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PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 4(8): 937-939, 2001

Effect of Nitrogen Rate and Time of Leaf Cutting on Green Fodder as Well as Seed Yield of Rice

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Abstract: The experiment was conducted with three nitrogen levels (N_1-50 kg N ha^{-1}, N_2-75 kg N ha^{-1}, N_3-100 kg N ha^{-1}) and four times of leaf cutting (C_0-no cutting, C_1-cutting at 21 DAT-Day After Transplanting, C_2-cutting at 35 DAT and C_3-cutting at 49 DAT) to find the possibility of production of rice for green fodder as well as seed. Nitrogen levels exhibited their difference in almost all crop characters. The plant height, number of total tillers $hill^{-1}$, green forage, forage dry matter, cumulative straw yield, number of productive tillers $hill^{-1}$, number of non-bearing tillers $hill^{-1}$, number of total spikelets $panicle^{-1}$, number of grains $panicle^{-1}$, number of sterile spikelets $panicle^{-1}$, grain yield and straw yield were found to be highest with the highest level of nitrogen. Panicle length and 1000-grain weight did not vary with nitrogen levels. The values of these characters were found to be lowest with the lowest level of nitrogen (50 kg N ha^{-1}). Harvest index was the highest at moderate level of nitrogen (75 kg N ha^{-1}). Time of leaf cutting had significant influence on all the parameter studied. Plant height, number of total tillers $hill^{-1}$, cumulative straw yield, number of productive tillers $hill^{-1}$, number of non-bearing tillers $hill^{-1}$, number of total spikelets $panicle^{-1}$, number of grains $panicle^{-1}$, number of sterile spikelets $panicle^{-1}$, 1000-grain weight, grain yield and straw yield were found to be highest for no leaf cutting which was statistically similar to cutting at 21 DAT but 1000-grain weight was also similar to cutting at 35 DAT and lowest for cutting at 49 DAT. Amount of green forage and forage dry matter were highest for cutting at 49 DAT. It may be concluded that there is a tremendous possibility to get green forage and grain or seed from the same rice plant.

Key words: Rice, seed, green fodder, leaf cutting, nitrogen.

Introduction

Rice ranks the top position among cereal crops of Bangladesh. But the horizontal expansion of rice area in Bangladesh is not possible due to heavy population pressure. So the only avenue left is to increase the production of rice through vertical means. Proper management of fertilizers is one of the effective means. For maximizing yield of rice, nitrogen fertilizer is the kingpin in rice farming. The nitrogen content of Bangladeshi soil is very low due to warm climate accompanied by extensive cultivation. It influences the growth and yield of rice. In studies using analytical approaches, the elasticity of rice yield variance usually is seen to increase as the level of nitrogen increases. Deficiency of nitrogen hampers the growth and yield of rice. Enormous efforts are, therefore, needed to formulate nitrogen recommendation for high yielding rice varieties that will technically be feasible, economically viable, socially acceptable and environmentally sound. Livestock plays an important role in agriculture in Bangladesh. The importance of livestock is widely recognized as an integral component of farming system and as a contributor to GDP. Cattle are the main source of draught power for cultivation. The biggest constraints of livestock production in country is the acute shortage of quality feeds and fodder. Due to high pressure on land for crop production for human consumption, farmers have a limited scope to grow fodder crop in separate field. To overcome the scarcity of green forage it is necessary to explore the feasibility of using green leaves of rice as forage without affecting grain yield. It is probable that rice leaves could be used as green fodder to meet fodder deficit because most of the area is covered by rice plant in all season. In rainy season when most of the fields are under water, rice plants remain above water. Though leaf is the primary source for supplying assimilate and in many cases yield increased with the increase of leaf area index (Yap and Harvey, 1972), the lower leaves appear to be very inefficient in influencing plant growth and grain production (Lizender and Brovtsyna, 1964; Tanaka and Kawano, 1966).

The present piece of research, was therefore, undertaken to find the effect of nitrogen fertilization on fodder and seed yield in transplant aman rice cv. BRRIdhan32, to find the effect of time of leaf cutting on fodder and seed yield in transplant aman rice cv. BRRIdhan32, and to find the feasibility of using green leaves of rice as forage.

Materials and Methods

The experiment was conducted at Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during June to December 1999. The experiment included two factors, (A) Nitrogen level-viz I) N_1-50 kg N ha^{-1}, ii) N_2-75 kg N ha^{-1} and iii) N_3-100 kg N ha^{-1}, (B) Time of leaf cutting viz. I) No cutting (control)-C_0, ii) Cutting at 21 DAT -C_1, iii)Cutting at 35 DAT -C_2, iv) Cutting at 49 DAT-C_3. The experiment was laid out in a split plot design with four replications. The nitrogen level was assigned in main plots and time of leaf cutting in sub-plots at random. The unit plot size was 4.0 x 2.5 m^2. Nitrogen was applied through urea as per experimental specification. The land was fertilized with 50 kg P_2O_5 ha^{-1}, 40 kg K_2O ha^{-1}, 10 kg S ha^{-1} and 8 kg Zn ha^{-1} in the form of triple super phosphate, muriate of potash, gypsum and zinc oxide, respectively. Seedlings were transplanted on 28 July 1999 at the rate of 3 seedlings $hill^{-1}$ maintaining a plant spacing 25 x 15 cm^2. Different intercultural operations were done as and when necessary. Leaf cutting of the whole plot was done 15 cm above the ground level within a plot. The data on different agronomic characters were recorded from the randomly selected hills in each plot and those on grain and straw yields were recorded from the whole plot. Data were analyzed using "Analysis of Variance" technique and mean differences were recognized by DMRT (Steel and Torrie, 1980).

Table 1: Effect of nitrogen level and time of leaf cutting on plant height, number of total tillers hill^{-1} and number of total leaves hill^{-1} at vegetative growth stage

Treatments	Plant height (cm)			No. of total tillers hill^{-1}			No. of total leaves hill^{-1}		
	20 DAT	34 DAT	48 DAT	20 DAT	34 DAT	48 DAT	20 DAT	34 DAT	48 DAT
Nitrogen level (kg ha^{-1})									
50 (N_1)	38.77	65.75b	77.92b	7.59	13.72b	14.34b	28.08	52.58b	61.72b
75 (N_2)	39.36	68.26ab	82.48a	7.56	14.63a	15.18ab	29.06	58.90ab	70.47a
100 (N_3)	38.25	69.38a	82.39a	7.50	14.95a	15.97a	28.56	62.10a	74.57a
Time of leaf cutting									
No cutting (C_0)	38.29	69.84a	85.43a	7.54	14.92a	15.98a	28.15	58.48ab	78.09a
Cutting at 21 DAT (C_1)	38.83	62.77b	82.15b	7.33	13.03b	15.09b	29.09	54.30b	74.13a
Cutting at 35 DAT (C_2)	38.99	69.05a	72.67c	7.75	14.85a	13.90c	28.53	57.94ab	45.63b
Cutting at 49 DAT (C_3)	39.06	69.53a	83.46ab	7.58	14.93a	15.67ab	28.57	60.73a	77.83a

In a column, figures bearing same or no letter(s) do not differ significantly at 5% level of significance, according to DMRT.

Table 2: Effect of nitrogen level and time of leaf cutting on various plant characters, yield and yield component of BRRIdhan32 at harvest

Treatments	Plant height (cm)	No. of total tillers hill^{-1}	No. of total leaves hill^{-1}	No. of bearing tillers hill^{-1}	No. of non-bearing tillers hill^{-1}	Panicle length (cm)	No. of total spikelets panicle^{-1}	No. of grains panicle^{-1}	No. of sterile spikelets panicle^{-1}
Nitrogen level (kg ha^{-1})									
50 (N_1)	120.16b	9.90c	26.00ab	8.60c	1.30b	23.45	103.10b	84.46b	18.69b
75 (N_2)	123.90a	10.89b	28.61a	9.40b	1.49b	23.44	107.00ab	85.68b	21.30a
100 (N_3)	124.70a	11.65a	30.26a	9.80a	1.85a	24.17	113.20a	90.11a	23.05a
Time of leaf cutting									
No cutting (C_0)	132.00a	11.77a	58.93a	9.86a	1.92a	25.55a	118.10a	95.68a	22.47a
Cutting at 21 DAT(C_1)	130.70a	11.00b	23.90a	9.33ab	1.67b	25.00a	114.80a	93.28a	21.57a
Cutting at 35 DAT(C_2)	118.60b	10.42bc	18.81c	9.02b	1.40c	22.61b	100.40b	81.29b	19.08b
Cutting at 49 DAT(C_3)	110.30c	10.05c	17.51c	8.85b	1.20c	21.59c	97.68b	76.74b	20.93ab

In a column, figures bearing same or no letter(s) do not differ significantly at 5% level of significance, according to DMRT.

Table 3: Effect of nitrogen level and time of leaf cutting on various plant characters, yield and yield component of BRRIdhan32 at harvest

Treatments	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index	Green forage yield (t ha^{-1})	Dry matter of green forage (t ha^{-1})	Cumulative straw yield (t ha^{-1})
Nitrogen level (kg ha^{-1})								
50 (N_1)	20.89	3.93b	5.07b	9.00b	43.94b	1.78b	0.43c	5.50b
75 (N_2)	21.22	4.28a	5.39b	9.68b	44.47a	2.04ab	0.50b	5.90b
100 (N_3)	21.08	4.63a	5.88a	10.50a	44.19ab	2.29a	0.56a	6.44a
Time of leaf cutting								
No cutting (C_0)	21.63a	4.86a	6.51a	11.38a	42.8c	-	-	6.51a
Cutting at 21 DAT(C_1)	21.45a	4.70a	6.17a	10.87a	43.24c	0.41c	0.10c	6.26a
Cutting at 35 DAT(C_2)	21.28a	4.12b	5.13b	9.25b	44.49b	2.10b	0.51b	5.64b
Cutting at 49 DAT(C_3)	19.89b	3.43c	3.98c	7.41c	46.26a	5.64a	1.37a	5.36b

In a column, figures bearing same or no letter(s) do not differ significantly at 5% level of significance, according to DMRT.

Results and Discussion

Nitrogen levels exhibited their difference in all the growth parameters considered. Plant height, number of total tillers hill^{-1} and number of total leaves hill^{-1} were found to be increased linearly with increasing level of nitrogen at all the sampling dates (Table 1&2). Plant height and Yield enhancing characters like number of total tillers hill^{-1}, number of bearing tillers hill^{-1} and number of grains panicle^{-1} were found to be the highest with the highest level of nitrogen (100 kg N ha^{-1}), the corresponding values for those characters were 124.70 cm, 11.65,9.80 and 90.11 respectively (Table 2). These results are similar to those of Reddy *et al.* (1988), who recorded positive effect of nitrogen level on plant height. Bardhan and Mondal (1988) reported similar results that leaf removal significantly decreased plant height at maturity. BRRI (1986) reported that leaf clipping at PI stage was more detrimental than that of active tillering stage. Andrade and Amorim Neto (1996) and Bhuiya *et al.* (1989) also reported that nitrogen level had positive influence on number of grains panicle^{-1}. Though the panicle length and 1000-grain weight did not differ significantly the numerically highest panicle length (24.17 cm) and second highest 1000-grain weight (21.22 g) was recorded with the highest level of nitrogen (100 kg N ha^{-1}). The yield retarding characters viz. number of non-bearing tillers hill^{-1} and number of sterile spikelets panicle^{-1} were also found to be the highest (1.85 and 23.05, respectively) with the highest level of nitrogen (100 kg N ha^{-1}). Among these characters 1000-grain weight was numerically highest at 75 kg N ha^{-1}. At 75 kg N ha^{-1} the value of plant height, total spikelets panicle^{-1}, sterile spikelets panicle^{-1} were statistically similar to high nitrogen level (100 kg N ha^{-1}) (Table 2 & 3). The lowest nitrogen level recorded the shortest plant (120.10 cm), lowest number of total tillers hill^{-1} (9.89), number of total tillers hill^{-1}, lowest number of productive tillers hill^{-1} (8.72), moderate number length of panicle (23.45 cm), lowest number of total spikelets panicle^{-1} (103.10), lowest number of grains panicle^{-1} (84.46) and lowest 1000-grain weight (20.89 g) (Table 2 & 3). The highest grain yield (4.36 t ha^{-1}) was recorded at 100 kg N ha^{-1} which was statistically similar with 75 kg N ha^{-1} (4.28 t N ha^{-1}). Islam *et al.* (1990), who observed that the grain yield of rice increased significantly up to 80 kg N ha^{-1} and there after the yield response was not found significant up to 120 kg N ha^{-1}. The lowest nitrogen level recorded the lowest grain yield (3.93 t ha^{-1}). The highest straw yield (5.88 t ha$^{-1)}$ was recorded at 100 kg N ha^{-1} and the lowest one (5.07 t ha^{-1}) was recorded at 100 kg N ha^{-1} which was statistically similar with 75 kg N ha^{-1} (5.39 t ha^{-1}). The highest harvest index (44.47%) was calculated at 75 kg N ha^{-1} identical with 100 kg N ha^{-1} (44.19%). The lowest one (43.94%) was given at 50 kg N ha^{-1} which was also similar to 100 kg N ha^{-1}. The highest amount of green forage recorded at 100 kg N ha^{-1} which was statistically similar to 75 kg N ha^{-1} (2.04 t ha^{-1}). The lowest one was recorded at 50 kg N ha^{-} (1.78 t ha^{-1}) which was also similar to 75 kg N ha^{-1}. The highest amount of dry matter of green forage (0.56 t ha^{-1}) was recorded at 100 kg N ha^{-1} and the lowest one (0.43 t ha^{-1}) was recorded at 50 kg N ha^{-1}. The highest cumulative straw yield (6.44 t ha^{-1}) was recorded at 100 kg N ha^{-1} and the lowest one (5.50 t ha^{-1}) was recorded at 50 kg N ha^{-1}.

Time of leaf cutting had significant influence on all the growth parameters studied. Plant height, number of total tillers $hill^{-1}$ and number of total leaves $hill^{-1}$ at all sampling date (except 20 DAT) varied significantly due to time of leaf cutting (Table 1 & 2). Yield contributing characters like plant height, number of total tillers $hill^{-1}$, number of bearing tillers $hill^{-1}$, number of non-bearing tillers $hill^{-1}$, panicle length, number of grains $panicle^{-1}$, number of total spikelets $panicle^{-1}$, number of sterile spikelets $panicle^{-1}$ and 1000-grain weight were found to be the highest at no cutting, the corresponding values for those characters were 132.00 cm, 11.77, 9.86, 1.90, 25.56, 118.10, 95.68, 22.47 and 21.63 g, respectively, of these characters plant height, number of bearing tillers $hill^{-1}$, panicle length, number of grains $panicle^{-1}$, number of total spikelets $panicle^{-1}$ and 1000-grain weight were statistically similar to C_1 (Table 2 & 3). The value of yield contributing characters decreased with increasing time of cutting. Bardhan and Mondal (1988) reported similar results that leaf removal significantly decreased plant height at maturity. BRRI (1986) which reported that leaf clipping at PI (panicle initiation) stage was more detrimental than that of active tillering stage. The shortest plant (110.30 cm), lowest number of total tillers $hill^{-1}$ (10.05), lowest number of bearing tillers $hill^{-1}$ (8.85), shortest panicle (21.59 cm), number of grains $panicle^{-1}$ (76.74), lowest number of total spikelets $panicle^{-1}$ (97.68) and lowest 1000-grain weight (19.89 g) were recorded for C_3. Gardner and Wiggons (1960) reported that clipping of oat plant after 5-leaf stage reduced panicle length. The lowest amount of sterile spikelets $panicle^{-1}$ was recorded in C_2 which was statistically similar to C_3 (Table 2 & 3). The highest grain yield (4.86 t ha^{-1}) was obtained at no cutting (C_0) which was statistically similar to cutting at 21 DAT (4.70 t ha^{-1}) and the lowest grain yield (3.43 t ha^{-1}) was obtained by cutting at 49 DAT (C_3) which was statistically similar to cutting at 35 DAT (4.12 t ha^{-1}) (Table 3). Straw yield and biological yield followed the same order of variation with time of leaf cutting. The highest harvest index (46.26%) was recorded for leaf cutting at 49 DAT. The minimum harvest index was recorded for no cutting (42.8%) which was statistically similar to cutting at 21 DAT (43.24%) (Table 3). The highest amount of green forage (5.64 t ha^{-1}) was recorded by cutting at 49 DAT followed by cutting at 35 DAT (2.10 t ha^{-1}) and at 21 DAT (0.41 t ha^{-1}). Green fodder was not found at no cutting. The highest dry matter of green forage (1.37 t ha^{-1}) was produced at 49 DAT and lowest one was produced by no leaf cutting, statistically followed by cutting at 21 DAT (Table 3). The highest cumulative straw yield was recorded by no leaf cutting which was statistically similar to cutting at 21 DAT. The lowest one was found for cutting at 49 DAT (5.64 t ha^{-1}) which was statistically similar to cutting at 35 DAT.

Within the scope and limitation of the present study, it may be concluded that moderate forage yield and higher seed yield of rice could be obtained at 100 kg N ha^{-1} with leaf cutting at 21 DAT from the same piece of land in the same rice growing season.

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