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Research Article

INFLUENCE OF INTEGRATED NUTRIENT MANAGEMENT ON ECONOMICS, SOIL PROPERTIES AND NUTRIENT UPTAKE OF LOCAL RICE (*Oryza sativa* L.) CULTIVARS UNDER RAINFED UPLAND CONDITIONS OF NAGALAND

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Abstract: The present investigation was undertaken during *kharif* season of 2015 at School of Agricultural Sciences and Rural Development, Nagaland University, Medziphema, Nagaland. The experiment was conducted in randomized block design with 10 treatments, replicated thrice with two local rice cultivars and five different nutrient management practices. The study results showed that the application of 100% RDF + 5 t ha^{-1} FYM recorded the highest grain yield (3140 kg ha^{-1}), straw yield (8889 kg ha^{-1}), soil available NPK (381.95 kg ha^{-1}, 24.55 kg ha^{-1} and 229.31 kg ha^{-1}, respectively). Combination of the cultivar 'Nyakmok' with an application of 100% RDF resulted significantly highest P uptake (19.93 kg ha^{-1}), K uptake (56.83 kg ha^{-1}), and B: C ratio (1.24). The highest gross return per hectare (₹ 44,305) was recorded in cultivar 'Nyakmok' + 100% RDF + 5 t ha^{-1} FYM.

Keywords: *Cultivars, Economics, Nutrient uptake, Soil nutrient status, Yield*

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Introduction

More than 60 percent of the Worlds population's food is contributed by rice which is also extensively cultivated in the World. Particularly in Asian countries, rice is the chief food crop grown and consumed. Though India possesses the largest area under rice cultivation, it ranks second in rice production after China. In India, rice holds 24 percent of the gross cropped area and contributes 42 percent of total country's food grain production. It plays a vital role in India's food grain supply. Also known as 'Switzerland of the East', Nagaland is a state in North-Eastern India where rice is the most important and dominant crop cultivated throughout the whole state particularly in the *kharif* season. It spreads over an area of 189480 ha with a production of 429640 tonnes out of which upland rainfed occupies an area of 94700 hectares with a production of 181820 tonnes [1]. At national level, the state's rice production seems non-significant, but at state level, rice comprises more than 50% of total arable land.

During the growing period of upland rice, its water requirement is meet with rain. Even though, the state receives high rainfall, the upland rice is grown without water stagnation due to runoff of rain water. Seventy seven percent of Nagaland's soil is acidic with soil pH ranging from 4.3 to 5.8 % and only 15% of total upland rice growing areas is fertile [2]. The rice productivity in the state is reported to be very low (*i.e.*, about 15 q ha^{-1}). Due to their economic circumstances, the farmers are unwilling to adopt modern agriculture comprising nutrient management for higher productivity. Therefore, the integrated use of nutrient sources appears to be the best option [3]. Integrated nutrient management (INM) helps in maintaining the soil productivity and improves fertilizer use efficiency. It cut back the use of chemical fertilizers by influencing the yield of *kharif* crop [4]. Therefore, the experiment was executed with the objectives to find out the suitable integrated nutrient management (INM) doses on local rice cultivars, and to find out the influence of INM on the economics, soil properties and uptake of nutrients of local rice cultivars.

Materials and Methods

Location

The field investigation was conducted in the experimental farm of School of Agricultural Sciences and Rural Development (SASRD), Nagaland University, Medziphema campus. The research farm was located at 25°45'43"N latitude and 95°53'04" E longitudes at an elevation of 310 meter above sea level. The soil was sandy loam in texture and well-drained. At 0-20 cm soil depth, the soil pH and soil organic carbon were 4.5 and 1.26%, respectively. The initial available nitrogen, available phosphorus and available potassium in soil were 285.39, 19.21, and 187.17 kg ha^{-1}, respectively.

Climatic condition

The experimental farm lies in a humid sub-tropical region and receives an average rainfall ranging from 2000-2500 mm annually. Maximum rainfall is received from May to October. During summer, the mean temperature ranges from 21°C-32°C and during winter, due to high atmospheric humidity it rarely goes below 80C. The detailed meteorological data during the point of investigation is shown in [Table-1].

Treatment details

The treatments consisted of two local rice cultivars *viz*. Nyakmok and Jamaghu and five different integrated nutrient management doses namely, 100% recommended dose of fertilizer (RDF) (60:30:30 N, P, K kg ha^{-1}), 100% RDF + 5 t ha^{-1} farmyard manure (FYM), 75% RDF + 5 t ha^{-1} FYM, 50% RDF + 10 t ha^{-1} FYM and 10 t ha^{-1} FYM. The ten treatments combinations were laid out in factorial randomized block design with three replications. The plot sizes were kept as 4-meter x 3 meter. Each plot was given same cultural treatments with regard to ploughing, cultivation, seed rate, and disease control. The seeds were sown at the rate of 80 kg ha^{-1} with 20cm maintained in row-row spacing and 10 cm maintained in plant-plant spacing.

Table-1 *Meteorological data during the period of investigation (2015)*

Date	Standard week no.	Temperature		Relative humidity (%)	Total rainfall (mm)
		Max.(°C)	Min.(°C)		
21st June - 27th June	25	31.70	25.20	73.00	19.3
28th June - 4thJuly	26	32.40	25.30	69.50	47.0
5th July - 11th July	27	32.30	25.40	70.50	47.4
12th July -18th July	28	32.40	25.20	73.00	81.8
19th July - 25th July	29	29.90	24.60	75.50	127.9
26th July - 1st August	30	32.70	24.30	68.00	53.8
2nd Aug - 8th Aug	31	35.02	27.89	84.78	0.98
9th Aug - 15th Aug	32	35.15	24.73	86.88	6.09
16th Aug - 22nd Aug	33	35.56	24.65	77.75	4.31
23rd Aug - 29th Aug	34	35.69	23.77	88.91	13.20
30th Aug - 5th Sept	35	35.69	23.61	85.10	15.03
6th Sept - 12th Sept	36	35.69	23.48	83.93	8.46
13th Sept - 19th Sept	37	35.69	23.43	85.78	10.66
20th Sept - 26th Sept	38	35.69	23.40	85.49	2.11
27th Sept – 3rd Oct	39	35.69	22.43	85.09	0.26
4th Oct – 10th Oct	40	35.69	22.86	85.44	6.49
11th Oct – 17th Oct	41	35.69	21.55	86.87	8.83

Source: Automatic Weather Station (AWS), Department of Agronomy, NU: SASRD

Table-2 *Effect of cultivars and fertilizer doses on the growth and yield of rice [NS: Non-significant]*

Treatments	Plant height (cm) at harvest	Number of green leaves plant^{-1} (45 DAS)	Plant population (m^{-2} (30 DAS)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index (%)
Cultivars (V)						
V_1-Nyakmok	170.07	5.72	88.00	3155.55	8250.00	28.16
V_2-Jamaghu	174.01	5.53	80.00	2481.11	7680.55	26.18
SEm±	2.22	0.07	4.25	133.18	333.93	0.91
CD (P=0.05)	NS	NS	NS	395.68	NS	NS
Fertilizer doses (F)						
F_1- 100% RDF (N_{60}:P_{30}:K_{30})	174.73	5.83	83.33	2868.06	7048.61	28.66
F_2- 100% RDF + 5 t ha^{-1} FYM	172.44	5.90	88.33	3140.28	8888.89	26.52
F_3- 75% RDF + 5 t ha^{-1} FYM	177.41	5.47	87.50	2326.39	7326.39	24.16
F_4- 50% RDF + 10 t ha^{-1} FYM	167.72	5.53	83.33	2843.39	8506.94	27.77
F_5-10 t ha^{-1} FYM	167.89	5.40	77.50	2913.89	8055.56	28.77
SEm±	3.52	0.12	6.73	210.57	527.99	1.45
CD (P=0.05)	NS	0.35	NS	625.63	NS	NS
Interaction (V x F)						
V_1F_1	171.41	5.93	88.33	3319.45	6875.00	32.68
V_1F_2	175.25	6.00	96.67	3361.11	10694.45	23.92
V_1F_3	182.69	5.60	91.67	2694.44	8819.44	23.41
V_1F_4	162.69	5.67	85.00	3333.33	7083.33	32.35
V_1F_5	158.17	5.40	78.33	3069.44	7777.78	28.47
V_2F_1	178.06	5.73	78.33	2416.67	7222.22	24.63
V_2F_2	169.63	5.80	80.00	2919.44	7083.33	29.11
V_2F_3	172.12	5.33	83.33	1958.33	5833.33	24.90
V_2F_4	172.64	5.40	81.67	2352.78	9930.55	23.19
V_2F_5	177.61	5.40	76.67	2758.33	8333.33	29.07
SEm±	4.97	0.17	9.51	297.78	746.69	2.04
CD(P=0.05)	14.78	NS	NS	NS	2218.52	6.07

FYM was applied 15 days ahead of sowing. The nitrogen dose in the form of urea was put in three split doses, *i.e.*, 1/3rd each as basal application, at active tillering stage, and panicle initiation stage. The dose of phosphorus and potassium were applied as basal dose at the time of final land preparation as per recommendation through single super phosphate (SSP) and muriate of potash (MOP), respectively. After every 20 days interval after sowing, hand weeding was performed to control weeds and continued till 60 days after sowing. Chlorpyriphos @ 2.5 ml litre-1 of water was applied through knapsack sprayer to control soil termites and stem borer infestation. The larva of the rice leaf folder was destroyed by clipping it off and destroying it. It was further controlled by the application of chlorpyriphos @ 3 ml litre-1. Hexaconazole 0.5% @ 1 ml litre-1 was sprayed as preventive measure against brown spot and blast. Sickles were used for harvesting plot-wise and then the harvested crop bundles were dried, threshed, and cleaned manually.

Five hills were picked randomly and tagged from each plot for recording the plant growth and yield attributes. The available soil nutrient status after harvest and plant nutrient uptake (NPK) was also recorded. Soil organic carbon was determined with the help of Walkey and Black rapid titration [5]. The available nitrogen content in soil samples was determined by the alkaline potassium permanganate method [6]. The available phosphorus content in soil samples was determined by Bray's method [7]. The neutral normal ammonium acetate method was used to determine the available potassium content in soil [8]. The data collected were subjected to analysis of variance. The significant difference was tested by 'f' test and difference between mean by CD at 5% level [9].

Results and Discussion

Growth Parameters

The growth parameters data were observed on plant height (cm) at harvest, number of green leaves per plant (45 DAS), plant population m^{-2} (30 DAS), grainy Yield (Kg ha^{-1}), straw yield (Kg ha^{-1}), and harvest index (%) for effects of integrated nutrient management in different cultivars and fertilizers [Table-2].

Experimental findings revealed that plant height did not differ significantly between the two rice cultivars. However, it was recorded that the cultivar 'Jamaghu' was superior to 'Nyakmok' in terms of plant height (174.01 cm). Similarly, among the fertilizer doses, no significant difference was recorded in plant height at harvest however, the plant height was again found highest (177.41 cm) in F3 (75% RDF + 5 t ha^{-1} FYM). Singh *et al.* (2012) [10] revealed that the plant height at harvest of rice was significantly higher due to the integrated application of biofertilizers, organic manure and urea.

The interaction effect of cultivars and fertilizer on plant height was significant at harvest. Among the 10 treatments, highest plant height (182.69 cm) was recorded from the interaction of cultivar 'Nyakmok' and F3 (*i.e.*, 75% RDF + 5 t ha^{-1} FYM). The variations in plant height of rice varieties may be attributable to the genetic makeup differences of varieties and their contrasting utilization ability of the different soil amendments rates applied. These also aligned with that of Hag *et al.* (2002) [11] who revealed that the vegetative growth of rice was favored with the increased rate of the NPK fertilizers.

At various stages of rice, the effect of cultivars on plant population (m^{-2}) was non-significant. The interaction effects of cultivars and fertilizer doses on plant population were also non-significant at various stages.

The different fertilizer doses positively influenced the number of green leaves per plant. The number of green leaves plant-1 at 45 DAS was highest (5.90) in F2 (100% RDF + 5 t ha^{-1} FYM). The cultivars and fertilizer interaction effect on the number of leaves plant-1 were non-significant.

Yield

The cultivar 'Nyakmok' produced a significantly higher grain yield (3155.55 kg ha^{-1}) than cultivar 'Jamaghu' (2481.11 kg ha^{-1}). This variation is due to the genetic characteristics of varieties and these may be the reasons for higher yield. Yield attributing characters in rice expresses the Grain yield [12].

The effect of different fertilizer doses on grain yield and straw yield were not significantly. However, F2 (*i.e.*, 100% RDF + 5 t ha^{-1} FYM) gave highest grain yield (3140.28 kg ha^{-1}) and straw yield (8888.89 kg ha^{-1}) which may be due to increase in plant growth attributes (plant height, number of productive tillers/hill, panicle weight, and 1000-grain weight) [13].

The interaction effect on straw yield due to cultivars and fertilizer dose was significant. The highest straw yield (10694.45 kg) was recorded for cultivar Nyakmok + 100% RDF + 5 t ha^{-1} FYM. This is similar with the outcomes of Lhungdhim *et al.* (2014) [14], where it recorded that a lower level of FYM in combination with 100% RDF + FYM @ 5 t ha^{-1} exhibited better yield than a higher compost level. This indicated that integrated nutrient application with nutrient-rich inputs (fertilizer) on the higher side of the dose always give better yield.

The interaction effect on harvest index due to cultivars and fertilizer dose was significant. The highest harvest index was recorded for cultivar 'Nyakmok' + RDF at 32.68 % followed by cultivar Jamaghu + 100% RDF + 5 t ha-1 FYM at 29.11%.

Economics

The data on total cost of cultivation (₹ ha^{-1}), gross returns (₹ ha^{-1}), net returns (₹ ha^{-1}), and B: C Ratio for effects of integrated nutrient management in different cultivars and fertilizers are shown in [Table-3].

The common cost of cultivation for each treatment was ₹ 12,550 /ha^{-1}. The highest cost of cultivation (₹ 20,405 /ha^{-1}) was observed in two treatments, *i.e.*, V1F2 [cultivar 'Nyakmok'+ (100% RDF + 5 t ha^{-1} FYM)] and V2F2 [cultivar 'Jamaghu' +100% RDF + 5 t ha^{-1} FYM]. Whereas, two treatments *i.e.*, V1F5 (cultivar 'Nyakmok' + 10 t ha^{-1} FYM) and V2F2 (cultivar 'Jamaghu' + 10 t ha^{-1} FYM) showed the lowest cost of cultivation (₹ 17,550 /ha^{-1}).

The highest gross return per hectare (₹ 44,305) was recorded in treatment V1F2 (cultivar 'Nyakmok' + 100% RDF + 5 t ha^{-1} FYM). This is due to high grain and straw yield. Lakshmi *et al.* (2013) [15] reported that the gross returns were more in INM treatments than 100% RDF and control plots.

Net income was also recorded to be maximum (₹ 23,900) in treatment V1F2 (cultivar 'Nyakmok'+ 100% RDF + 5 t ha^{-1} FYM). This is due to higher net gross returns. The treatment V1F1 (cultivar 'Nyakmok' + 100% RDF) recorded the highest B: C ratio (1.24). The other treatment resulted in a lower benefit-cost ratio due to the higher cost of cultivation. These findings confirmed with Panigrahi *et al.* (2014) [16] who reported that the application of RDF (60-30-30 kg N-P_2O_5–K_2O ha^{-1}) was more profitable in terms of net returns and returns per rupee invested than integrated nutrient management or organic farming practice due to the higher cost of organic manures. This high cost of FYM decreased the B: C ratio in treatments having FYM as organic addition, alone or in combination with other organics.

Table-3 *Economics of cost of cultivation*

Treatments	Total cost of cultivation (₹ ha^{-1})	Gross Returns (₹ ha^{-1})			Net Return (₹ ha^{-1})	B:C Ratio
		Grain	Straw	Total		
V x F						
V_1F_1	17905	33194	6875	40069	22164	1.24
V_1F_2	20405	33611	10694	44305	23900	1.17
V_1F_3	19045	26944	8819	35763	16718	0.88
V_1F_4	20220	33333	7083	40416	20196	1.00
V_1F_5	17550	30694	7778	38472	13484	1.19
V_2F_1	17905	24167	7222	31389	15872	0.75
V_2F_2	20405	29194	7083	36277	6371	0.78
V_2F_3	19045	19583	5833	25416	13238	0.33
V_2F_4	20220	23528	9930	33458	13238	0.65
V_2F_5	17550	27583	8333	35916	18333	1.04

**Data not statistically analysed. Note: Cost of urea @ ₹10 kg^{-1}, SSP(Single Super Phosphate) @ ₹15 kg^{-1}, MOP (Muriate of Potash) @ ₹25 kg^{-1}; Price of grain @ ₹10 kg^{-1}; Price of straw @ ₹1000 t^{-1}; FYM @ ₹500 t^{-1}; Labour charge @ ₹150 day^{-1}*

Soil nutrient status

The data observed on the effects of integrated nutrient management in different cultivars and fertilizers on soil pH value, organic carbon (%), available nitrogen (kg ha^{-1}), available phosphorus (kg ha^{-1}), and available potassium (kg ha^{-1}) after harvest are depicted in [Table-4].

A significant variation was recorded on soil pH, organic carbon, available nitrogen, and available potassium due to cultivars. Cultivar 'Nyakmok' recorded significantly higher pH (4.74) than 'Jamaghu' (4.67). Cultivar 'Jamaghu' recorded a significantly higher value of organic carbon (1.68%), available nitrogen (329.02 kg ha^{-1}), and available potassium (212.90 kg ha^{-1}).

There was a significant difference in soil nutrient status after harvest. This may be due to the different application of fertilizer doses. The highest pH (4.81) was obtained in F5 (50% RDF + 10 t ha^{-1} FYM). The fertilizer dose F4 (75% RDF + 5 t ha^{-1} FYM) showed the highest value of organic carbon (1.85%). This may be due to the organic nutrient source application which might have produced conducive environment to form humic acid and induced the soil microbial activity, hence increasing soil organic carbon content [17].

Table-4 *Effect of cultivars and fertilizer doses on soil nutrient status after harvest*

Treatments	Soil nutrient status after harvest				
	pH value	Organic carbon (%)	Available nitrogen (kg ha^{-1})	Available phosphorus (kg ha^{-1})	Available potassium (kg ha^{-1})
Cultivars (V)					
V_1	4.74	1.57	314.34	22.40	208.17
V_2	4.67	1.68	329.02	22.42	212.90
SEm±	0.01	0.01	4.38	0.58	0.43
CD (P=0.05)	0.03	0.04	13.02	NS	1.29
Fertilizer doses (F)					
F_1	4.63	1.73	291.4	21.17	206.48
F_2	4.81	1.26	381.95	24.55	229.31
F_3	4.53	1.85	352.28	24.29	220.37
F_4	4.81	1.78	307.05	20.46	198.50
F_5	4.75	1.52	275.75	21.58	198.01
SEm±	0.02	0.02	6.93	0.92	0.69
CD (P=0.05)	0.05	0.07	20.58	2.72	2.04
V x F					
V_1F_1	4.63	1.64	276.39	23.12	195.13
V_1F_2	4.94	1.06	372.14	21.58	224.68
V_1F_3	4.47	2.14	363.36	24.83	228.07
V_1F_4	4.78	1.62	293.09	19.63	205.78
V_1F_5	4.79	1.40	266.74	22.85	187.19
V_2F_1	4.63	1.82	306.41	19.22	217.82
V_2F_2	4.59	1.45	391.75	27.52	233.94
V_2F_3	4.59	1.56	321.2	23.74	212.67
V_2F_4	4.83	1.94	321.01	21.30	191.22
V_2F_5	4.70	1.63	284.75	20.30	208.83
SEm±	0.02	0.03	9.80	1.30	0.97
CD(P=0.05)	0.05	0.09	29.10	3.85	2.88

NS: Non-significant

The highest value of available nitrogen (381.95 kg ha1), phosphorous (24.55 kg ha^{-1}), and available potassium (229.31 kg ha^{-1}) was associated with fertilizer dose F1 (100% RDF +5 t ha^{-1} FYM). Similarly, Chesti *et al.* (2015) [18], revealed that the integrated application of 10 t FYM ha^{-1} and 100% NPK significantly improved the soil organic carbon and available N, P, and K contents over the chemical fertilizers alone. Sharma and Subehia (2014) [19], also revealed that integrated application of organics with fertilizers recorded higher available P content over the application of inorganic fertilizers alone. The build-up in available P with the application of fertilizers and organics together attributed to the release of organic acids during decomposition which in return assist in releasing native phosphorus through the solubilizing action of these acids.

The interaction effect of cultivars and fertilizer dose on soil pH, organic carbon, available NPK were significant. The treatment V1F2 (cultivar 'Nyakmok'+ 100 % RDF + FYM at 5 t ha^{-1}) recorded the highest soil pH (4.94). The highest soil organic carbon (2.14%) was recorded in V1F3 (cultivar 'Nyakmok' + 75% RDF + 5 t ha^{-1} FYM). The highest value of available nitrogen (391.75 kg ha^{-1}), available phosphorous (27.52 kg ha^{-1}), available potassium (233.94 kg ha^{-1}) was recorded in V2F2 (cultivar Jamaghu + 100% RDF + FYM at 5 t ha^{-1}). This may be due to increased levels of FYM and fertilizer [20].

Nutrient uptake

The data observed on NPK uptake (kg ha^{-1}) at harvest for effects of integrated nutrient management in different cultivars and fertilizers are depicted in [Table-5].

Table-5 *Effect of cultivars and fertilizer doses on nutrient uptake after harvest*

Treatments	NPK uptake (kg ha^{-1}) at harvest		
	N	P	K
Cultivars (V)			
V_1	50.38	15.50	40.35
V_2	48.81	13.95	40.17
SEm±	0.79	0.07	0.09
CD (P=0.05)	NS	0.21	NS
Fertilizer doses (F)			
F_1	51.70	18.31	51.32
F_2	51.28	13.22	38.48
F_3	47.49	10.43	29.20
F_4	48.53	14.61	37.33
F_5	48.97	17.09	44.98
SEm±	1.25	0.11	0.15
CD (P=0.05)	NS	0.33	0.44
V x F			
V_1F_1	51.47	19.93	56.83
V_1F_2	52.51	14.84	41.97
V_1F_3	49.50	10.26	31.33
VF_4	50.28	15.65	29.77
V_1F_5	47.93	16.82	41.97
V_2F_1	51.92	16.68	45.80
V_2F_2	50.05	11.59	35.10
V_2F_3	45.29	10.59	27.07
V_2F_4	46.77	13.56	44.90
V_2F_5	50.00	17.35	48.00
SEm±	1.77	0.16	0.21
CD (P=0.05)	NS	0.47	0.63

NS: Non-significant

The N and K uptake by rice plants due to cultivars were non-significant. However, a significant difference was found in P uptake due to cultivars. Cultivar 'Nyakmok' recorded the higher P uptake (15.50 kg ha^{-1}).

Similarly, the N uptake was non-significant due to the effect of fertilizer doses. Whereas for P and K uptake it was significant. The highest value of phosphorus uptake (19.93 kg ha^{-1}) and potassium uptake (56.83 kg ha^{-1}) was associated with F1 (100% RDF). This is supported with the findings of Roy *et al.* (2013) [21] where the highest NPK uptake by grain and straw was found with the 100% RDN (Recommended Dose of Nitrogen) through inorganic fertilizer. The treatments applied with nitrogen through inorganic fertilizer had a relatively quicker nutrient release, which displayed higher grain and straw yield and thus had higher uptake of nutrient.

The interaction effects of cultivars and fertilizers dose on P and K uptake of the plant were significant. Cultivar 'Nyakmok' + 100% RDF recorded the highest uptake of N (19.93 kg ha^{-1}) and P (56.8 kg ha^{-1}). This variation in more uptake of nutrients with the application of inorganic fertilizer may be because of increased nutrient concentration and increased biomass production [22].

Conclusion

Cultivar 'Nyakmok' was more suitable under the rainfed upland condition of Nagaland. Cultivar 'Nyakmok' produced a higher grain yield (3156 kg ha^{-1}) and straw yield (8250 kg ha^{-1}) compared to cultivar 'Jamaghu'. Application of 100% RDF + 5 t ha^{-1} FYM enhanced the yield of both the local rice cultivars. Combination of the cultivar 'Nyakmok' with the application of 100% RDF showed significantly higher uptake of P (19.93 kg ha^{-1}) and K (56.83 kg ha^{-1}) and also resulted in a higher B: C ratio (1.24) when compared with the other treatment combinations under test. However, the combination of 'Nyakmok' + 100% RDF + 5 t ha^{-1} FYM resulted in the highest gross return per hectare (₹ 44,305). Therefore, integration of inorganic fertilizer and organic manure can be adopted to improve the crop and soil productivity under rainfed upland conditions of Nagaland.

Application of research: To select the suitable integrated nutrient management doses in local rice cultivation.

Research Category: Agronomy, Nutrient Management

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Cultivar / Variety / Breed name: Cultivars- 'Nyakmok' and 'Jamaghu'

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