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FOLIAR FERTILIZATION ON BRRI dhan28 TO REDUCE SOIL APPLICATION OF NITROGENOUS FERTILIZER

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Abstract

The experiment was conducted at the research farm of Crop Physiology and Ecology Department, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur during November 2019 to June 2020 to find out the effect of foliar fertilization on the performance of rice var. BRRI dhan28 and to estimate how much nitrogenous fertilizer can be saved by foliar fertilization without yield reduction. The experiment was laid out following split plot design with three replications. Four levels of foliar fertilization (F_0 – N_o foliar fertilization, F_1 – Foliar fertilization with 2% KNO_3, F_2 - Foliar fertilization with 2% DAP and F_3 - Foliar fertilization with 1% American NPKS) were placed in the main plot treatments whereas three nitrogen fertilizer levels (N_{50} -50% of the recommended nitrogen fertilizer, N_{75} – 75% of the recommended nitrogen fertilizer and N_{100} – 100% of the recommended nitrogen fertilizer) were placed randomly in the sub-plots. Foliar fertilization with KNO_3, DAP (Di-ammonium phosphate) and American NPKS significantly increased the grain yield (t ha^{-1}) compare to control (F_0) but KNO_3 and American NPKS performed better than DAP. Foliar fertilization with KNO_3 and American NPKS could save 25% of recommended nitrogen fertilizer but foliar fertilization with DAP could not save nitrogen fertilizer applied in soil for getting comparable grain yield found in F_0N_{100}. Foliar fertilization of KNO_3 and American NPKS with recommended nitrogen fertilizer applied in soil could increase 11.8 and 12.5% grain yield, respectively compare to F_0N_{100}.

Introduction

Rice (*Oryza sativa* L.) is one of the most important crops in Bangladesh in terms of acreage and production but the average grain yield is very low (2 t ha^{-1}) as compared to Egypt (8.4 t ha^{-1}) and USA (6.6 t ha^{-1}). There are many reasons for lower yield of rice and among these the most important is the indiscriminate and improper application of nutrients with unfavorable condition. Many factors determine the fertilizer efficiency for rice crop during cultivation such as soil, cultivar, season, environment, planting time, water management, weed control, time and methods of fertilizer application (De Datta, 1978). Nutrient management practices determine the sustainability of the most intensively cropping systems (Flinn *et al.,* 1982). Foliar application is well recognized and is being practiced in agriculturally advanced countries. In many cases aerial spray of nutrients is preferred and gives quicker and better results than the soil application (Jamal e*t al*., 2006). Fageria *et al.* (2009) also reported that crops respond to soil applied fertilizers in five to six days, while the response is faster (48 hours) in foliar application. Foliar application increase nutrients uptake at critical growth stages and resulted in enhanced physiological activity leading to increase yield (Kundu and Sarkar, 2009). Foliar fertilization has great advantage because of low application rates, uniform distribution of fertilizer, reduction in plant stress, plant's natural defense mechanisms to resist plant disease and insect infestations, improvement of plant health and yield (Finck, 1982). Ali *et al.* (2005) reported that foliar spray increased the metabolic activity of plant. Nitrogen fertilizer is more urgent for security rice production. Sharief *et al.* (2006) found that increasing nitrogen fertilizer levels had significant effect on yield and yield attributes of rice. Hasewaga *et al.* (2000) reported that foliar fertilizers have significant influences of growth and rice paddy yield. Ahamad and Jabeen (2005) indicated that foliar nutrition generally increases the grain yield as well as decreases the amount of fertilizers which applied as soil application. Pramanik *et al.* (2015) showed that foliar application of fertilizer can increase rice growth and decrease the chemical fertilizer usage. Alam *et al.* (2010) opined that foliar application could be considered only as a supplement to soil application of N. However, foliar fertilization is supplementary to and cannot replace the basal fertilization. Keeping in view the study was therefore designed to find out the effect of foliar fertilization on the performance of BRRI dhan28 and to estimate how much nitrogenous fertilizer can be saved by foliar fertilization without yield reduction.

Materials and Methods

The experiment was set up at the research farm of Crop Physiology and Ecology Department, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur during November 2019 to June 2020. The experimental field was a medium high land belonging to the non-calcareous dark gray floodplain soil under the agro-ecological zone (AEZ-1) of old Himalayan Piedmont Plain. The soil is sandy loam under the Order Inceptisol. The initial soil contained 1.28% organic matter, 0.064% Nitrogen, 18.56 µg /g Phosphorous and 0.18 me / 100g Potassium. The experimental site is situated in the sub-tropical region characterized by heavy rainfall during the months from May to September and scantly rainfall in the rest of the year. The experiment was conducted in a split plot design with three replications. Four levels of foliar fertilization viz. F_0 – N_0 foliar fertilization, F_1– Foliar fertilization with 2% KNO_3, F_2 – Foliar fertilization with 2% DAP and F_3- Foliar fertilization with 1% American NPKS were placed in the main plot treatments whereas three nitrogen fertilizer levels viz. N_{50} – 50% of the recommended nitrogen fertilizer, N_{75} – 75% of the recommended nitrogen fertilizer and N_{100} – 100% of the recommended nitrogen fertilizer were placed randomly in the sub plots as sub plot treatments. Rice var. BRRI dhan28 was used.

Seedbed was prepared and seeds were sown uniformly on 1 December 2019 to obtain 34 days old seedling at transplanting date 3 January, 2020. After land preparation, cow dung and full doses of TSP, MOP, gypsum, and zinc sulphate were incorporated thoroughly into the soil as basal dose. Urea was splited into equal amount in three times i.e. basal application during land preparation, rapid tillering and before panicle initiation. Fertilizer was applied at a recommended rate of 300–100–160–111.2–5.58 Kg ha^{-1} as urea, triple supper phosphate (TSP), muriate of potash (MOP), gypsum, and zinc sulphate (BARC, 2018).

Thirty-four days old seedlings were carefully uprooted from a seedling nursery and planted on well puddle unit plots. Three healthy seedlings were transplanted in each hill. Intensive cares were taken during the growing period to ensure adequate growth and development of the crop. 2% KNO_3, 2% Di-ammonium phosphate, and 1% American NPKS solution were prepared and applied in the respective plot for three times at 20 days interval starting from 40 days after transplanting. American NPKS is a foliar applied mixed fertilizer providing four major nutrient elements of nitrogen, phosphorous, potassium and sulphur with a grade mixing ratio of 8:20:14:5. American NPKS is also a complete fertilizer as it contains all three principal elements extremely essential for overall plants growth and development. USA company Stoller markets American NPKS fertilizer. Weeding, gap filling and other intercultural operations were done as when necessary. Data were collected on plant height in cm at 60 and 75 days after transplanting and also at harvest, tillers $hill^{-1}$ at 60 and 75 days after transplanting and also at harvest, panicles $hill^{-1}$, panicle length (cm), spikelets $panicle^{-1}$, grains $panicle^{-1}$, unfilled spikelet per panicle, 1000-grain weight, grain yield per hill, straw yield (g $hill^{-1}$) and grain yield (t ha^{-1}). The data were analyzed and means were separated by Tukey's test by partitioning the total variance as described by Gomez and Gomez (1984).

Results and Discussion

Plant height and tillers $hill^{-1}$ at different days after transplanting

Plant height and number of tillers $hill^{-1}$of BRRI dhan28 were not significantly influenced by foliar fertilization, nitrogen levels and their interaction effect at 60 days after transplanting (Table 1).

Table 1. Effect of foliar fertilization and nitrogen levels on plant height and tillers hill^{-1} of BRRI dhan28 at different days after transplanting (DAT)

Treatment	Plant height (cm)		Tillers hill^{-1}	
	At 60 DAT	At 75 DAT	At 60 DAT	At 75 DAT
	Foliar fertilization			
F_0	49.52	63.37	13.67	17.07
F_1	48.07	64.22	12.52	17.41
F_2	48.89	63.25	13.70	16.70
F_3	46.89	63.67	11.96	16.45
Significance level	NS	NS	NS	NS
CV (%)	12.17	5.82	25.70	9.74
	Nitrogen levels			
N_{50}	47.17	61.25 b	12.14	15.36 b
N_{75}	49.58	64.19 ab	13.28	17.31 a
N_{100}	48.28	65.44 a	13.47	18.06 a
Significance level	NS	*	NS	**
CV (%)	6.01	5.67	17.03	8.33
	Foliar fertilization × Nitrogen levels			
F_0N_{50}	50.22	63.67	11.67	16.78 ab
F_0N_{75}	50.55	64.33	15.11	18.33 ab
F_0N_{100}	47.78	62.11	14.22	16.11ab
F_1N_{50}	45.33	62.89	11.89	13.67 b
F_1N_{75}	50.22	65.78	13.34	19.89 a
F_1N_{100}	48.67	64.00	12.33	18.67 a
F_2N_{50}	46.89	59.66	13.00	15.56 ab
F_2N_{75}	50.22	63.55	13.67	15.56 ab
F_2N_{100}	49.56	66.55	14.44	19.00 a
F_3N_{50}	46.28	58.78	12.00	15.45 ab
F_3N_{75}	47.33	63.11	11.00	15.45 ab
F_3N_{100}	47.11	69.11	12.89	18.44 ab
Significance level	NS	NS	NS	**
CV (%)	6.01	5.67	17.03	8.33

In a column, means followed by different letter(s) within main and interaction effect differed significantly at $p \leq 5\%$ level of probability by Tukey's test

Here, F_0 = No foliar fertilization, F_1 = Foliar fertilization with KNO_3, F_2 = Foliar fertilization with DAP, F_3 = Foliar fertilization with American NPKS, N_{50} = 50% of the recommended nitrogen fertilizer, N_{75} = 75% of the recommended nitrogen fertilizer, N_{100} = 100% of the recommended nitrogen fertilizer, NS indicates insignificant, ** indicates significant at 1% level of probability

At 75 days after transplanting, number of tillers hill^{-1} of BRRI dhan28 was significantly influenced by nitrogen levels and the interaction effect of foliar fertilization and nitrogen levels but foliar fertilization had no significant influence on number of tillers hill^{-1} (Table 1). At 75 days after transplanting, the maximum number of tillers hill^{-1} (18.06) was recorded from N_{100} which was statistically similar to N_{75} (17.31). The lowest tillers hill^{-1} (15.36) was obtained from N_{50}. Among the treatment combinations, the maximum number of tillers hill^{-1} was obtained from F_1N_{75} (19.89) which was statistically similar to those recorded from all other treatment combinations except F_1N_{50} which provided the lowest number of tillers hill^{-1} (13.67). The results of the present study were also supported by the findings of Swaroopa and Lakshmi (2015), Shafiee *et al.* (2013) and Shayganya *et al.* (2011).

Plant height and tillers hill^{-1} at harvest

Plant height of BRRI dhan28 at harvest was significantly influenced by foliar fertilization, nitrogen levels and their interaction effect of foliar fertilization and nitrogen levels (Table 2). Among the treatment combinations, the maximum plant height was obtained from F_3N_{100} (96.17 cm) which was statistically similar to F_3N_{75}. While F_0N_{50} treatment combination provided the lowest plant height (85.50 cm). Foliar fertilization with KNO_3 could not save soil application of nitrogen fertilizer for getting comparable plant height found in F_0N_{100}. This is in line with the findings of Mohan *et al.* (2017), Pramanik *et al.* (2015) and Rabin *et al.* (2016).

The number of tillers hill^{-1} was influenced significantly by nitrogen levels and the interaction effect of foliar fertilization and nitrogen levels but it was not influenced significantly by foliar fertilization (Table 2). Among the treatment combinations, the maximum number of tillers hill^{-1} was recorded in F_2N_{100} (15.60) followed by F_3N_{100} (15.60) which was statistically similar to all other treatment combinations except F_0N_{50} (12.00) and F_2N_{50} (12.13). Foliar fertilization with KNO_3 and American NPKS could save 50% of recommended nitrogen fertilizer and foliar fertilization with DAP could save 25% of recommended nitrogen fertilizer applied in soil for getting comparable number of tillers hill^{-1} was found in F_0N_{100}. The result in tiller production is with line as reported by Swaroopa and Lakshmi (2015), Pramanik *et al.* (2015) and Rabin *et al.* (2016).

Table 2. Effect of foliar fertilization and nitrogen levels on plant height and tillers hill^{-1} of BRRI dhan28 at harvest

Foliar fertilization	Plant height (cm)				Tillers hill^{-1}			
	Nitrogen levels			Mean of foliar fertilization	Nitrogen levels			Mean of foliar fertilization
	N_{50}	N_{75}	N_{100}		N_{50}	N_{75}	N_{100}	
F_0	85.50 f	89.10 de	92.03 b	88.89 c	12.00 b	13.20 ab	13.93 ab	13.04
F_1	87.60 e	90.00 cd	91.50 bc	89.70 c	13.27 ab	13.33 ab	15.60 a	14.07
F_2	88.10 de	92.60 b	93.03 b	91.24 b	12.13 b	15.40 a	15.60 a	14.38
F_3	89.32 de	95.50 a	96.17 a	93.66 a	14.33 ab	14.53 ab	15.53 a	14.80
Mean of nitrogen levels	87.63 c	91.81 b	93.18 a		12.93 c	14.12 b	15.17 a	
CV (%)		5.72				5.56		
Level of significance		**				*		

Means followed by different capital letter(s) for main effect and small letter (s) for interaction differed significantly at $p \le 5\%$ level of probability by Tukey's test

CV for foliar fertilization (plant height and tillers hill^{-1}) = 5.55% and 8.40%

CV for nitrogen levels (plant height and tillers hill^{-1}) = 5.72% and 5.56%

Number of panicles and Panicle length

Number of panicles hill^{-1} of BRRI dhan28 was significantly influenced by foliar fertilization, nitrogen levels and their combination effect of foliar fertilization and nitrogen levels (Table 3). Panicle length (cm) of BRRI dhan28 was not significantly influenced by foliar fertilization, nitrogen levels and their combination effect of foliar fertilization and nitrogen levels (Table 3). Among the treatment combinations, the highest number of panicles hill^{-1} was obtained from F_1N_{100} (14.40) which was statistically similar to those recorded from F_3N_{100} (14.07), F_3N_{75} (13.60), F_2N_{100} (13.53) and F_1N_{75} (13.47). The lowest number of panicles hill^{-1} was obtained from F_0N_{50} (9.60) which was statistically at par with F_2N_{50} (10.20). Foliar fertilization with KNO_3 could save 50% of recommended nitrogen fertilizer and foliar fertilization with DAP and American NPKS could save 25% of recommended nitrogen fertilizer applied in soil for getting equivalent number of panicles hill^{-1} found in F_0N_{100}. These results are in agreement with the findings of Jothi *et al.* (2019) and Rani *et al.* (2014).

Table 3. Effect of foliar fertilization and nitrogen levels on panicles hill^{-1} and panicle length of BRRI dhan28

Foliar fertilization	Panicles hill^{-1}				Panicle length (cm)			
	Nitrogen levels			Mean of foliar fertilization	Nitrogen levels			Mean of foliar fertilization
	N_{50}	N_{75}	N_{100}		N_{50}	N_{75}	N_{100}	
F_0	9.60 e	11.60 cd	13.20 ab	11.47 b	20.12	22.00	21.57	21.23
F_1	12.53 bc	13.47 ab	14.40 a	13.47 a	20.30	22.13	21.67	21.28
F_2	10.20 de	12.20 bc	13.53 ab	11.98 b	22.10	20.58	21.67	21.45
F_3	11.33 cd	13.60 ab	14.07 a	13.00 a	22.00	22.10	21.60	21.90
Mean of	10.92 c	12.72 b	13.80 a		21.07	21.70	21.63	

nitrogen levels		
CV (%)	3.24	7.94
Level of significance	**	NS

Means followed by different capital letter(s) for main effect and small letter (s) for interaction differed significantly at $p \le 5\%$ level of probability by Tukey's test
CV for foliar fertilization (Panicles hill^{-1} and Panicle length) = 3.62% and 3.62%
CV for nitrogen levels (Panicles hill^{-1} and Panicle length) = 3.24% and 7.94%

Spikelets panicle^{-1} and grains panicle^{-1}

Foliar fertilization, nitrogen levels and their interaction had significant influence on number of spikelets panicle^{-1} and number of grains panicle^{-1}of BRRI dhan28 (Table 4).

Table 4. Effect of foliar fertilization and nitrogen levels on spikelets panicle^{-1} and grains^{-1} panicle of BRRI dhan28

Foliar fertilization	Spikelets panicle^{-1}				Grains panicle^{-1}			
	Nitrogen levels			Mean of foliar fertilization	Nitrogen levels			Mean of foliar fertilization
	N_{50}	N_{75}	N_{100}		N_{50}	N_{75}	N_{100}	
F_0	110 f	141 e	165 a-d	139 C	76 g	102 ef	129 c	102 c
F_1	158 b-e	166 a-d	176 ab	166 A	114 d	129 c	143 ab	129 a
F_2	138 e	148 de	168 a-d	152 B	92 f	111 de	131 c	111 b
F_3	151 c-e	170 a-c	180 a	167 A	115 d	132 bc	144 a	130 a
Mean of nitrogen levels	139 c	157 b	172 a		99 c	119 b	137 a	
CV (%)		4.53				2.74		
Level of significance		*				**		

Means followed by different capital letter(s) for main effect and small letter (s) for interaction differed significantly at $p \le 5\%$ level of probability by Tukey's test
CV for foliar fertilization (Spikelets panicle^{-1} and Grains panicle^{-1}) = 4.68% and 2.85%
CV for nitrogen levels (Spikelets panicle^{-1} and Grains panicle^{-1}) = 4.53% and 2.74%

Among the treatment combinations, the maximum number of spikelets panicle^{-1} (180) was recorded in F_3N_{100} which was statistically similar to F_1N_{100} (176), F_3N_{75} (170), F_2N_{100} (168), F_1N_{75} (166), F_0N_{100} (165). The lowest number of spikelets panicle^{-1} was obtained from F_0N_{50} (110) which was followed by F_2N_{50} (138) and F_0N_{75} (141). Foliar fertilization with KNO_3 and American NPKS could save 50% of recommended nitrogen fertilizer and foliar fertilization with DAP could save 25% of recommended nitrogen fertilizer applied in soil for getting statistically similar number of spikelets panicle^{-1} found in F_0N_{100}. Similar trend has been reported by Jagathjothi *et al.* (2012), Manik *et al.* (2016) and Hasan *et al.* (2020).

Among the treatment combinations, the maximum number of grains panicle^{-1} (144) was recorded in F_3N_{100} which was statistically similar to F_1N_{100} (143). The lowest number of grains panicle^{-1} was obtained from F_0N_{50} (76) which was followed by F_2N_{50} (92), F_0N_{75} (102), F_2N_{75} (111), F_1N_{50} (1114) and F_3N_{50} (115). Foliar fertilization with KNO_3 and American NPKS could save 25% of recommended nitrogen fertilizer but foliar fertilization with DAP could not save nitrogen fertilizer applied in soil for getting comparable number of grains panicle^{-1} found in F_0N_{100}. Similar trend has been reported by Saleem *et al.* (2013) and Khan *et al.* (2009).

Unfilled spikelets panicle^{-1} and thousand grain weight

Unfilled spikelets panicle^{-1} and thousand grain weight were not influenced significantly by foliar fertilization, nitrogen levels and the combined effect of foliar fertilization and nitrogen levels (Table 5).

Table 5. Effect of foliar fertilization and nitrogen levels on unfilled spikelets panicle^{-1} and thousand grains weight of BRRI dhan28

Treatment	Unfilled spikelet panicle^{-1}	1000 grains weight (g)
	Foliar fertilization	
F_0	36.58	22.65
F_1	37.69	22.30
F_2	40.23	23.06
F_3	36.54	22.14
Significance level	NS	NS
CV (%)	14.51	5.28
Nitrogen levels		
N_{50}	39.80	22.65
N_{75}	38.02	22.67
N_{100}	35.40	22.94
Significance level	NS	NS
CV (%)	18.21	4.14
Foliar fertilization × Nitrogen levels		
F_0N_{50}	34.06	22.57
F_0N_{75}	39.07	22.72
F_0N_{100}	36.60	22.47
F_1N_{50}	43.07	22.63
F_1N_{75}	37.54	22.51
F_1N_{100}	32.47	21.77
F_2N_{50}	46.73	22.41
F_2N_{75}	37.33	23.31
F_2N_{100}	36.63	23.47
F_3N_{50}	35.34	22.81
F_3N_{75}	38.14	22.15
F_3N_{100}	36.13	21.47
Significance level	NS	NS
CV (%)	18.21	4.14

In a column, means followed by different letter(s) within main and interaction effect differ significantly at $p \leq 5\%$ level of probability

Grain yield hill^{-1}

Grain yield hill^{-1} was influenced significantly by foliar fertilization, nitrogen levels and the combined effect of foliar fertilization and nitrogen levels (Table 6). Among the treatment combinations, the maximum grain yield hill^{-1} was recorded in F_3N_{100} (33.75 g) which was statistically similar to F_1N1_{00} (33.16 g) followed by $F_3N_{75,}$ (31.15 g), F_2N_{100} (30.89 g), F_0N_{100} (30.13 g), and F_1N_{75} (30.00 g). The lowest grain yield hill^{-1} was obtained from F_0N_{50} (18.09 g) which was followed by F_1N_{50} (20.90 g) and F_2N_{50} (21.60 g). Foliar fertilization with KNO_3 and American NPKS could save 25% of recommended nitrogen fertilizer but foliar fertilization with DAP could not save nitrogen fertilizer applied in soil for getting equivalent number of grain yield hill^{-1} found in F_0N_{100}. Similar results were also observed by Pramanik *et al*. (2015) and Rabin *et al*. (2016).

Table 6. Effect of foliar fertilization and nitrogen levels on grain yield hill^{-1} of BRRI dhan28

Foliar fertilization	Grain yield hill^{-1} (g)			
	Nitrogen levels			Mean of foliar fertilization
	N_{50}	N_{75}	N_{100}	
F_0	18.09 f	24.80 d	30.13 b	24.34 d
F_1	20.90 e	30.00 b	33.16 a	28.02 b
F_2	21.60 e	26.16 cd	30.89 b	26.22 c
F_3	27.50 c	31.15 b	33.75 a	30.80 a
Mean of nitrogen levels	22.02 c	28.03 b	31.98 a	
CV (%)		2.42		
Level of significance		**		

Means followed by different capital letter(s) for main effect and small letter (s) for interaction differed significantly at $p \leq 5\%$ level of probability by Tukey's test
CV for foliar fertilization and nitrogen levels= 1.83% and 2.42%

Straw yield hill^{-1}

Straw yield hill^{-1} of BRRI dhan28 was not influenced significantly by foliar fertilization and the interaction effect of foliar fertilization and nitrogen levels but it was influenced significantly by nitrogen levels (Fig. 1). Fig. 1 shows that straw yield (g hill^{-1}) was increased gradually with the increment of nitrogen level. The highest straw yield (25.33 g hill^{-1}) was obtained when recommended nitrogen fertilizer was applied as urea (N_{100}) which was statistically equal to that recorded in N_{75} (23.80 g hill^{-1}). The lowest straw yield (19.15 g hill^{-1}) was recorded in N_{50}. Saleem *et al.* (2013), Pramanik *et al.* (2015) and Rabin *et al.* (2016) also reported increase in nitrogen levels caused significant increase in straw yield in rice. Similar trend has been reported by Fageria *et al.* (2009), Jagathjothi *et al.* (2012) and Surya (2015).

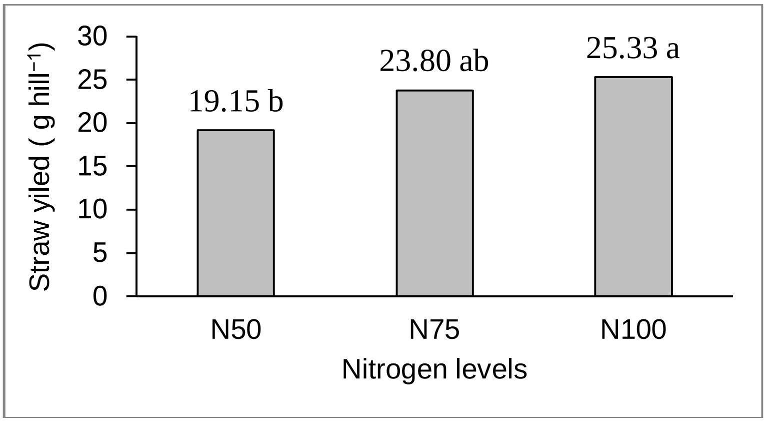

Fig.1. Effect of nitrogen levels (N_{50} = 50% of the recommended nitrogen fertilizer, N_{75} = 75% of the recommended nitrogen fertilizer and N_{100} = 100% of the recommended nitrogen fertilizer) on straw yield of BRRI dhan28.

Grain yield

Grain yield (t ha^{-1}) was influenced significantly by foliar fertilization, nitrogen levels and the combined effect of foliar fertilization and nitrogen levels (Table 7). Among the treatment combinations, the maximum grain yield (t ha^{-1}) was recorded in F_3N_{100} (7.63 t ha^{-1}) which was statistically similar to F_1N_{100} (7.58 t ha^{-1}) followed by F_3N_{75}, (7.00 t ha^{-1}), F_2N_{100} (6.95 t ha^{-1}), F_0N_{100} (6.78 t ha^{-1}), and F_1N_{75} (6.82 t ha^{-1}). The lowest grain yield was obtained from F_0N_{50} (4.07 t ha^{-1}) which was followed by F_2N_{50} (4.87 t ha^{-1}) and F_0N_{750} (5.42 t ha^{-1}). Foliar fertilization with KNO_3 and American NPKS could save 25% of recommended nitrogen fertilizer but foliar fertilization with DAP could not save nitrogen fertilizer applied in soil for getting comparable grain yield found in F_0N_{100}. Foliar fertilization of KNO_3 and American NPKS with recommended nitrogen fertilizer applied in soil could increase 11.8 and 12.5% grain yield, respectively compare to F_0N_{100}. Similar trend has been reported by Hasan *et al.* (2020), Jothi *et al.* (2019), Manik *et al.* (2016), Pramanik *et al.* (2015) and Saleem *et al.* (2013).

Table 7. Effect of foliar fertilization and nitrogen levels on grain yield of BRRI dhan28

Foliar fertilization	Grain yield (t ha^{-1})			
	Nitrogen levels			Mean of foliar fertilization
	N_{50}	N_{75}	N_{100}	
F_0	4.07 f (- 40.0)	5.42 de (- 20.1)	6.78 c (0.0)	5.42 c
F_1	6.06 d (- 10.6)	6.82 c (+ 0.5)	7.58 ab (+ 11.8)	6.82 a
F_2	4.87 e (- 28.2)	5.91 d (- 12.8)	6.95 bc (+ 2.5)	5.91 b
F_3	5.67 d	7.00 bc	7.63 a	6.77 a

	(- 16.4)	(+ 3.2)	(+ 12.5)	
Mean of nitrogen levels	5.17 c	6.29 b	7.24 a	
CV (%)		3.03		
Level of significance		**		

Means followed by different capital letter(s) for main effect and small letter (s) for interaction differed significantly at p ≤ 5% level of probability by Tukey's test, Values in parenthesis indicates percent change over F_0N_{100}

Conclusion

Foliar fertilization with KNO_3, DAP (Di-ammonium phosphate) and American NPKS significantly increased the grain yield (t ha^{-1}) compare to control (F_0) but KNO_3 and American NPKS performed better than DAP. Foliar fertilization with KNO_3 and American NPKS could save 25% of recommended nitrogen fertilizer but foliar fertilization with DAP could not save nitrogen fertilizer applied in soil for getting comparable grain yield found in F_0N_{100}. Foliar fertilization of KNO_3 and American NPKS with recommended nitrogen fertilizer applied in soil could increase 11.8% and 12.5% grain yield, respectively compare to F_0N_{100}.

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