone. Higher yield and better NUE were correlated with better nutrient management like SSNM using LCC.(Bijay *et al.,* 2006).

Table 3: Comparison of N use efficiencies (2 years polled data)

Nutrient management	Apparent N recovery (AR_N) (%)	Agronomic Efficiency of N (AE_N) (kg ha^{-1})	Production Efficiency of N (PE_N) (kg grain/kg N absorbed)
SR	11.34	3.83	33.78
INM	30.26	10.22	33.78
INM+SSNM	39.87	13.80	34.62

Soil Fertility

Significant differences in available N, P, K and soil reactions of post harvest soil were observed amongst the treatments in both the years. However, no such significant changes in oxidisable organic carbon were observed (Table 4). All the treatments in most cases resulted significantly higher available N, P and K than control. Available N was highest in INM+SSNM (193.0 and 194.8 kg ha^{-1} in 2011 and 2012, respectively) which was at par with INM. However, in both the years, available N in control and SR plots was significantly lower than INM (T3) and INM+SSNM (T4). Highest available P was recorded in INM system (10.5 and 11.8 kg ha^{-1} in 2011 and 2012,respectively) and lowest was in control (5.2 and 4.2 kg ha^{-1}), In, 2011, available P in INM system was found at par with INM+SSNM; although in 2012, available P in INM was recorded to be significantly higher (11.8 kg ha^{-1}) than INM+SSNM (10.9 kg ha^{-1}) Perusal of data (Table 4) indicates that pH of the soil in INM system was significantly higher than INM+SSNM, which might be due to more split application of urea in the later which resulted significant increase in available P in INM over INM+SSNM in the second year trial where carryover effects might also play a role. Rama Lakshmi *et al.,(*2015) also reported that available nutrient status and their uptake were higher in INM practices in rice based cropping system with positive cumulative and residual effects. Available K in INM (T3) and INM+SSNM (T4) was found at par in 2011. On the other hand in 2012, INM+SSNM showed significantly higher available K than INM. Conversely, in 2012 available K in INM plot was at par with SR unlike 2011.As only *Azospirillum* and PSB were used as bioferilizers in INM system , no such clear cut trend of soil available K was observed.

Table 4: Properties of post harvest soil

Treatment	pH		Avail. N (kg ha^{-1})		Avail. P (kg ha^{-1})		Avail. K (kg ha^{-1})		OC (g ka^{-1})	
	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
Control	5.1	5.0	180.0	158.5	5.2	4.2	103.3	85.4	6.4	6.2
SR	4.8	4.7	158.3	160.7	8.1	8.2	113.4	105.1	6.5	6.4
INM	5.2	5.3	189.0	192.2	10.5	11.8	119.8	107.1	6.9	6.3
INM+SSNM	4.9	4.9	193.0	194.8	10.2	10.9	119.1	153.5	7.0	6.8
CD (0.05)	0.21	0.09	6.96	4.04	0.75	0.53	1.22	17.2	NS	NS

It may be concluded from the results that combined application of INM and SSNM using LCC improves N use efficiency and yield and yield attributes of rainfed *kharif* paddy subject to availability of rainfall during critical crop growth stages. The technology as a promising eco-friendly and inexpensive toll may be promoted to improve the soil and crop health by minimizing nitrogen loss and fertilizer related pollution of the surface and ground water owing application of chemical fertilizers.

REFERANCES

Alam, M.M., Ladha, J.K., Khan, S.R., Foyjunnessa, Harun-urRashid, Khan, A.H. and Buresh, R.J. (2005) Leaf color chart for managing nitrogen fertilizer in lowland rice in *Bangladesh Agronomy Journal* **97**: 949-959

Bijay, S., Gupta, R. K., Yadvinder, S., Gupta, S. K., Jag-deep, S., Bains, J.S. and M. Vashishta (2006) Need-based nitrogen management using leaf color chart in wet direct-seeded rice in Northwestern India. *Indian Journal of New Seeds* **8**(1): 35-47.

Gogoi Bhabesh (2011) Soil Properties and nutrients availability as affected by integrated nutrient management after rainfed cropping sequence. *Indian Journal of Agricultural Research* 45 (4) : 346 – 349

Jackson, M.L. (1973) Soil Chemical Analysis. Prentice Hall of India Private Limited, New Delhi.

Jayanthi , T., Gali, S. K., Angadi, V. V. and Chimmad, V. P (2007) Effect of leaf colour chart based nitrogen management on growth and yield parameters of rainfed rice. *Karnataka Journal Agricultural Science* 20(2): 272-275

Mohanty, M., Nanda, S. S. and Barik, A. K. (2013) Effect of integrated nutrient management on growth, yield, nutrient uptake and economics of wet season rice (Oryzasativa) in Odisha. *Indian Journal of Agricultural Sciences* **83**(6): 599-604

Rama Lakshmi, Ch.S., Rao, P.C., Sreelatha, T., Madahvi, M., Padmaja, G., Rao, P.V. and Sireesha, A. (2012) Nitrogen use efficiency and production efficiency of rice under rice-pulse cropping system with integrated nutrient management. *Journal of Rice Research* **5** (1 & 2): 42-49

Rama Lakshmi, Ch. S., Rao, P.C., Sreelatha, T., Padmaja, G., Madahvi, and Rao, P.V. (2015) Effect of integrated nutrient management on soil properties, yield and nutrient uptake in rice-greengram cropping system in an Inceptisol of Andhra Pradesh. *Journal of the Indian Society of Soil Science* **63** (4): 400-405.