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Effect of nutrient management in lowland rice for improving productivity, profitability and energetics under the mid hill of Nagaland

MANOJ KUMAR*, DJ RAJKHOWA[2], KL MEENA[3], RAKESH KUMAR[4], PATU K ZELIANG[1], E LIRENI KIKON[1], [1]K LILY RANGNAMEI[1] AND A NAMEI[1]

ICAR- RC for NEH Region Nagaland Centre, Jharnapani, Nagaland, India

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ABSTRACT

On-Farm trail was conducted in Longleng district of Nagaland during the *kharif* season of 2014-15 and 2015-16 to find out the most suitable nutrient management practices *viz.* recommended doses of fertilizers (RDF) 80:60:40 kg NPK/ha, locally available weed biomass (*Eupatorium* @ 10 t/ha) and farmers practices at farmers field of Krishi Vigyan Kendra, Longleng, Nagaland. The experiment was laid out in Completely Randomized Block Design. Result revealed that growth and yield parameters were recorded maximum under RDF and followed by *Eupatorium* @ 10 t/ha compared to farmers practice. The maximum grain yield (3590 kg/ha) was with RDF closely followed by weed biomass @10t/ha (3270 kg/ha) over the farmer's practices (2730 kg/ha), respectively. Grain yield was increased by 31.5 % in RDF and 11.8 % in *Eupatorium* @ 10 t/ha compared to the farmer's practices. Similarly, production efficiency was recorded the highest with RDF (28 kg/ha/day) followed by *Eupatorium* @ 10 t/ha (25.5 kg/ha/day) and farmers practice (21.3 kg/ha/day). With respect to economics, the maximum net returns and benefit: cost ratio (B: C ratio) were recorded with RDF (Rs.18850/ha and 1.91) as compared to other treatments. Economic efficiency was also noted highest under RDF (Rs.147.27/ha/day) followed by *Eupatorium* @10 t/ha (Rs.128.36/ha/day). Hence, it may be concluded that the farmer's practices can be replaced with the adoption of RDF or locally available weed biomass (*Eupatorium*) as a source of nutrition for achieving the higher productivity and profitability of the lowland rice under the mid-hill altitude condition of Nagaland.

Keywords: Rice, Weed biomass, Fertilizers, Yield, Economics, Energetics

INTRODUCTION

Rice is the major food crop of South Asia but it plays a major and pivotal role in Indian National food security system (Singh *et al.,* 2017). Rice occupies North East India and occupying an area of ~3.5 m ha, which accounts ~7% of the area and 6.5% of the country rice production (Kumar *et al.,* 2017). The productivity of rice in NE states is ~1.5 t/ha, is much below than average national a productivity of rice 2.26 t/ha. In context to Nagaland, rice is primary food and cultivated in an area of ~18.3 thousand ha and producing 38.1 thousand tonnes with a productivity of ~ 2.1 t/ha. Longleng district in the states falls under most backward as per classified by the planning commission of India. The livelihood of the people largely depends on agriculture production system and rice is the staple food in the region and cultivated in an area of ~7.4 thousand ha with the production of 13.62 thousand tonnes and productivity ~1.83 t/ha (Kumar *et al.,* 2016). The tribal people of the region are not even able to meet their food requirement due to the lowest productivity of rice. The main problems associated with the lowest productivity of rice are lack of knowledge about the improved agricultural practices. Therefore, the Krishi Vigyan Kendra Longleng took the initiative and conducted an On-Farm Testing (OFT) during the *kharif* season of 2014-15 and 2015-16 to compare the different nutrient management practices along with farmers practices in lowland rice (*Cv.* Teiphek youh) for achieving optimum productivity and profitability of the poor tribal of the NEH region.

MATERIALS AND METHOD

A field experiment was conducted at farmer's field of Krishi Vigyan Kendra, Longleng, ICAR- Research Complex for North Eastern Hill Region, Nagaland Centre Jharnapani, Medziphema during the two consecutive *kharif* seasons of 2014 and 2015. The experimental site was located between at 26^0 26' 0'' N Latitude, 94^0 52' 0'' E Longitude with an altitude of 1366 m above mean sea level. The soil of the experimental field was sandy loam and acidic in reaction (pH 5.3), high in organic carbon (0.93%), low in available N (296 kg/ha) and medium in available P (12 kg/ha) and K (170 kg/ha). Mean monthly average temperatures were varying from 18.3°C to 24.9°C in 2014 and 20.0°C to 26.4°C in 2015, respectively (Fig 1). Total rainfall received during the cropping period was 1442 mm and 1160 mm in 2014 and 2015, respectively. However, the rainfall distribution over a month was better in 2015 as compared to 2014. The monthly rainfall was recorded maximum in the month of June 2014 and July 2015. The treatment comprised of recommended doses of fertilizers (100% RDF) 80:60:40 kg NPK/ha, locally available weed

SMS (Agronomy), Krishi Vigyan Kendra, Longleng, Nagaland, [2]Joint Director, ICAR RC for NEH Region Nagaland Centre Jharnapani, Nagaland, India [3]Head, Krishi Vigyan Kendra, Longleng, Nagaland, Nagaland, India [4]Scientist (Agronomy), Division of Crop Research ICAR- RC for Eastern Region, Patna, Bihar, India
*Corresponding Author: Email: mkumar_cprs@yahoo.co.in

biomass (*Eupatorium*) @ 10 t/ha and farmers practices in a completely randomized block design with six replications.

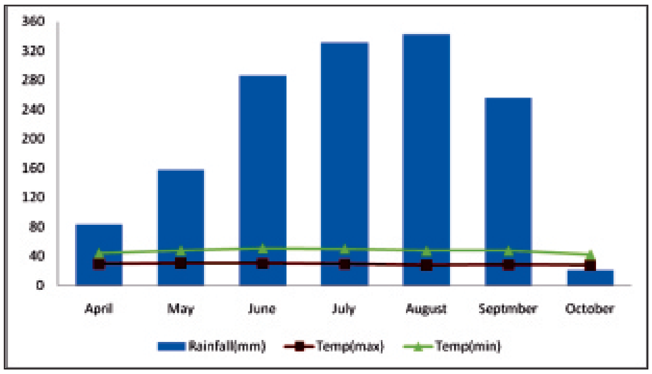

Fig. 1: Rainfall, the maximum and minimum temperature of the cropping period (Mean 2 year)

Weed biomass (*Eupatorium spp.*) was contained 2.47% N, 0.56% P and 0.82% K on dry weight basis. Weed biomass was collected from a nearby area of the field and chopped in small pieces after that incorporated into the rice field treatment wise 15 days before transplanting. Entire doses of phosphorus and potassium were applied as basal and incorporated into the soil incorporated uniformly before the transplanting of rice in the form of DAP and MOP. Fertilizers N in the form of urea was applied in three equal splits i.e., 1/3rd as basal, 1/3rd as tillering and 1/3rd at panicle initiation stage. Thirty days old seedlings were transplanted with three seedlings per hill at a spacing of 20x 15 cm. Two hand weeding was given at 20 and 45 days after transplanting (DAT). Neem oil @ 3ml per litre of water during the flowering stage for controlling the insect and no disease appeared during the cropping cycle. Five plants were selected from hill at randomly in each treatment to record the observation on growth and yield parameters. Data collected on plant height, dry matter and tillers/m^2, grains/panicle, panicle length, panicle weight and 1000-grain weight were recorded at crop maturity. Grain and straw yield were determined from net plot area in centre of each plot and adjusted to a standard moisture content of 0.14 g H_2O g^{-1} fresh weight. The filled grain of 1000 number was counted and weight treatment wise as test weight. Moisture content of the grain of each plot was determined and test weight was converted to a standard 12% moisture content.

Harvest index (HI) was computed by the formula given below

$$HI = \frac{\text{Grain yield}}{\text{Biological (Grain + Straw) yield}} \times 100$$

Grain yield of rice was converted into an equivalent value of carbohydrate (t/ha) as given by Gopalan *et al.* (2014). In economics, cost of cultivation was taken into account for calculating economics of treatments as work out net return per ha and benefit-cost ration.

The gross returns were taken as total income from the produce of grain and straw yield based on prevailing price. Net return and benefit-cost ratio was calculated with the help of following formula:

Net Return (ha^{-1}) = Gross return (ha^{-1}) - cost of cultivation (ha^{-1})

$$\text{Benefit: Cost ratio} = \frac{\text{Grain yield}}{\text{Biological (Grain + Straw) yield}}$$

Production efficiency and economic efficiency were calculated with the help of the formula

$$\text{Production efficiency (kg/ha/day)} = \frac{\text{Grain yield (kg/ha)}}{\text{Total duration of the crop (days)}}$$

$$\text{Economic efficiency(Rs/ha/day)} = \frac{\text{Net return (Rs/ha)}}{\text{Total duration of the crop (days)}}$$

Energy input and output were calculated by converting various inputs used viz. labour, fertilizer and farmyard manure and output i.e. grain and straw into energy units (MJ) as indicated by Devasenapathy *et al.* (2009). Energy output from the product (grain) was calculated by multiplying the amount of production and its corresponding energy equivalent. Energy outputs from by-product (straw/leaves/stalk) were estimated by multiplying to its corresponding energy equivalent.

Net energy return: It is the difference between the gross output energy produced and the total energy required to obtain it (input energy).

$$\text{Energy profitability} = \frac{\text{Net energy return (MJ/ha)}}{\text{Input Energy (MJ/ha)}}$$

$$\text{Energy use efficiency (\%)} = \frac{\text{Energy output (MJ/ha)}}{\text{Energy input (MJ/ha)}}$$

$$\text{Energy intensity (MJ/Rs)} = \frac{\text{Energy output (MJ/ha)}}{\text{Energy intensity (MJ/Rs)}}$$

$$\text{Energy productivity (kg/MJ)} = \frac{\text{Crop economic yield (Kg/ha)}}{\text{Energy input (MJ/ha)}}$$

Mean data of all the observation over two years were pooled and statistically analysed using F-test (Panse and Sukhatme, 1978). The test of significance of treatment was done on the basis of the t-test.The significant differences between treatments means were compared with the critical difference (CD) values at 5% level of probability (P=0.05). Difference between two treatment means which were higher than respective CD values was considered as significant.

RESULTS AND DISCUSSION

Effect of nutrient management Growth, yield attributes

Result revealed that growth and yield parameters were recorded the maximum with RDF and followed by *Eupatorium* @ 10 t/ha compared to the farmer's practice. Plant height was recorded highest with the application of 100% RDF (80:60:40 kg NPK/ha) as compared to other nutrient management practices (Table 1).

The yield attributes i.e. panicle/m^2, panicle length, panicle weight and 1000 seed weight were recorded 136.5,21.7,3.8, 29.2 with 100% RDF (80:60:40 kg/ha) followed by weed biomass @10t/ha (126,19.2,3.5,27.45) and the farmers practices (117,18.8cm, 3.15 g and 26 g) respectively. The percentage increase in panicle length, panicle weight and 1000 seed weight were 15.43,20.63,12.31 with 100% RDF and 13.30, 9.52

and 6.73 with weed biomass @ 10 t/ha, respectively over farmers practice. The more nos. of yield attributes recorded with the application of NPK might be due to more availability of nitrogen, which plays a vital role in cell division.

Table 1: Effect of nutrient management on growth and yield attributes of lowland rice (Pooled data of 2 years)

Treatment	Plant height (cm)	Panicle /m^2 (no.)	Panicle length (cm)	Panicle weight (g)	Test weight (g)
Farmers practice	109	117	18.8	3.15	26
100% RDF	128.1	136.5	21.7	3.8	29.2
Weed biomass	118.1	126	19.2	3.5	27.45
SEm (±)	3.11	2.81	0.34	0.14	0.23
LSD (P=0.05)	8.76	7.93	0.97	0.40	0.65

Effect of nutrient management on yield

Maximum grain yield was recorded 3590 kg/ha with RDF followed by weed biomass @10t/ha (3270 kg/ha) and the farmer's practices (2730 kg/ha). The grain yield was increased by 31.5% in 100% RDF and 11.8% in *Eupatorium* @ 10 t/ha compared to farmers practices (Table 2). Production efficiency was recorded highest with RDF (28 kg/ha/day), followed by *Eupatorium* @10 t/ha (25.5 kg/ha/day) and the farmer's practices (21.3 kg/ha/day). The highest straw yield and harvest index were recorded 4512 kg/ha and 44.3%, respectively with the application of 100% RDF (80:60:40 kg/ha) than other two treatment. This might be due to the application of NPK availability is more for rice, which ultimately helps for better growth and development from source to sink. This finding in concordance with the Kumar *et al.* (2017).

Table 2: Effect of nutrient management on yields of lowland rice (Pooled data of 2 years)

Treatment	Grain yield (kg/ha)	Straw yield (kg/ha)	Harvest Index (%)
Farmers practice	2730	4139	39.7
100% RDF	3590	4512	44.3
Weed biomass	3270	4397	42.7
SEm (±)	113.10	173.7	1.04
LSD (P=0.05)	319.80	NS	2.94

Table 3: Effect of nutrient management on economics of lowland rice (Pooled data of 2 years)

Treatment	Net Profit (Rs./ha)	B:C Ratio	Production Efficiency (kg/ha/ day)	Economic Efficiency (Rs./ha/ day)	Carbohydate yield (t/ha)
Farmers practice	10970	1.615	21.33	85.70	2135
100% RDF	18850	1.91	28.05	147.27	2807
Weed biomass	16430	1.8	25.55	128.36	2557

Economics

Maximum net return (Rs.18850/ha) and benefit-cost ratio (1.91) were recorded with 100% RDF as compared to other treatments (Table 3). Economic efficiency was found highest under RDF (Rs.147.27/ha/day) followed by Eupatorium @10 t/ha (Rs.128.36/ha/day) and farmers practices (85.70/ha/day). Application of 100% RDF recorded the maximum net profit and B:C ratio. Highest returns with 100% RDF were recorded due to higher rice productivity owing to the favorable effect of the higher use of nutrition (Kalita *et al*., 2015 and Singh *et al*., 2013).

Energetics

Energy analysis is new tools for judging treatment efficiency and the respective treatment is considered more efficient when it produces higher output energy and requires less input energy. The highest total energy was recorded with the application of 100% RDF (28945.8MJ/ha) followed by weed biomass applied @ 10 t/ha (25595.5MJ/ha) over farmers practice (23085.4MJ/ha). Maximum output energy was recorded 101275 MJ/ha), which was 18 and 6% higher over farmers practice and weed biomass, respectively (Table 4).

The net energy was recorded the highest with 100% RDF (72329.2 MJ/ha) followed by weed biomass (70242.3 MJ/ha) and the farmer's practices (72329.2 MJ/ha). Whereas, the energy use efficiency, energy profitability and energy productivity were found maximum under weed biomass treatment followed by farmers practices and 100% RDF. This might be due to respective treatment, energy input was the minimum and comparatively higher output was noted (Kumar *et al*., 2017).

Table 4: Effect of nutrient management on energetic of lowland rice (Pooled data of 2 years)

Treatment	Energy Input (MJ/ha)	Energy output (MJ/ha)	Net energy (MJ/ha)	Energy profit ability	Energy productivity	Energy use efficiency
Farmers practice	23085.4	85862.5	62777.1	2.72	0.298	3.72
100% RDF	28945.8	101275	72329.2	2.50	0.280	3.50
Weed biomass	25595.2	95837.5	70242.3	2.74	0.300	3.74

CONCLUSION

From the above result, it was concluded that the farmer's practices can be replaced with the adoption of RDF or locally available weed biomass (*Eupatorium*) for higher productivity and profitability under the foot hill agro-ecosystem of Nagaland.

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