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Effect of Nutrient Management Practices in Rice - Green Gram in *Jhum* field under Rainfed Condition of Nagaland

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ABSTRACT

To evaluate the effect of different crop establishment methods and nutrient management practices in rice-green based cropping sequence, a field experiment was conducted at Krishi Vigyan Kendra, ICAR Research Complex for NEH Region Longleng, Nagaland during *kharif and rabi* season of 2018-19 and 2019-20. Two crop establishment methods, viz. Farmer practice and Improve practice were kept in main plots and seven nutrient management practices, viz. Absolute Control, Lime (250 kg)+ NPK (kg/ha) 30:30:20 (50% of RDF), Lime (250 kg)+ NPK (kg/ha) 30:30:20 (50% of RDF) + OM as FYM @ 2.5 t/ha, Lime + DAP @ 2% as foliar application at 2 intervals (30 DAS & 60 DAS), T_5 - Lime + Rice + Soybean (4:2 ratio), Lime + BF + OM as FYM @ 2.5 t/ha, Lime + Rice + Soybean (4:2 ratio) + BF were allotted to sub-plots in a split-plot design and replicated thrice. The result showed that number of panicles, tiller, filled grains, test weight, straw, and grain yield were recorded at maturity from each plot were recorded significantly higher under improve practice. Among the nutrient management practices, application of Lime (250 kg) + NPK (kg/ha) 30:30:20 (50% of RDF) + OM as FYM @ 2.5 t/ha was recorded significantly higher rice grain 26.10 and 29.63 q/ha and green gram 14.58 and 16.05 kg/ha yield in year 2018-19 and 2019-20 respectively. Higher nutrient uptake (NPK) by rice grain and straw uptake was recorded under improve practice (line sowing). Similarly, in nutrient management practices higher nutrient uptake by grain and straw was recorded with Lime (250 kg) + NPK (kg/ha) 30:30:20 (50% of RDF) + OM as FYM @ 2.5 t/ha.

Keywords: Productivity; cropping sequence; nutrient management; jhum field; sustainability

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INTRODUCTION

Rice (*Oryza sativa* L.) is one of the most important staple food crops, which supplies major source of calories for about 45 per cent of world population, particularly to the people of Asian countries. In India rice is grown in 43.86 million ha, the production level is 104.80 million tones and the productivity is about 2390 kg/ha. It is grown under diverse soil and climatic conditions the productivity level of rice is low compared to the productivity levels of many countries in the world. There are improved technologies and various interventions which could be adapted to increase the productivity in the country. Better nutrient management strategies can support the needed future yield increase. Emergence of widespread multi nutrient deficiencies, depletion of native nutrient reserves, imbalanced fertilization is matter of serious concern, causing serious stagnation and declining productivity of various rice ecosystems (Shukla *et al.,* 2015).

Rice is most important crop in *Jhum* field of Longleng district of Nagaland. About 12% of the total geographical area of the district is under *Jhum* rice. Rice cultivation in the region has been predominantly a subsistence occupation with little or no emphasis on commercial approach. Mixed cropping is practiced in *Jhum* farming where rice is predominant crop. Rice productivity in *Jhum* is very low 1.6 t mainly due to poor cultivation practices, no input cultivation, lack of soil and water conservation measures, use of low yielding varieties etc. Rice is cultivated during February-March to July-August leaving rest of the period of the year as fallow. Whereas the rainfall in the region continues up to the end of October and residual moisture remains in the field till December. Thus, there is potential for growing a *pre-rabi* crop for which would increase cropping intensity, per unit productivity and income of the *Jhumias* (National Seminar on Sustaining Hill Agriculture in Changing Climate-2015, Agartala, Tripura).

In Nagaland, green gram is cultivated in an area of 350 ha with a production of 350 MT and productivity of only 1000 kg/ha (Statistical Handbook of Nagaland-2015). It is grown mainly in pre-rabi seasons after harvest of rice. Rice-green gram cropping system is the most important cropping system which could enhance the crop productivity as well as sustain the soil fertility to the optimum level in the subsequent year.

Plant growth is the result of a complex process whereby the plant synthesizes solar energy, carbon dioxide, water, and nutrients from the soil. In all, between 21 and 24 elements are crucial for plant growth (Dubey *et al.,* 2014). The primary nutrients for plant growth are nitrogen, phosphorus, and potassium. When inadequate, these nutrients are most often responsible for limiting crop growth. Nitrogen, the most intensively used element, is available in virtually huge quantities in the atmosphere and is continually recycled

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among plants, soil, water, and air. However, it is often unavailable in the correct form for proper absorption and synthesis by the plant. In addition to the primary nutrients, less intensively used secondary nutrients (sulphur, calcium and magnesium) are necessary as well (Khan *et al.* 2010 and Kumar and Chopra, 2014). A number of micronutrients such as chlorine, iron, manganese, zinc, copper, boron, and molybdenum also impact plant growth and production (Srivastava *et al.*, 2015). These micronutrients are required in meager amounts (ranging from a few grams to a few hundred grams per hectare) for the proper functioning of plant metabolism. The absolute or relative absence of any of these nutrients can hamper plant growth; alternatively, too high a concentration can be toxic to the plant or to humans (Pandey and Chandra, 2013).

In order to meet the food demands on a rising population in the 21st century, farmers must maintain nutrients and soil fertility in an integrated way. Required yield increases of major crops cannot be achieved without ensuring that plants have an adequate, balanced supply of nutrients. Integrated nutrient management (INM) is an approach that seeks to both increase agricultural production and safeguard the environment for future generations. It is a strategy that incorporates both organic and inorganic plant nutrients to attain higher crop productivity, prevent soil degradation, and thereby help meet future food supply needs.

Therefore, an attempt has been made to evaluate the effect of different nutrient management practices in rice-green gram-based cropping sequence on productivity and soil fertility status in *jhum* field under rain-fed condition of Nagaland.

MATERIALS AND METHODS

The field experiment was conducted at KVK Longleng under ICAR NEH Region, Nagaland Centre, Medziphema, Nagaland (situated at the latitude 26º29'16.3428" N, longitude 94º48'52.4952" E at an altitude of 1258 m above MSL) of Nagaland in Eastern Himalayas on rice (*Oryza sativa* L.) Chako yoh (Var. Local) during wet season (*kharif* season) followed by Green gram in the year (2018-19) and 2nd year crop (rice-green gram) was sown with the same treatment repeatedly on the same plot of land in the year 2019-20. The soil of experimental field was sandy loam and acidic in reaction (pH 5.02), high in organic carbon (1.72%), medium in available N (427 kg/ha) and K (194.5 kg/ha) and low in available P (9.5 kg/ha). The experiment was conducted in split plot design with three replications. The mean monthly average temperatures were varying from 7°C to 29°C in 2018-19 and 7.5°C to 31°C in 2019-20, respectively. Total rainfall received during the crop period was 1485 mm and 1117 mm in 2018-19 and 2019-20 respectively. However, rainfall distribution over month was better in 2012 as compare to 2011. The monthly rainfall was the maximum in month of July in both years. Three crop establishment methods, viz. farmer practice and improve practice were kept in main plots and seven nutrient management practices, viz. Absolute Control, Lime (250 kg)+ NPK (kg/ha) 30:30:20 (50% of RDF), Lime (250 kg)+ NPK (kg/ha) 30:30:20 (50% of RDF) + OM as FYM @ 2.5 t/ha, Lime + DAP @ 2% as foliar application at 2 intervals (30 DAS & 60 DAS), T_5 - Lime + Rice + Soybean (4:2 ratio), Lime + BF + OM as FYM @ 2.5 t/ha, Lime + Rice + Soybean (4:2 ratio) + BF were allotted to sub-plots in a split-plot design and replicated thrice. The gross and net plot sizes were 4.5 m × 4.5 m and 4 m × 4 m, respectively and treatments were superimposed in the same plot every year to study the cumulative effect of treatments. Rice (*Oryza sativa* L.) variety Chako yoh local variety was used as test crop and sown at 3 seedlings/hill with the spacing of 20 cm × 110 cm. The supply of N, P and K was ensured through urea, di-ammonium phosphate (DAP) and muriate of potash (MOP) fertilizer. A half dose of N and full dose of P and K were applied as basal. Remaining half dose of N was applied in two equal splits at maximum tillering and panicle initiation stages. Two hand weeding at 20- and 45-days DAS. Yield attributes such as result showed that number of panicles, tiller, filled grains, test weight, straw, and grain yield were recorded at maturity from each plot. The crop samples were subjected to the chemical analysis for uptake of N, P, K, Zn, Mn, Fe and Cu. The samples were oven dried at 70-75°C for 72 hr and ground to pass a 20-mesh sieve. Uptake of nitrogen in straw and grain sample was determined by Modified Kjeldahl method as per procedure outlined by Jackson (1973). Phosphorus uptake was estimated by absorption of solution was recorded after 30 min at 420 nm on spectrophotometer using blue filter. Potassium uptake of the plant sample was estimated by using a flame photometer. The content of Fe, Cu, Mn and Zn in the straw and grain digest was determined by using atomic absorption spectrophotometer as per procedure outlined by Tandon (2001). Surface soil samples collected from 0-15 cm depth were air dried in shade, sieved through 2 mm mesh and analyzed for soil physical and chemical properties. Soil organic carbon (SOC) was determined according to Walkley and Black (1934). Available N in soil was estimated according to (Subbiah and Asija 1973) by distillation of soil with alkaline potassium permanganate (0.32% $KMnO_4$). Available P (Brays) in soil was determined according to Brays *et al.* (1954) extracting soil P in sodium bicarbonate ($NaHCO_3$). Available K (readily exchangeable plus water soluble K) in soil was extracted in neutral normal ammonium acetate (1 *N* CH_3COONH_4). Soil microbial biomass carbon (SMBC) was determined by ethanol-free chloroform fumigation extraction method. The analysis of variance method (Gomez and Gomez 1984) was followed to statistically analyze the various data. The significance of different sources of variations was tested by error mean square of Fisher Snedecor's 'F' test at probability level (P =0.05).

RESULTS AND DISCUSSION

Yield attributes and yield

Yield attributes of rice and green gram crop, viz. number of panicles, tiller, test weight, rice grain and green gram yield were significantly higher in improve practice than farmer practice (Table 1). All the yield attributes in relation to individual plots were recorded maximum under improve practice.

Results revealed that maximum number of panicles per unit area was recorded with improved practices in both the year and 2 years mean was also recorded under improved practices. The crop establishment practice showed not any significant difference with each other. This might be due to optimum environment condition suited for improved rice cultivation practices, which helps for better root development and ultimately increased the growth attributes. Among nutrient management practices, maximum number of panicles per unit area was recorded with the application of Lime@ 250 kg /ha along with biofertilizers and FYM @ 2.5 t/ha and the minimum under absolute control. Nutrient management practices showed not any significantly difference on number of panicles per unit area during both the years. Results corroborate the findings of Shobhit *et al.* (2017) and Anup *et al.,* (2014).

The number of tillers at harvest in 1st year rice ranged between 74.50 to 115.00. The higher number of tillers (115.00) were recorded with plot received treatment T_3 Lime (250 kg) + NPK (kg/ha) 30:30:20 (50% of RDF) + OM as FYM @ 2.5 t/ha followed by T_2. The lowest (74.50) tillers were recorded in control. Control was ~35% below as compared to plot with the treatment T_3. There was non-significant difference among the treatments in respect of tillers per unit area in 1st year.

From second year data of number of tillers further revealed that the addition of lime along with NPK and organic manure resulted a higher number of tillers in the subsequent year. The number of tillers at harvest significantly ranged between 80.17 to 111.50 in T_1 – control and T_3 Lime (250 kg) + NPK (kg/ha) 30:30:20 (50% of RDF) + OM as FYM @ 2.5 t/ha respectively. However, plot with the T_3 reported 39% higher than absolute control. On other hand, FYM continued the beneficial effect in the next season due to slower decomposition rate and application of organic materials in higher quantities compared to other chemical fertilizers (Singh *et al.,* 2015).

The test weight of rice under improve practice was more (23.50 g in 1st year and 23.89 g 2nd year) which was significantly different than that of farmer practice (22.21 g in 1st year and 22.73 g in 2nd year). The mean value was also found significantly higher in case of improved practice. Sultana *et al.* (2015) recorded that 1000- grain weight was increased by the application of chemical fertilizer along with organic manure. Among nutrient management practice, test weight of rice seeds of T_3 - Lime (250 kg) + NPK (kg/ha) 30:30:20 (50% of RDF) + OM as FYM @ 2.5 t/ha was comparatively more (23.98 g in 1st year and 23.80 g 2nd year) than that of other treatments but they were at par with the test weight of T_3 rice seeds. The mean value of test weight was also found higher in case of T_3. No significant difference was noticed among the nutrient management treatments.

Among the nutrient management practices, maximum rice grain yield was significantly recorded 26.10 q/ha, 29.63 q/ha with the application of Lime (250kg) + NPK (kg/ha) 30:30:20 (50% of RDF) along with 2.5 t/ha FYM (T3) followed by application of Lime (250 kg) + NPK (kg/ha) 30:30:20 (T2) as compared to the other nutrient management practice during the year 2018-19 and 2019-20 respectively. Pooled rice yield of 2 years was also significantly recorded 27.87 q/ha with application of Lime (250kg) + NPK (kg/ha) 30:30:20 (50% of RDF) along with 2.5 t/ha FYM (T_3) followed by application of Lime (250 kg) + NPK (kg/ha) 30:30:20 23.52 q/ha over nutrient management practices. This might be due to combination of lime, NPK and FYM showed more effect of physiology of rice plant than other nutrient management practices and had capacity to produce more yield over other nutrient management practice (Gudadhe *et al.,*2015).

The residual effect on green gram crop yield was recorded

Table 1: Yield attributes of rice as influenced by establishment methods and nutrient management practices.

Method of Practice	No. of panicle per sq. m		No. of tiller per sq. m		Test weight (g)		Rice Grain yield (q/ha)		Green gram yield (q/ha)	
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
M1:Farmer practice	95.48	101.52	86.62	88.10	22.21	22.73	17.83	18.92	11.02	12.78
M2:Improve practice	101.43	104.14	92.05	99.10	23.50	23.89	20.10	21.58	11.96	12.80
SEm(±)	**4.38**	**2.63**	**5.35**	**8.69**	**0.09**	**0.23**	**0.56**	**0.53**	**0.10**	**0.16**
CD(P=0.05)	**NS**	**NS**	**NS**	**52.85**	**0.57**	**NS**	**NS**	**NS**	**0.61**	**NS**
Nutrient Management										
T1	88.50	77.50	74.50	80.17	22.28	22.98	17.13	19.23	7.83	9.00
T2	105.33	108.33	94.67	102.17	23.35	23.58	22.45	24.58	8.75	9.53
T3	108.33	122.83	115.00	111.50	23.98	23.80	26.10	29.63	14.58	16.05
T4	94.17	105.83	86.83	85.83	23.20	23.32	19.58	21.58	10.70	12.55
T5	92.00	97.33	78.67	88.50	22.43	23.03	12.80	16.57	11.32	12.22
T6	100.33	101.17	87.17	88.50	22.40	23.15	20.10	22.55	13.25	14.47
T7	100.50	106.83	88.50	98.50	22.33	23.28	14.60	17.98	14.02	15.72
SEm(±)	**10.21**	**10.42**	**8.43**	**5.83**	**0.49**	**0.31**	**0.43**	**1.01**	**1.13**	**0.46**
CD(P=0.05)	**NS**	**NS**	**NS**	**17.03**	**NS**	**NS**	**1.27**	**2.96**	**3.29**	**1.35**

Treatments: T1- Absolute Control, T2 - Lime (250 kg)+ NPK (kg/ha) 30:30:20 (50% of RDF), T3 - T2 + OM as FYM @ 2.5 t/ha, T4 - Lime + DAP @ 2% as foliar application at 2 intervals (30 DAS & 60 DAS), T5 - Lime + Rice + Soybean (4:2 ratio), T6 - Lime + BF + OM as FYM @ 2.5 t/ha, T7 - Lime + Rice + Soybean (4:2 ratio) + BF.

*FYM = Field Yard Manure, BF = Biofertilizer, OM = Organic Manure maximum with 14.58 q/ha in T_3 treatment being at par with T_5, T_6 and T_7 and significantly higher over rest of the treatments in 1st year. However, the minimum green gram yield (7.83 q/ha) was recorded in absolute control.

Similarly, in second year of investigation, treatment T_3 recorded maximum (16.05 q/ha) green gram yield which was significant over rest of treatment but remained at par with T_7. As compared to control, T_3 treatment showed ~78% higher green gram seed yield. The improvement in green gram yield of rice followed a chain process. Addition of different Lime, soybean and biofertilizer enhanced soil pH, seed germination and nitrogen fixation of the soil that played a key role for improving soil fertility and crop productivity. The increased uptake of nutrients by green gram improved metabolic activities in the plants. (Sourov *et al.,* 2014) reported that the pooled data revealed that integrated source of nutrients (combination of inorganic and organic sources) applied @125% recommended doses (RD) increased the yield of rice by 32.5%, potato by 81.5% and green gram by 47.3%. Biofertilizer containing free living nitrogen fixing bacteria have the potential to supply the nitrogen element and to make insoluble organic and inorganic P nutrient available for rice production. A large number of biofertilizers are being used in many countries China, India, Pakistan, Egypt, Vietnam and Indonesia (Kennedy and Cocking 2017).

Nutrient uptake

Nutrient uptake (N, P and K) by grain and straw uptake by the rice crop were recorded significantly higher with improve practice followed by followed by farmer practice (Table 2). Among the nutrient management practices, application of Lime (250 kg)+ NPK (kg/ha) 30:30:20 (50% of RDF) + OM as FYM @ 2.5 t/ha significantly improved NPK uptake by grain and straw uptake by rice crop as compared to other sources of nutrient management. This might be due to the initial quick availability of nutrient from inorganic source and later from an organic source, leading to an overall higher nutrient uptake (Das et al. 2010). Almost all of the nutrients used by plants are taken up in soluble, inorganic free ion forms from the soil solution. In these forms nutrients are able to pass from the soil solution through the root surface. These ions may be positively charged cations or negatively charged anions. The quantity of nutrient taken up is a function of crop species and growth. The uptake of major and micro nutrients by grain and straw of rice increased significantly with integrated application of different treatment combinations.

Soil health

Different establishment methods did not show any significant effect on soil fertility except in total organic carbon (TOC), whereas all the soil nutrients recorded higher value in improve practice except EC showed equal value and copper (cu) showed higher value in farmer practice (Table 3). This might be due to line sowing under improve practice, created better physico-chemical conditions, which enhance the soil microbial activities and P availability.

Among the nutrient management practices, higher pH (4.93), SOC (1.52%), TOC (3.95%), P (10.35 kg/ha), Fe (4.03 mg/kg) and Zn (1.12 mg/kg) was recorded with the application of Lime (250 kg) + NPK (kg/ha) 30:30:20 (50% of RDF), T_3- T_2 + OM as FYM @ 2.5 t/ha. Available N (444.61 kg/ha) was recorded with Lime + Rice + Soybean (4:2 ratio) + BF over control. Increase in available N and P might be due to the direct addition of N through rice straw and improved microbial activities, which might have converted organically bound N to inorganic forms. Increase in P availability might be due to the fact that organic materials form a cover on sesquioxides and thus reduce the phosphate fixing capacity of the soil and

Table 2: Nutrient uptake of grain and straw as influenced by establishment methods and nutrient management practices

Method of Practice	Grain (kg/ha)						Straw (kg/ha)					
	N		P		K		N		P		K	
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
M1:Farmer practice	18.83	19.22	3.22	3.95	30.52	32.78	12.21	13.36	2.63	2.56	10.35	11.52
M2:Improve practice	25.01	27.79	5.00	5.88	36.03	39.48	15.91	17.50	4.21	4.55	12.16	13.82
SEm(±)	**0.35**	**0.65**	**0.18**	**0.20**	**0.40**	**0.47**	**1.32**	**0.19**	**0.14**	**0.19**	**0.43**	**0.30**
CD(P=0.05)	**2.12**	**3.96**	**1.07**	**1.20**	**2.41**	**2.84**	**0.22**	**1.15**	**0.87**	**1.16**	**NS**	**1.83**
Nutrient Management												
T1	17.16	18.96	3.11	3.83	29.50	32.81	10.46	11.88	2.18	2.31	9.33	10.76
T2	24.53	25.40	4.28	4.77	40.52	40.41	16.51	16.82	3.96	3.62	13.03	13.58
T3	29.24	23.97	5.12	5.42	45.69	44.22	19.83	19.16	4.55	4.00	15.48	15.61
T4	22.66	24.34	4.19	4.81	33.91	35.97	14.01	15.03	3.46	3.71	11.68	13.13
T5	15.59	21.79	2.92	4.31	22.31	31.03	9.50	13.23	2.41	3.19	7.70	10.96
T6	25.29	26.37	5.02	5.83	34.52	35.93	15.67	16.35	4.22	4.11	12.34	12.88
T7	18.96	23.70	4.15	5.47	26.46	32.54	12.47	15.54	3.19	3.95	9.23	11.76
SEm(±)	**0.77**	**1.48**	**0.12**	**0.19**	**1.00**	**1.40**	**0.51**	**0.70**	**0.11**	**0.21**	**0.35**	**0.42**
CD(P=0.05)	**2.24**	**4.33**	**0.35**	**0.56**	**2.93**	**4.10**	**1.49**	**2.04**	**0.33**	**0.60**	**1.03**	**1.21**

Treatments: T1- Absolute Control, T2 - Lime (250 kg)+ NPK (kg/ha) 30:30:20 (50% of RDF), T3 - T2 + OM as FYM @ 2.5 t/ha, T4 - Lime + DAP @ 2% as foliar application at 2 intervals (30 DAS & 60 DAS), T5 - Lime + Rice + Soybean (4:2 ratio), T6 - Lime + BF + OM as FYM @ 2.5 t/ha, T7 - Lime + Rice + Soybean (4:2 ratio) + BF.

*FYM = Field Yard Manure, BF = Biofertilizer, OM = Organic Manure

Table 3: Soil health as influenced by establishment method and nutrient management practices (Pooled data of 2 years)

Method of Practice	pH 1:2.5	EC m.mhos/cm	SOC %	TOC %	SMBC Ppm	Avl. N kg/ha	Avl. P kg/ha	Avl. K kg/ha	Fe mg/kg	Cu mg/kg	Zn mg/kg	Mn mg/kg
M_1:Farmer practice	4.58	0.08	1.37	3.25	185.51	402.84	8.74	192.68	3.68	0.18	0.91	2.37
M_2:Improve practice	4.82	0.08	1.45	3.83	191.32	424.83	10.13	209.22	3.98	0.17	0.96	2.48
SEm(±)	**0.09**	**0.00**	**0.04**	**0.09**	**4.78**	**24.82**	**0.66**	**5.45**	**0.10**	**0.01**	**0.03**	**0.16**
CD(P=0.05)	**NS**	**NS**	**NS**	**0.49**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Nutrient Management												
T_1	4.39	0.06	1.32	3.17	180.91	409.23	8.30	200.41	3.62	0.20	0.67	2.02
T_2	4.60	0.07	1.34	3.37	188.07	402.08	8.64	215.36	3.96	0.24	1.00	2.48
T_3	4.98	0.07	1.52	3.95	192.64	391.00	10.35	211.16	4.03	0.18	1.12	2.27
T_4	4.82	0.09	1.44	3.55	183.26	426.83	10.20	200.96	3.71	0.16	0.87	2.54
T_5	4.72	0.08	1.42	3.63	192.20	423.34	9.89	208.00	3.90	0.15	1.03	2.68
T_6	4.68	0.08	1.43	3.66	196.49	399.74	9.52	177.30	3.64	0.17	0.94	2.57
T_7	4.71	0.09	1.40	3.43	185.34	444.61	9.15	193.48	3.92	0.15	0.90	2.41
SEm(±)	**0.14**	**0.01**	**0.08**	**0.13**	**10.07**	**19.61**	**0.95**	**16.06**	**0.23**	**0.02**	**0.16**	**0.16**
CD(P=0.05)	**0.36**	**NS**	**NS**	**0.38**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.06**	**NS**	**NS**

Treatments: T1- Absolute Control, T2 - Lime (250 kg)+ NPK (kg/ha) 30:30:20 (50% of RDF), T3 - T2 + OM as FYM @ 2.5 t/ha, T4 - Lime + DAP @ 2% as foliar application at 2 intervals (30 DAS & 60 DAS), T5 - Lime + Rice + Soybean (4:2 ratio), T6 - Lime + BF + OM as FYM @ 2.5 t/ha, T7 - Lime + Rice + Soybean (4:2 ratio) + BF.

*FYM = Field Yard Manure, BF = Biofertilizer, OM = Organic Manure

increased phosphorus solubilization for the native soil pool. The benefit of using organic manure like FYM was due to release of aliphatic and aromatic hydroxy acids and humates leads to higher availability of nutrients. The results corroborate with the similar findings of Das and Sinha (2004). Whereas, available K (215.36 kg/ha) and Cu (0.24 mg/kg) was recorded with application of Lime (250 kg) + NPK (kg/ha) 30:30:20 (50% of RDF).

CONCLUSION

From the present investigation, it could be concluded that improve practice by line sowing with recommended dose of lime, fertilizers, organic manure and biofertilzers. Cereal-based cropping system is the most promising system for about 70% of the global population. It could be concluded that green gram is a viable option for growing in residual soil moisture just after harvesting of *jhum* rice but also in all the *jhum* land where similar climate is existing for getting additional income of the farmers and also enhance the soil fertility status which ultimately increase the yield of succeeding rice/green gram crop and also intercropping *jhum* rice with the soybean. In facilitating proper management and use of nutrient resources, there is also a need to create strong collective action at national, regional and local levels. The reduction in the use of chemical fertilizers and balanced supply of nutrients in an integrated manner through inorganic, organic and biofertilizers will enhance the yield and soil fertility.

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