The Pharma Innovation Journal 2018; 7(7): 426-429

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2018; 7(7): 426-429

www.thepharmajournal.com
Received: 21-05-2018
Accepted: 23-06-2018

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Effect of integrated nutrient management on growth and yield of local rice (*Oryza sativa* L.) under rainfed upland condition of Nagaland

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Abstract
An investigation to assess the "Integrated nutrient management in local rice (*Oryza sativa* L.) Cultivars under rainfed upland condition of Nagaland" was carried out at School of Agricultural Sciences and Rural Development, Nagaland University, Medziphema, Nagaland, during *kharif* season of 2015. This experimentation was carried out under factorial randomized block design (FRBD) based on three replications with 10 treatments. The factors comprised of two local rice cultivars *viz*. Nyakmok (V_1) and Jamaghu (V_2) and five fertilizer doses. The results revealed that, the application of 100% RDF + 5 t ha^{-1} FYM enhanced the growth and yield of both the local rice cultivars. The application of 100% RDF + 5 t ha^{-1} FYM recorded highest number of panicles m^{-2} (120), length of panicle (28.93 cm), test weight (30.55 g), grain yield (3140.28 kg ha^{-1}) and straw yield (8888.89 kg ha^{-1}). Combination of cultivar 'Nyakmok' with the application of 100% RDF resulted in significantly highest harvest index (32.68 %), uptake of P (19.93 kg ha^{-1}) and K (56.83 kg ha^{-1}). It is concluded from the study that Cultivar 'Nyakmok' was more suitable with 100% RDF + 5 t ha^{-1} FYM under rainfed upland condition of Nagaland.

Keywords: Rice cultivars, nutrient, yield

Introduction
Rice (*Oryza sativa* L.) crop occupies the enviable prime place among the food crops cultivated around the world and remains as the most important staple food crop of the world (Krishnan *et al*. 2011) [6]. Rice crop grows between 55^0N and 36^0S latitudes under diverse climate and weather conditions in different ecosystems. India is the second most populous nation and the largest producer of rice in the world after China. India produces about 152.6 million tons from 42.5 million ha with an average productivity of 3.57 tons/ha while, China produces 204.3 million tons from 30.3 million ha with an average productivity of 6.73 tons/ha.

In Nagaland, rice being the most important crop of the people, it is grown throughout the entire state and covers an area of 1,89,480 hectares with a production of 4,29,640 tonnes out of which upland rainfed occupies an area of 94,700 hectares with a production of 1,81,820 tonnes (Anonymous, 2014) [1]. The upland rice in Nagaland is grown under high rainfall without water stagnation as rain water is lost due to runoff. The 77% of Nagaland are acidic in reaction (pH range 4.3 to 5.8). Only 15% of total upland rice growing areas are fertile (Singh *et al*., 2011) [14]. The productivity of rice in the state is very low (about 15 q ha^{-1}). Rice is the dominant crop of Nagaland which is grown especially in the *kharif* season. Therefore, integrated use of nutrient source appears to be best option (Lakaria *et al*., 2010) [7]. Owing to economic condition, farmers are reluctant to adopt modern agriculture including nutrient management for higher productivity. Enhancing the rice productivity through the improvement of yield potential of genotypes and appropriate nutrient management has been the main thrust of Indian rice policy. Inorganic fertilizer is one of the key factors to increase the rice productivity. Rice yield and biomass increased rapidly due to increased use of chemical fertilizers. In the recent years, crop productivity has stagnated or decreased in spite of consumption of increased rate of chemical fertilizers. As a result, agricultural ecosystems remain in a state of chemical nutrient saturation, leading to huge nutrient losses through leaching, runoff, volatilization, emissions, immobilization Integrated nutrient management has been shown to considerably improve rice yields by nutrient management in local rice in Nagaland for better growth, greater productivity and higher profit.

Material and Methods

The investigation was conducted at Department of Agronomy, SASRD, Nagaland University, Medziphema campus, during *kharif* season of 2015 to evaluate the integrated nutrient management in local rice (*Oryza sativa* L.) Cultivars under rainfed upland condition of Nagaland.

Location: The latitude and longitude of the experiment location are $25^0$45'43"N and $95^0$53'04" E respectively. The mean altitude is 310 m above mean sea level and Medziphema campus comes under farm lies in humid sub-tropical region with an average rainfall ranging from 2000-2500 mm annually. The maximum rainfall is received during May to October. The mean temperature ranges from 21°C-32°C during summer. The weather data during crop growing season shown in (figure 1.).

Study was conducted as factorial randomized block design (FRBD) based on three replications with 10 treatments. The factors comprised of two local rice cultivars *viz.* Nyakmok (V_1) and Jamaghu (V_2) and five fertilizer doses viz. 100% RDF (F_1), 100% RDF + 5 t ha^{-1} FYM (F_2), 75% RDF + 5 t ha^{-1} FYM (F_3), 50% RDF + 10 t ha^{-1} FYM (F_4) and 10 t ha^{-1} FYM (F_5). The soil of the experiment field was sandy loam in texture well drained and with acidic reaction (pH 4.5). The organic carbon content of the soil was high (1.26) whereas the available nitrogen, available phosphorus and available potassium were found to be medium. The total number of plot 30 and size as 4 x 3 meter with a spacing 10 X 20 cm. Five hills in each plot were randomly selected and tagged for recording growth parameter as well as yield attribute were recorded.

Results and Discussions

Growth Parameters

The data observed on plant height (cm), number of green leaves per plant, Leaf Area Index, Day to 50 % flowering and day to maturity for effects of integrated nutrient management in different cultivars and fertilizers are depicted in Table1.

Plant height (cm) at 60 Day after sowing (DAS) was positively influenced by different fertilizer dose F 3 (75% RDF + 5 t ha $^{-1}$ FYM) recorded the highest plant height (131.57 cm). Singh *et al.* (2012) [13] reported that plant height of rice was significantly higher due to the integrated application of biofertilizers and organic manure in combination with chemical fertilizer. The interaction effect of cultivars and fertilizer on plant height was significant at harvest. The highest plant height (182.69 cm) was associated with the interaction of cultivar 'Nyakmok' and F 3 (75% RDF + 5 t ha $^{-1}$ FYM). The variations in plant height of rice varieties may be attributable to differences in the genetic makeup of the varieties and their differences in the utilization ability of the different rates of soil amendments applied. These observations were in consonance with that of Halder *et al.* (2000) [4] and Hag *et al.* (2002) [3] who reported that increased rate of the NPK fertilizer favoured the vegetative growth in rice plant.

Number of green leaves per plant at 60 DAS the effect of cultivars on number of green leaves per plant was non-significant at various stages. Number of green leaves per plant was positively influenced by different fertilizer doses. The number of green leaves per plant was highest (5.53) in F3 (100% RDF + 5 t ha^{-1} FYM).

Number of tillers per (m^2) the results showed that effects of cultivars and fertilizers and interaction effects on number of tillers (m^{-2}) at 75 DAS was found significant in cultivars. The number of tillers was found highest (168.67) in cultivar 'Nyakmok'. The significant differences observed in the number of tillers can be ascribed to differences in the ability of the cultivars to utilize the fertilizer as well as partition their photosynthates and accumulation of dry matter. The differences in the ability of crop cultivars to utilize available nutrients and optimally partition its photosynthates had been recognized (Ndon and Ndaeyo, 2001) [11].

Leaf Area Index (LAI) the differences in leaf area index at 60 DAS due to fertilizers were non- significant. However, the maximum LAI (1.54) was recorded for F5 (10 t ha $^{-1}$ FYM). This observation are in consonance with the findings of Panigrahi *et al.* (2014) [12], who reported that application of organic manure (FYM 15.0 t ha $^{-1}$) improved growth attributes like plant height, tillering, LAI and CGR of basmati rice varieties, increased panicle production and filled grains per panicle, produced high grain (4.42 t ha $^{-1}$) and straw (6.57 t ha $^{-1}$) yields.

Days to 50% flowering and Days to maturity the cultivar Nyakmok recorded more days to 50% flowering. This findings was associated with Nair (1984) [10], who reported that the variation in cultivars due to genetic components. There was no significant difference in days to maturity due to cultivars as well as no significant difference in days to 50% flowering and days to maturity due to the different fertilizer doses and interaction effects. It was reported by Singh *et al.* (2012) [13] that days to 50% maturity were not significantly influenced due to varietal difference or different doses of nutrition.

Yield Attributes

The data observed on number of panicle per (m^2), length of panicle, weight of panicle, number of grains per panicle, filled grains percentage, test weight (g), grain yield (Kg per ha.), straw yield and harvest index are depicted in Table 2. The result inferred that different cultivars performed differently on yield attributes. The cultivar 'Nyakmok' produced 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. Grain yield is the manifestation of yield attributing characters in rice (Matsushima, 1976) [8]. Cultivar 'Nyakmok' also recorded higher straw yield (8250 kg ha^{-1}) and harvest index (28.16). The effect of fertilizer doses on the length of panicle was also non- significant. However, it was recorded highest (28.93 cm) in F_2 (100% RDF + 5 t ha^{-1} FYM. The effect of fertilizer doses on the weight of panicle, number of grains per panicle and filled grains percentage were non-significant. However, it was recorded highest in F_1 (100% RDF) followed by F_2 (100% RDF + 5 t ha^{-1} FYM). This is in close conformity with the findings of Hossian *et al.* (2010) [5], who reported that the growth attributes of aromatic rice showed higher value with the incorporation of cow dung in combination with recommended dose of chemical fertilizers. The test weight was recorded highest (30.55 g) in F_2 (100% RDF + 5 t ha^{-1}FYM) followed by F_1 (100% RDF) with 29.84 g. The grain yield and straw yield were not significantly affected by the different fertilizer doses. However, grain yield (3140.28 kg ha^{-1}) and straw yield (8888.89 kg ha^{-1}) was found highest in F_2 (100% RDF + 5 t ha^{-1} FYM). The increasing fertilization might have increased the biological yield in terms of more biomass production thus resulting in reduction in harvest index of rice (Choudhary *et al*., 2007) [2].

The interaction effect on straw yield due to cultivars and fertilizer dose was significant where highest straw yield (10694.45 kg) was recorded for V_1F_2 (cultivar Nyakmok + 100% RDF + 5 t ha^{-1} FYM) and highest harvest index was recorded for V_1F_1 (cultivar Nyakmok + RDF) at 32.68 % followed by V_2F_2 (cultivar Jamaghu + 100% RDF + 5 t ha^{-1} FYM) at 29.11%. Naing Oo (2010) [9], also reported that combining FYM and inorganic fertilizers increased shoot dry matter, tiller and panicle number per hill, grain number per panicle and grain yield.

Table 1: Effect of cultivars and fertilizer doses on crop growth and phenological attributes of rice.

	Plant height (cm)	**Number of green leaves plant^{-1}**	**Number of tillers (m^{-2})**	**Leaf Area Index (LAI)**	**Days to 50% flowering**	**Days to maturity**
Treatments	60 DAS	60 DAS	75 DAS	60DAS		
Cultivars(V)						
V_1-Nyakmok	122.15	5.28	168.67	1.30	84.53	112.00
V_2-Jamaghu	118.57	5.37	145.00	1.46	81.93	112.00
SEm±	2.36	0.10	7.89	0.07	0.32	0.00
CD (P=0.05)	NS	NS	23.44	NS	0.95	NS
Fertilizer doses (F)						
F_1- 100% RDF (N_{60}:P_{30}:K_{30})	126.10	5.53	159.17	1.44	83.50	112.00
F_2- 100% RDF + 5 t ha^{-1} FYM	126.93	5.37	158.33	1.21	82.83	112.00
F_3- 75% RDF + 5 t ha^{-1} FYM	131.57	5.53	160.00	1.38	82.67	112.00
F_4- 50% RDF + 10 t ha^{-1} FYM	117.13	5.03	155.00	1.32	83.33	112.00
F_5-10 t ha^{-1} FYM	116.73	5.20	151.67	1.54	83.83	112.00
SEm±	3.74	0.15	12.47	0.12	0.51	0.00
CD (P=0.05)	11.10	NS	NS	NS	NS	NS
Interaction of V x F	NS	NS	NS	NS	NS	NS

Table 2: Effect of cultivars and fertilizer doses on yield and yield attributes of rice

Treatments	**Number of panicles (m^{-2})**	**Length of panicle (cm)**	**Weight of panicle (g)**	**Number of grains per panicle**	**Filled grains percentage (%)**	**Test weight (g)**	**Grain yield (kg ha^{-1})**	**Straw yield (kg ha^{-1})**	**Harvest index (%)**
Cultivars(V)									
V_1-Nyakmok	118.33	28.13	8.34	218.29	83.95	30.59	3155.55	8250.00	28.16
V_2-Jamaghu	114.33	28.35	6.42	235.89	90.06	28.04	2481.11	7680.55	26.18
SEm±	3.98	0.48	0.47	6.23	1.39	0.49	133.18	333.93	0.91
CD (P=0.05)	NS	NS	1.39	NS	4.13	1.45	395.68	NS	NS
Fertilizer doses (F)									
F_1- 100% RDF (N_{60}:P_{30}:K_{30})	119.17	28.80	8.65	241.10	91.13	29.84	2868.06	7048.61	28.66
F_2- 100% RDF + 5 t ha^{-1} FYM	120.00	28.93	8.39	233.23	88.41	30.55	3140.28	8888.89	26.52
F_3- 75% RDF + 5 t ha^{-1} FYM	117.50	28.67	7.16	224.87	81.24	28.64	2326.39	7326.39	24.16
F_4- 50% RDF + 10 t ha^{-1} FYM	114.17	27.29	6.34	220.15	86.78	28.25	2843.39	8506.94	27.77
F_5-10 t ha^{-1} FYM	110.83	27.52	6.36	216.15	87.46	29.29	2913.89	8055.56	28.77
SEm±	6.30	0.76	0.74	9.85	2.20	0.77	210.57	527.99	1.45
CD (P=0.05)	NS	NS	NS	NS	NS	2.30	625.63	NS	NS
V x F									
V_1F_1	121.67	28.40	9.44	244.60	89.10	30.94	3319.45	6875.00	32.68
V_1F_2	128.33	28.73	9.39	219.47	85.14	33.09	3361.11	10694.45	23.92
V_1F_3	120.00	28.40	7.79	199.93	76.85	29.38	2694.44	8819.44	23.41
V_1F_4	111.67	27.47	7.56	223.70	84.56	29.13	3333.33	7083.33	32.35
V_1F_5	110.00	27.67	7.52	203.73	84.10	30.40	3069.44	7777.78	28.47
V_2F_1	116.67	29.20	7.87	237.60	93.15	28.74	2416.67	7222.22	24.63
V_2F_2	111.67	29.13	7.38	247.00	91.68	28.01	2919.44	7083.33	29.11
V_2F_3	115.00	28.93	6.52	249.80	85.63	27.90	1958.33	5833.33	24.90
V_2F_4	116.67	27.12	5.12	216.60	89.00	27.36	2352.78	9930.55	23.19
V_2F_5	111.67	27.37	5.20	228.47	90.81	28.18	2758.33	8333.33	29.07
SEm±	8.91	1.07	1.05	13.93	3.11	1.09	297.78	746.69	2.04
CD(P=0.05)	NS	NS	NS	NS	NS	NS	NS	2218.52	6.07

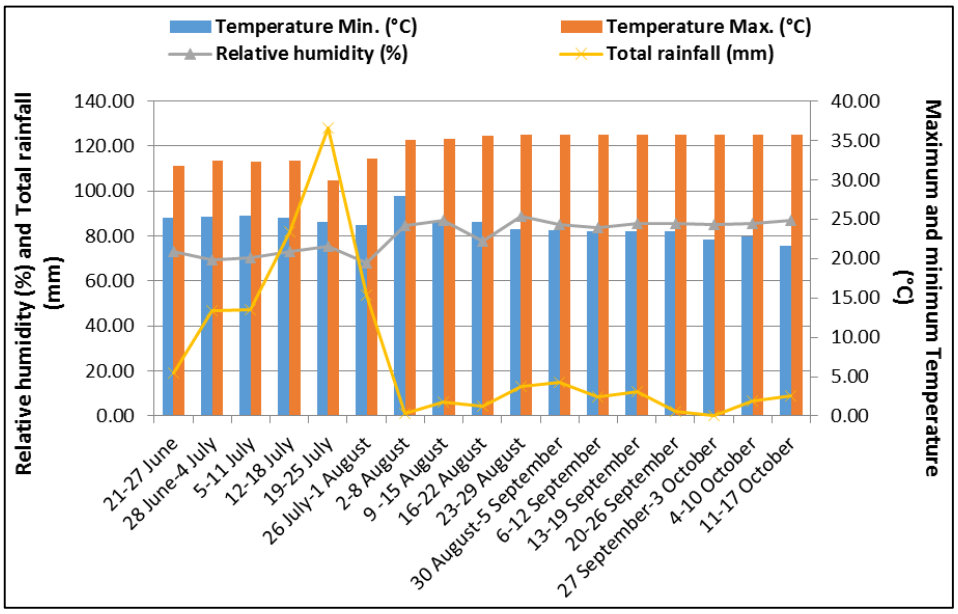

Fig 1: Meteorological data during the period of experiment

Conclusion

Effect of Integrated nutrient management could be attributed to enhanced the growth and yield of both the local rice cultivars. The Cultivar Nyakmok' was more suitable under rainfed upland condition of Nagaland than cultivar Jamaghu. And both the cultivar give more production with nutrient Application of 100% RDF + 5 t ha^{-1} FYM.

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