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Effect of Green Manures and Levels of Nitrogen on Some Growth Attributes of Transplant Aman Rice

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Abstract: An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh, during the period from May to November 1998 to investigate the effect of green manures and different levels of nitrogen on the growth performance of transplant aman rice (cv. BRRI dhan 32). The experiment consisted of 3 green manuring crops viz. *Sesbania rostrata, Sesbania aculeata* and *Crotalaria juncea* and 5 levels of nitrogen viz. 0, 20, 40, 60 and 80 kg ha^{-1}. Growth attributes such as leaf area index, crop growth rate and net assimilation rate increased up to 67 DAT irrespective of green manure crops and different levels of nitrogen and thereafter declined. On the other hand, plant height and leaf area duration increased with the increasing levels of nitrogen in combination with green manuring crops. Application of 40 kg N ha^{-1} along with *Sesbania rostrata* green manuring showed the best performance in respect of grain yield and net assimilation rate of transplant aman rice. *S. aculeata* exhibited similar behaviour as that of *S. rostrata* but *Crotalaria juncea* showed relatively poor performance in respect of growth attributes of rice due to less amount of biomass added during incorporation.

Key words: Green manuring, nitrogen, growth attributes, transplant aman rice

INTRODUCTION

Rice-rice cropping system emerges as important cropping system in Bangladesh. No doubt this system is highly productive but very exhaustive and hence may not be sustainable. Deterioration of soil physical properties and decline in the fertility status of the soil are often associated with this system because high yielding varieties need more nutrients for higher yield. This situation is also due to non-judicious use of chemical fertilizers and addition of small amount of organic matter in the soil. Moreover, use of cow dung, organic waste, leaves and crop residues as fuel has been depriving the agricultural soils from their replenishment[1]. Organic matter can play an important role in the improvement of soil fertility and crop growth. This undesirable situation can be overcome only by addition of huge amount of organic matter to the soil from different sources. It has been reported that organic matter cycling is related to the agricultural potential of soils[2]. Inclusion of Leguminous green manures in the cropping system is known to improve the soil conditions for enhanced and sustained rice production during wet season[3]. Green manuring crops in combination with nitrogen fertilizer can influence growth attributes of plants to a great extent[4].Green manuring along with application of nitrogenous fertilizer helps to release nutrient elements slowly during the period of crop growth[5]. Application of green manure plus chemical fertilizers are found to produce significantly higher yield than that of sole application of chemical fertilizer[6]. Boro rice-fallow-transplant aman rice is the predominant cropping pattern under irrigated condition which covered 60% of the boro rice based cropping pattern[7]. After the harvest of boro rice a large area of land remains vacant for about 2-3 months. This period could be utilized to raise green manures without sacrificing the main crops. Therefore, the present investigation was conducted to study the effect of green manure and different levels of nitrogen on the growth performance of transplant aman rice.

MATERIALS AND METHODS

The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during the period from May to November 1998. The experimental land was medium high in topography under the Old Brahmaputra Floodplain

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(AEZ-9) and characterized by non-calcareous dark gray floodplain soil belonging to the Sonatola soil series. The soil was silt loam in texture having pH 5.38 and 1.19% organic matter. The experiment consisted of 3 green manure crops viz. *Sesbania rostrata, Sesbania aculeata* and *Crotalaria juncea* and 5 levels of nitrogen viz., 0, 20, 40, 60 and 80 kg ha^{-1}. The experiment was laid out in a randomized complete block design with 3 replications. Seeds of green manure crops were sown at the rate of 50, 40 and 50 kg ha^{-1} for *S. rostrata, S. aculeata* and *C. juncea,* respectively, on 18 May. Green manuring crops were fertilized with N, P_2O_5 and K_2O at 10-20-15 kg ha^{-1}, respectively, before sowing. Sixty day old green manuring plants were chopped into pieces and incorporated in the soil by spading 10 days before transplanting of rice seedlings. The mean fresh biomass and dry biomass production from *S. rostrata, S. aculeata* and *C. juncea* were 18.41, 22.56, 15.83 and 4.57, 5.68 and 4.21 t ha^{-1}, respectively. The corresponding nitrogen addition through these green manures were 51.18, 35.22 and 31.57 kg ha^{-1}. Forty day old rice seedlings were transplanted at a spacing of 20×15 cm with three seedlings $hill^{-1}$. Transplant aman rice was fertilized with 60 kg P_2O_5, 40 kg K_2O, 60 kg gypsum and 10 kg $ZnSO_4 ha^{-1}$ during land preparation. Nitrogen, as specified in the treatment, was applied in the form of urea in three equal splits at 20, 35 and 50 days after transplanting (DAT). Different growth parameters such as plant height, leaf area index (LAI), crop growth rate (CGR), net assimilation rate (NAR) and leaf area duration (LAD) were recorded at 15 day intervals beginning 37 DAT up to harvesting following the standard formula. All management practices were done at proper time starting from land preparation to crop harvest. Soil samples were collected three times to determine its physico-chemical properties. Data recorded on growth attributes were statistically analyzed using "analysis of variance" and differences among treatment means were adjudged with Duncan's multiple range test[8].

RESULTS AND DISCUSSION

Plant height: Plant height of transplant aman rice was significantly influenced by soil incorporation of green manures and different levels of nitrogen. The highest plant height was obtained with the incorporation of *Sesbania rostrata* and that of the lowest with *Crotalaria juncea* (Table 1). Plant height increased with higher levels of nitrogen. The highest plant height was observed when the crop was fertilized with 80 kg N ha^{-1} and that of the lowest was obtained in the plots without nitrogen application. Interaction of green manures and levels of nitrogen had significant influence on plant height. The highest plant height was obtained in the treatment combination of *S. rostrata* and 80 kg N ha^{-1}. The lowest plant height was observed in *C. juncea* and without nitrogen treatment. An increasing trend of plant height was observed in the treatment combination of green manuring crops and higher levels of nitrogen. It was evident from the study that higher levels of nitrogen stimulated elongation growth of the rice plant.

Leaf area index (LAI): Leaf area index (LAI) was significantly influenced by the soil incorporation of green manuring crops. The highest LAI value was obtained with the soil incorporation of *Sesbania rostrata* followed in order by *S. aculeata* and *C. juncea* throughout the growth period (Table 1). Similar trend was reported by Hiremath and Patel[9]. LAI increased gradually with the increasing levels of N and the highest value was observed when the crop was fertilized with 80 kg N ha^{-1}. The lowest LAI was found in the no nitrogen treatment. It was observed that *Sesbania* sp. in combination with 40 kg N ha^{-1} gave the highest LAI values at all dates of sampling (Table 1) while *C. juncea* in combination with 80 kg N ha^{-1} produced the highest LAI of transplant *aman* rice. Among the green manuring crops *Sesbania rostrata* in combination with 40 kg N ha^{-1} appeared as the promising practice in respect of leaf area index. Irrespective of green manuring crops LAI increased up to 52 days after transplanting and thereafter exhibited a decreasing trend.

Grain yield: Incorporation of green manures had significant influence on grain yield. The highest grain yield was obtained with the incorporation of *S. rostrata* followed in order by *S. aculeata* and *C. juncea* (Table 1). The lowest grain yield obtained with the incorporation of *C. juncea* was probably due to less amount of biomass added during incorporation. Similar results were also reported by Setty and Channabasavanna[10]. Application of different levels of nitrogen had significant influence on grain yield. The highest grain yield was obtained when the crop was fertilized with 40 kg N ha^{-1} followed in order by 60 kg, 80 kg and 20 kg N ha^{-1}, respectively. The lowest grain yield was obtained in the crop not fertilized with nitrogen. However, fertilization with 60 kg and 80 kg N ha^{-1} were at par with that of 40 kg N ha^{-} in respect of grain yield. Similar results were found by Hiremath and Patel[9]. They also reported that nitrogen fertilizer application would be reduced to 50% of recommended dose due to green manure. Interaction of green manuring crops and different levels of nitrogen had significant effect on grain yield of transplant aman rice. *S. rostrata* in combination with 40 kg N ha^{-1} produced the highest grain yield. The result was at par with the treatment

Table 1: Plant height, Leaf area index (LAI) and grain yield of transplant aman rice as influenced by green manuring crops, levels of nitrogen and green manuring crops×levels of nitrogen interaction

Treatments		Plant height (cm)	Leaf area index (LAI) 37 DAT	52 DAT	67 DAT	82 DAT	Grain yield (t ha^{-1})
Green manuring crops							
Sesbania rostrata		116.07a	2.17a	3.75a	3.00a	2.73a	5.01a
Sesbania aculeata		114.23ab	1.93b	3.20b	2.67b	2.32b	4.82ab
Crotalaria juncea		110.46b	1.67c	2.63c	2.22c	1.92c	4.59b
Level of significance		0.01	0.01	0.01	0.01	0.01	0.01
Levels of nitrogen (kg ha^{-1})							
0		108.6d	1.73d	2.75d	2.26d	2.00d	4.13c
20		111.6cd	1.85c	3.00c	2.49c	2.17c	4.64abc
40		113.7bc	2.00ab	3.32b	2.75b	2.44b	5.18a
60		115.7ab	2.00ab	3.32b	2.75b	2.44b	5.07ab
80		118.35a	2.05a	3.59a	2.91a	2.56a	4.99ab
Level of significance		0.01	0.01	0.01	0.01	0.01	0.01
Green manuring crops × levels of nitrogen (kg ha^{-1})							
Sesbania	0	111.83	1.93cd	3.22c	2.60de	2.33def	4.45b-e
rostrata	20	114.43	2.10b	3.55b	2.88c	2.53b	4.88a-d
	40	115.93	2.31a	4.07a	3.27a	2.95a	5.51a
	60	117.90	2.25a	4.03a	3.17ab	2.93a	5.18ab
	80	120.30	2.23a	3.89a	3.10b	2.92a	5.02abc
Sesbania	0	108.53	1.75e	2.82d	2.35f	2.06g	4.15de
aculeata	20	112.20	1.87d	2.97d	2.50e	2.23f	4.74a-d
	40	114.52	2.02bc	3.50b	2.87c	2.49bc	5.26a
	60	116.70	2.02bc	3.49b	2.89c	2.44bcd	4.09ab
	80	119.20	1.99bcd	3.23e	2.76c	2.38cde	4.85a-d
Crotalaria	0	105.40	1.52g	2.18f	1.84h	1.61j	3.80e
juncea	20	108.27	1.56fg	2.49c	2.03g	1.74j	4.32cde

In a column, under each treatment, figures hving similar letter(s) or without letter do not differ significantly whereas figures bearing dissimilar letter(s) differ significantly as per DMRT., NS= non significant.

combination of *S. aculeata*×40 kg N ha^{-1}. The lowest grain yield was obtained with the treatment combination of *C. juncea*×0 kg N ha^{-1}. It was noticeable that the interactions which produced the highest LAI also produced the highest grain yield which was especially reflected in the interaction of *S. rostrata*×40 kg N ha^{-1} (Table1).

Crop growth rate (CGR): The study showed increasing trend of crop growth rate (CGR) with the age of plant and attained the peak within the period 53-67 days after transplanting and thereby declined due to leaf abscission. Numerically the highest CGR value was observed with the soil incorporation of *Sesbania rostrata* and fertilization with 80 kg N ha^{-1} (Tabel 2). The lowest CGR value observed with the soil incorporation of *Crotalaria juncea* and no nitrogen application treatment.

Net assimilation rate (NAR): From the study it was observed that irrespective of green manuring and nitrogen application, net assimilation rate (NAR) increased with plant growth and attained the peak within the period 53-67 DAT and thereafter declined gradually as the plants approached towards maturity (Table 3). The reason might be due to mutual leaf shading, aging and increasing number of older leaves, which reduced photosynthesis.

Table 2: Crops growth rate (CGR)as influenced by green manuring crops, levels of N and green manuring crops x levels of N interaction

Treatments	Crop growth rate (10^{-4} gm^{-2}d^{-1}) 37-52 DAT	53-67 DAT	68-82 DAT
Green manuring crops			
Sesbania rostrata	11.6	16.0	9.7
Sesbania aculeata	10.9	15.2	9.1
Crotalaria juncea	10.5	14.5	8.8
Level of significance	NS	NS	NS
Levels of nitrogen (kg ha^{-1})			
0	9.9	13.7	7.7
20	10.5	14.6	8.7
40	11.1	15.4	9.4
60	11.6	16.0	10.0
80	11.8	16.4	10.3
Level of significance	NS	NS	NS
Green manuring crops × levels of nitrogen (kg ha^{-1})			
Seabania rostrata	0	14.3	8.2
	20	15.4	9.2
	40	16.2	10.0
	60	16.8	10.5
	80	17.4	10.8
Seabania aculeata	0	13.6	7.6
	20	14.5	8.5
	40	15.4	9.2
	60	16.0	9.8
	80	16.4	10.2
Crotalaria juncea	0	13.2	7.2
	20	14.0	8.4
	40	14.6	9.0
	60	15.1	9.6
	80	15.5	10.0
Level of significance	NS	NS	NS

In a column, under each treatment, figures having similar letter(s) or without letter do not differ significantly whereas figures bearing dissimilar letter(s) differ significantly as per DMRT. NS= Not significant.

Leaf area duration (LAD): Leaf area duration (LAD) of transplant aman rice was significantly influenced by green manuring, application of different levels of nitrogen and interaction between green manuring crops and levels of nitrogen. The highest LAD value was obtained with the soil incorporation of *Sesbania rostrata*, fertilization with 80 kg N ha^{-1} and interaction between *Sesbania rostrata* and 80 kg N ha^{-1} (Table 3). This increasing trend of leaf area duration with the application of higher levels of nitrogen through green manures was mainly due to increased leaf number and its size. It was evident from the study that application of higher levels of nitrogen stimulated vegetative growth and thereby panicle initiation, flowering and maturity of transplant *aman* rice were delayed. Similar trend was observed by Hiremath and Patel[9].

The second highest LAD value was obtained with the soil incorporation of *Sesbania aculeata* individually and in combination with 80 kg N ha^{-1}. This might be due to sufficient nitrogen added by the decomposition of *Sesbania* spp., the highest dose of nitrogen individually and in combination of both. On the other hand, *Crotalaria juncea* showed the lower LAD values individually and in combination with different levels of

Table 3: Net assimilation rate and leaf area duration as influenced by green manuring crops, levels of N and green manuring crops×levels of N interaction

Treatments		Net assimilation rate (10^{-4} gm^{-2}d^{-1}) 37-52 DAT	53-67 DAT	68-82 DAT	Leaf area duration (in days)
Green manuring crops					
Sesbania rostrata		3.55b	5.67b	3.40b	106.50a
Sesbania aculeata		4.03ab	6.91ab	3.70b	100.96b
Crotalaria juncea		4.98a	7.68a	5.20a	95.23c
Level of significance		0.01	0.01	0.01	0.01
Levels of nitrogen (kg ha^{-1})					
0		4.36	6.91	5.11	83.51e
20		4.73	6.63	4.62	94.42d
40		4.38	7.11	3.69	102.12c
60		3.79	6.89	3.71	108.53b
80		3.67	6.24	3.34	114.25a
Level of significance		NS	NS	NS	0.01
Green manuring crops × levels of nitrogen (kg ha^{-1})					
Seabania	0	3.51	6.38	3.94	89.65bc
rostrata	20	4.19	5.18	4.02	100.41abc
	40	3.46	5.68	2.94	107.05ab
	60	3.27	5.73	3.21	112.65a
	80	3.32	5.39	2.87	117.76a
Seabania	0	4.02	7.11	4.49	84.45c
aculeata	20	4.17	7.12	4.09	94.36abcd
	40	4.11	7.17	2.99	102.88abc
	60	3.75	6.83	3.51	108.61ab
	80	4.08	6.37	3.42	114.52a
Crotalaria	0	5.52	7.25	6.91	76.43d
juncea	20	5.85	6.58	5.76	88.50bc
	40	5.58	8.52	5.15	96.43abcd
	60	4.30	8.10	4.43	104.33abc
	80	3.59	6.96	3.73	110.48ab
Level of significance		NS	NS	NS	0.01

In a column, under each treatment, figures having similar letter(s) or without letter do not differ significantly whereas figures bearing dissimilar letter(s) differ significantly as per DMRT., NS= Not significant.

nitrogen in comparison with *Sesbania* spp. This might be due to insufficient nitrogen released by the decomposition of less amount of biomass added by *Crotalaria juncea*. Therefore, it may be inferred that *Sesbania rostrata* individually and in combination with 40 kg N ha^{-1} showed better performance than other green manuring species in terms of LAI, CGR and NAR.

From the study it may be concluded that *S. rostrata* appeared as the promising green manuring species compared to *S. aculeata* and *C. juncea*. *S. rostrata* in combination with 40 kg N ha^{-1} emerged out as a promising practice for the growth and yield of transplant aman rice.

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