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Growth, yield attributes and yield of rice as influenced by nitrogen levels and its split application in plateau of North Eastern Hilly region

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Abstract
In Meghalaya, the quantity of nitrogen fertilizer applied, but it's being considered as high rainfall areas the losses are increased. As a consequence of high rainfall areas its loss through leaching and runoff which reduced the utilization rate. Newly developed rice varieties have fertilizer responsive with better nutrient translocation ability from source to sink compared to common rice. That leads to urgent further consideration of appropriate rate of nitrogen fertilizer to be applied. A field experiment with 5 nitrogen levels such as 0, 30, 60, 90, 120, 150 kg ha^{-1} and 3 split application, 1st Split (50% as basal + 50% at 45 DAT as top dressing), 2nd Split (50% as basal + 25% at 45 DAT and 25% at 60 DAT as top dressing) and 3rd Split (25% as basal + 25% at 45 DAT, 25% at 60 DAT and 25% at 75 DAT as top dressing) with *Shahsarang* variety during 2018-19 and 2019-20. Growth, yield attributes and grain yield along with harvest index were measured. The results showed that with the increase nitrogen dose with different splitting in ascertain range, the number of tillers, dry matter production, test weight along with grain and straw yields increased while the harvest index (HI), decreased beyond 120 kg N ha^{-1}. Additionally, with the increase of nitrogen application, the grain yield and harvest index (HI) of rice followed a parabolic trend.

Keywords: Nitrogen, split application, grain yield and harvest index

Introduction

Rice (*Oryza sativa* L.) is the most important cereal crop in Asia, grown under varying hydrological conditions. It is the principal source of food for more than half of the world population (Nguyen, 2002) [8], especially in South and Southeast Asia, Latin America and Indonesia. About 90% of the world's rice is grown and produced 143 m ha area with a production of 612 million tons of paddy in Asia (FAO, 2009) [3]. To assure food security for feeding 1.6 billion peoples by 2050, India needs to produces 450 million tons of food grains with an additional production of 1.7 million tons of rice every year. This additional rice production will put huge challenge to the people who are involved directly or indirectly in agriculture (Das and Chandra, 2013) [2]. In India the area and production of *Kharif* rice is about 42.8 million hectare and 93.88 million tonnes, respectively. In North Eastern Hill (NEH) region of India, rice is the principal food grain crop sharing 85-90% of total food grain production. The area and production under *kharif* rice in NEH region is 33,310 ha and 1,75,689 metric tonnes with productivity of 2.7 t ha^{-1}, respectively. (www.megagriculture.gov.in 2016-17). However, the productivity of rice inclined by advances in agronomic crop management such as weed management, N fertilization with combinations of suitable cultivars, can sustained its productivity. Among plant nutrients the contribution of nitrogen is the main nutrient related with crop yield. Further, nitrogen is the most important nutrient and high yields are associated with large N applications. However, N recovery efficiency is low in flooded culture because of N losses through leaching, denitrification, ammonia volatilization, etc. It is also the most yield limiting nutrient in rice cropping systems worldwide. N fertilizer recommendations are usually based on field trial with various N fertilizer rates to determine optimum rates, which are then used as recommendation for larger areas.

Material and Methods

The experiment was carried out at the experimental farm of the College of Post Graduate Studies, (CAU), Umiam, Ri-bhoi district of Meghalaya during *kharif* season, 2018-19 and

2019-20, respectively. The experimental site is situated at 91˚18' E longitude and 25˚40' N latitude and at an altitude of 950 m above the mean sea level (MSL). However, in totality North Eastern Hilly Region receives a very high amount of annual rainfall ranging from 1500-12,000 mm. Soil is a critically important component of the earth's biosphere, functioning not only in the production of food and fibre but also in the maintenance of local, regional and worldwide environmental quality. Productivity of the soil is the function of management practices which are determined by its dynamic physical and chemical characteristics. The soil of the experimental plot was sandy clay loam in texture, acidic in reaction (pH 5.0 to 5.1), high in organic carbon (2.85 to 2.69%) and medium in available nitrogen (302.88 to 304.06 kg ha^{-1}), medium in phosphorus (15.59 to 14.09 kg ha^{-1}) and medium in potassium (195.68 to 171.43 kg ha^{-1}) during both the year 2018-19 and 2019-20, respectively. The experiment was comprised of 5 level of Nitrogen, viz 30, 60, 90, 120, 150 kg ha^{-1} and 3 split application, 1st Split (50% as basal + 50% at 45 DAT as top dressing), 2nd Split (50% as basal + 25% at 45 DAT and 25% at 60 DAT as top dressing), 3rd Split (25% as basal + 25% at 45 DAT, 25% at 60 DAT and 25% at 75 DAT as top dressing) and control, were tested in three time replicated factorial randomize block design (FRBD). Rice (Shahsarang) was sown using seed rate 45 kg ha^{-1} during first week of July with a spacing of 25 cm × 10cm. However, uniform amount 60 and 40 of kg P_2O_5 and K_2O ha^{-1} were applied in each plot. Whereas, recommended agronomic management practices were followed to raise the crop. The rice crop was harvested in fourth week of October 2018-19 and 2019-20. The standard methodology was followed for recording data on crops. Data regarding numbers of tillers $hill^{-1}$, leaf area index, dry matter production (g $hill^{-1}$) were recorded at 15, 30, 45, 60, 75, 90 days after transplanting (DAT) and harvesting. The data on yield attributes were recorded at time of harvesting as per standard procedures. Subjected analysis and interpretation of data were done using the Fisher's method of analysis of variance technique used for analysis and interpretations of data obtained from the field as described by Gomez and Gomez (1984). The levels of significance using 'F' and 't' test was at p = 0.05. Critical difference values were calculated wherever the 'F' test was significant.

Result and Discussion

Numbers of tillers $hill^{-1}$

The data pertaining to number of tillers $hill^{-1}$ as influenced by different nitrogen level and split application at different stage crop growth stage are given in the figure 1. The maximum number of tillers $hill^{-1}$ was recorded in different levels of nitrogen at the rate of 150 N kg ha^{-1} (N_5), 12.94 tillers $hill^{-1}$ followed by 120, 90, 60 and 30 N kg ha^{-1} 12.06, 11.97, 11.82 and 11.68 tillers $hill^{-1}$ 2018-19 and 2019-20, respectively. While the lowest number of tillers $hill^{-1}$ was recorded in control 10.20 tillers $hill^{-1}$. The application of nitrogen at 150 kg N ha^{-1} has a significant effect on number of tillers $hill^{-1}$ over the other levels of nitrogen application. Whereas in split application following the same trend as nitrogen applied in three splits produced higher number followed by two and one split (Manzoor *et al*., 2015, Awan *et al*., 2011 and Tayefe *et al*., 2014) [6, 1, 11].

Plant dry matter production (g $hill^{-1}$)

The data on plant dry matter production as influenced by different nitrogen level and split application at different stage crop growth stage are given in the figure 2. The higher plant dry matter production was recorded at the harvesting stage where nitrogen level was applied at the rate of 150 kg N ha^{-1} (N_5), which was at par with 120 (N_4), 90 (N_3) and 60 kg N ha^{-1} (N_2), 80.76, 79.74,79.07 and 76.51 g $hill^{-1}$ in 2018-19 and 2019-20, respectively. While the plant dry matter production was recorded in control 58.0 g $hill^{-1}$ plant dry matter production. The application of nitrogen at 150 kg N ha^{-1} has a significant effect on plant dry matter production over the other levels of nitrogen application. Whereas in split application following the same trend. These results also supported by (Rehman *et al*., 2013, Lin *et al*., 2005) [9, 5].

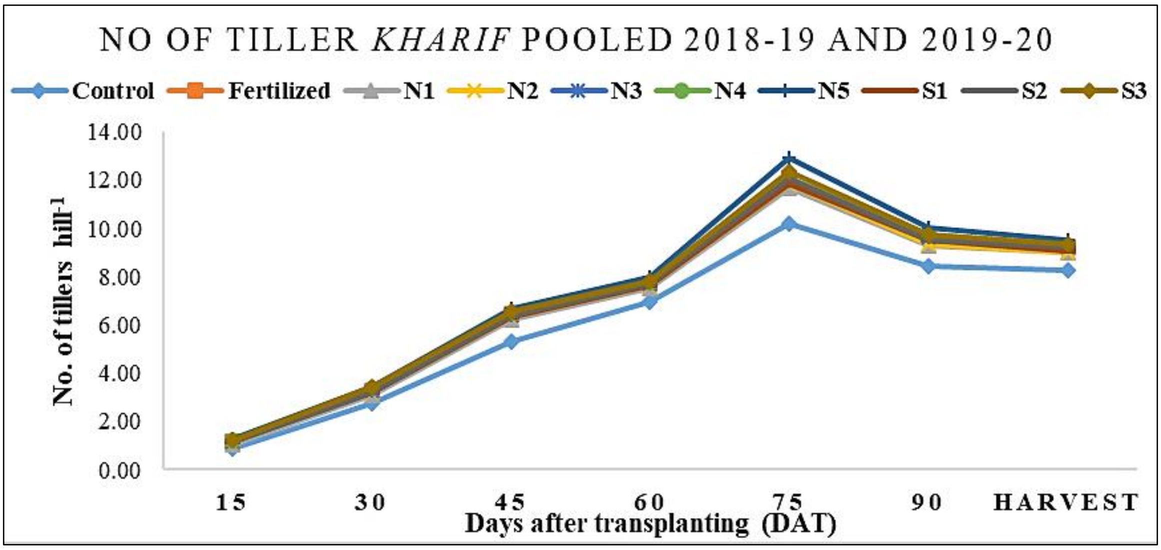

Fig 1: Effect of Different Levels of Nitrogen and split doses on number of tillers $hill^{-1}$ of rice

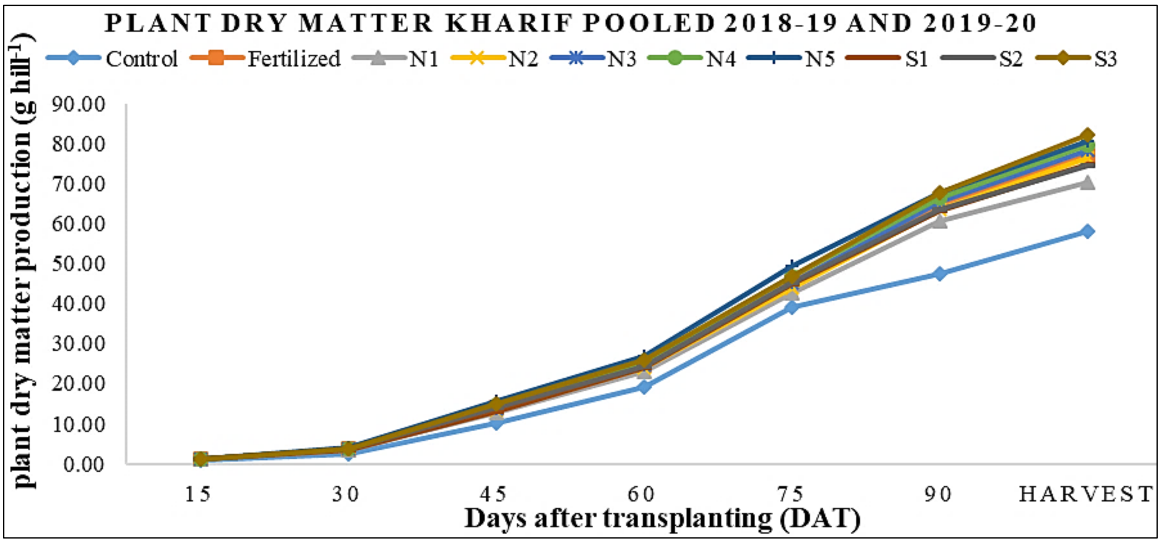

Fig 2: Effect of Different Levels of Nitrogen and split doses on plant dry matter production (g hill^{-1}) of rice

Yield and its attributes

The test weight (g) was influenced significantly by different nitrogen level and split application during both the years of *kharif* season, respectively given in the table1. The heavier 1000-grain weight (g) was recorded at the rate of 150 kg N ha^{-1} (N_5) 28.53 to 28.25 (g) followed by 120, 90, 60 and 30 kg N ha^{-1} 25.40 to 25.25.13, 25.15 to 24.65, 24.44 to 24.43 and 23.75 to 23.29 (g). The application of nitrogen at 150 kg N ha^{-1} has a significant effect on test weight over the other levels of nitrogen application both the years and pooled. While the lowest 1000-grain weight (g) was recorded in control 20.82 to 20.62 (g). Whereas in split application following the same trend. However, in *kharif* season 2019-20 split three (S_3) at par with split two (S_2) and split one (S_1). Similar result also reported by (Rehman *et al.*, 2013, Kumar and Rao, 1992; Thakur 1993) [9, 4, 12].

The grain yield (t ha^{-1}) was influenced significantly by different nitrogen level and split application during both the year and pooled, *kharif* presented in the table 1, respectively. The highest grain yield (t ha^{-1}) was recorded where nitrogen level was applied at the rate of 150 kg N ha^{-1} (N_5) 4.31 to 4.43 t ha^{-1} followed by 120, 90, 60 and 30 kg N ha^{-1} 4.05 to 4.17, 3.64 to 3.74, 3.21 to 3.30 and 2.89 to 2.97 t ha^{-1} both the years 2018-19 and 2019-20, respectively. Which was highly significant both the years and pooled. While the lowest grain yield (t ha^{-1}) was recorded in control 2.42 to 2.49 t ha^{-1}. Whereas in split application following the same trend. These results are in agreement with the findings of (Manzoor *et al.*, 2015, Rehman *et al.*, 2013, Sheng-Gang *et al.*, 2012) [6, 9, 10].

The straw yield (t ha^{-1}) was influenced significantly by different nitrogen level and split application during both the year and pooled, *kharif* 2018-19 and 2019-20, respectively given in the table 1. The straw grain yield (t ha^{-1}) was recorded where nitrogen level was applied at the rate of 150 kg N ha^{-1} (N_5) 6.84 to 6.82 t ha^{-1} followed by 120, 90, 60 and 30 kg N ha^{-1} 6.02 to 6.28, 5.96 to 5.88, 5.50 to 5.63 and 5.46 to 5.40 t ha^{-1} both the years 2018-19 and 2019-20, respectively. Which was highly significant both the years and pooled. While the lowest straw yield (t ha^{-1}) was recorded in control 4.42 to 4.41 t ha^{-1}. Whereas in split application following the same trend. However, split three (S_3) at par with split two (S_2) in *kharif* 2019-20 and pooled. These results are in agreement with the findings of (Sheng-Gang *et al.*, 2012, Rehman *et al.*, 2013, Manzoor *et al.*, 2006) [10, 9, 7].

Harvest index, the ratio of economic yield to biological yield of lowland rice influenced significantly by different levels of nitrogen and split application during both the years of rice crop experimentation were given in the table 1. Maximum harvest index (%) was recorded at 120 kg ha^{-1} (N_4) 40.18 to 39.92% followed by 150, 90, 60 and control 38.68 to 39.43, 37.91 to 38.87, 36.83 to 36.90 and 35.38 to 36.12 % both years 2018-19 and 2019-20, respectively. While the lowest harvest index (%) was recorded in 30 kg N ha^{-1} 34.62 to 35.51%. Whereas in split application following the same trend. However, split three (S_3) at par with split two (S_2) and split one (S_1) in pooled. These results are in agreement with the findings of (Sheng-Gang *et al.*, 2012, Rehman *et al.*, 2013) [10, 9].

Conclusion

From the two consecutive year study it is concluded that different levels of nitrogen applied in splitting has a great influence on the morpho-phsiological characteristics of rice like number of tillers hill^{-1}, plant dry matter production, and yield attributes due to better crop nutrition and reduced N losses. However, nitrogen level 150 kg N ha^{-1} with three splits produced significantly higher grain yield in north eastern hilly region.

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Table 1: Effect of different levels of nitrogen and split application on test weight (g), grain yield (t ha^{-1}), straw yield (t ha^{-1}) and harvest index (%)

Treatments	Test weight (g)			Grain yield (t ha)			Straw yield (t ha)			Harvest index (%)		
	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
Control	20.27	22.32	21.29	2.42	2.49	2.46	4.42	4.41	4.42	35.38	36.12	35.75
Fertilized	25.57	26.48	26.02	3.62	3.72	3.67	5.96	6.00	5.98	37.64	38.14	37.89
SE(m)±	0.76	0.81	0.79	0.11	0.12	0.12	0.16	0.24	0.21	0.94	0.29	0.69
CD (p=0.0)	2.23	2.36	2.29	0.33	0.35	0.34	0.46	0.71	0.60	2.74	0.85	2.03
Nitrogen Levels (g ha-1)												
N1	22.60	25.22	23.91	2.89	2.97	2.93	5.46	5.40	5.43	34.62	35.51	35.06
N2	24.01	25.62	24.82	3.21	3.30	3.25	5.50	5.63	5.56	36.83	36.97	36.90
N3	25.48	25.79	25.64	3.64	3.74	3.69	5.96	5.88	5.92	37.91	38.87	38.39
N4	25.76	26.74	26.25	4.05	4.17	4.11	6.02	6.28	6.15	40.18	39.92	40.05
N5	29.98	29.04	29.51	4.31	4.43	4.37	6.84	6.82	6.83	38.68	39.43	39.06
SE(m)±	0.43	0.45	0.44	0.06	0.07	0.07	0.09	0.14	0.12	0.52	0.16	0.39
CD (p=0.05)	1.25	1.32	1.28	0.19	0.19	0.19	0.26	0.40	0.34	1.53	0.47	1.13
Splits Application												
S1	25.07	26.45	25.76	3.43	3.53	3.48	5.64	5.70	5.67	37.63	38.10	37.87
S2	25.79	26.48	26.13	3.59	3.69	3.64	6.01	6.06	6.03	37.26	37.70	37.48
S3	25.85	26.52	26.18	3.83	3.95	3.89	6.22	6.25	6.24	38.03	38.62	38.33
SE(m)±	0.33	0.35	0.34	0.05	0.05	0.05	0.07	0.11	0.09	0.41	0.13	0.30
CD (p=0.05)	0.96	1.02	0.99	0.14	0.15	0.15	0.20	0.31	0.26	1.19	0.37	0.88

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