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PERFORMANCE OF DIFFERENT GREEN MANURING CROPS IN BANGLADESH

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A B S T R A C T

An experiment was conducted at Sher-e-bangla Agricultural University during May to July, 2016 to examine the morpho-physical potentiality of eight green manure species and these species are viz. *Sesbania aculeata, Sesbania rostrata, Crotalaria juncea, Vigna unguiculata, Vigna mungo, Vigna radiata, Leucaena leucocephala* and *Mimosa pudica.* Leaves number, biomass production and nodulation are an important character of any green manuring crops as these crops are very potential for increasing soil fertility after incorporation. The growth habits of these species were studied from 15 DAS to 45DAS whereas dry matter/plant and nodulation data were taken from 25 DAS to 50DAS. At 45DAS, *Sesbania aculeata, Sesbania rostrata* and *Vigna unguiculata* shown 53% to 149% higher plant height compared to *Vigna mungo*, although *C. juncea* performed better at 30DAS compared to *V. unguiculata*. Again, *C. juncea* along with *S. rostrata* and *S. aculeata* gave the highest fresh biomass (24% to 72%), dry biomass (2.6t/ha to 5.25t/ha), dry matter plant^{-1} (60% to 83%) and nodulation compared to rest green manures at 45DAS whereas *V. unguiculata* produced higher dry matter plant^{-1} at 20DAS but later it declined insignificantly at 50DAS.The lowest performance was observed from *V. mungo* followed by *V. radiata and M. pudica.* It was shown that *S. rostrata, S. aculeata, C. juncea, V. unguiculata* and *L.leucocephala* performed better regarding biomass, dry matter and nodule production.

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INTRODUCTION

Soil Fertility of Bangladesh is declining day by day due to injudicious application of chemical fertilizer especially nitrogen fertilizers as the principal source of plant nutrients for rice production. Higher dose of chemical fertilizers especially inorganic nitrogen fertilizers result in soil acidification and structure damage, water depletion, and alteration in the populations of soil microbes as well as their activities (Liu *et al*. 2013). Therefore, any alternative means has to be suggested to the farmers to maintain the high level of productivity. Growing green manure crops is the ray of hope in that aspect as it has tremendous quality to improve soil fertility.Green manure crops usually belong to leguminous families and incorporate into the soil after sufficient growth. The function of a green manure crop is to add organic matter to the soil and for this addition, the nitrogen supply of the soil may be increased and certain nutrients made more readily available, thereby increasing the productivity of the soil. Green manure crops also have the ability to increase solar energy harvest and C flux into the soil and provide food for soil macro- and micro-organisms (Dabney et al. 2001). There are two types of green manures: legumes and non-legumes. Legumes are plants whose roots work with the bacteria in the soil to grab atmospheric nitrogen. Green manuring (GM) crops generally have a considerable amount of biomass which comprises aboveground and belowground biomass. Yadvinder *et al*. (1991) stated that leguminous green manure species differed widely in biomass production and N accumulation. The most productive green manure crops yielded about 4-5 tha $^{-1}$ of dry biomass in 50-60 days. Rupella and Saxena (1989) stated that the leguminous crops are the potential crops for their capability of nodule formation and nitrogen fixation and mungbean can fix nitrogen 30-40 kg N ha^{-1}. Singh *et al*. (1997) reported that legumes are effective green manures as they contain high N contents and production of large quantities of biomass within a short period of time. Bhuiyan and Zaman (1996) stated the benefits of green manuring are generally interpreted as its capacity to provide nitrogen as a substitute for fertilizers. This helps to increase crop yields keeping the use of chemical fertilizers at low level. Bhuiya and Hossain (1994) stated that the *Sesbania rostrata* contains more nitrogen and attains more height than *Sesbania aculeata*. Mureithi *et al*. (1994) stated that *leucaena* contain 3-5% nitrogen and after decomposition it has significant residual effects on soil fertility and productivity of the following crops. Kalidurai and Kannaiyan (1991) stated that, *S. rostrata* stems produced a higher number of nodules than the root and the nitrogen content of *S. rostrata* plant was greater than *S. aculeata* or *S. speciosa.* Micronutrient accumulation was also higher in *S. rostrata.* Paisancharoen *et al*.(1990) found that, due to vigorous growth and high amount of biomass being produced within two months, cowpea (21 t/ha fresh biomass) was the most promising green manure crop, followed by *Crotalaria juncea*(18 tha^{-1} fresh biomass) and pigeon pea (10 t/ha fresh biomass) for improving soil fertility.

Furthermore, cowpea had a high nutrient content, especially nitrogen and cations such as potassium.Leaves number, biomass production and nodulation are an important character of any green manuring crops as these crops are very potential for increasing soil fertility after incorporation.For the above facts, the current experiments being conducted to find out the better green manuring crops out of eight green manuring crops in relation to plant height, biomass, dry matter and nodule production.

MATERIALS AND METHODS

The experiment was conducted at Sher-e-bangla Agricultural University from May to July, 2016. Eight different species viz. *Sesbania aculeata,Sesbania rostrata, Crotalaria juncea, Vigna unguiculata, Vigna mungo, Vigna radiata, Leucaena leucocephala, Mimosa pudica* were selected as green manuring crop species. The leaves of these plants are easily decomposable and reported to contain more protein, and rich sources of nitrogen and phosphorus when used as green manure. The experiment was laid out in a Randomized Complete Block Design with three replications. There were eight different green manuring crops along with three replications. The total number of experimental units was 24 (8 x 3). The size of each plot was 17.5 m (5m x 3.5m). The replications were separated from one another by 1 m spacing. Spacing between plots was 80 cm. The experimental plots were fertilized with the recommended doses of 20-17.6-24.9 kg N, P and K ha^{-1} (BARI, 2008) from their sources of Urea, TSP and MoP. The whole amount of urea and muriate of potash, triple superphosphate were applied at the time of final land preparation and as basal dose. The seeds of different crops were sown after final land preparation following their recommended seed rate. The collected data were analyzed statistically by using the Statistic-10 computer package. The mean comparisons of all parameters were done with Tukey's W-procedure (Gomez and Gomez, 1984).

Collection of experimental data

Ten plants plot^{-1} were selected randomly for data collection.

(i) **Plant height:** The height of the ten plants was measured from the ground level to the tip of the top most ends at 15, 30 and 45 days of sowing and finally averaged to plant^{-1} basis.

(ii) **Number of leaves plant^{-1}:** The number of leaves for each ten plants was counted at 15, 30 and 45 days after sowing and finally averaged to plant^{-1} basis.

(iii) Fresh, Dry biomass and dry matter: The sample plants were uprooted at15 days interval and taken fresh weight immediately and after sun drying dry biomass were taken. After drying in the oven at 60^{0} for 24 hours from which dry matter was measured and converted to t ha^{-1}.

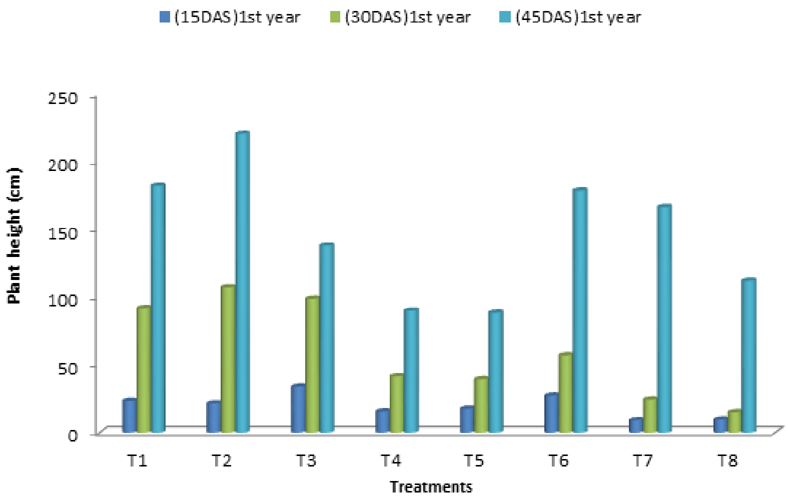
(iv) Nodule production:

Nodule number plants^{-1} was measured at 30 and 50 DAS following the standard procedure without disturbing the roots and finally averaged to plant^{-1} basis.

RESULTS AND DISCUSSION

Plant height of green manuring crops

There was a significant difference observed in plant height among the green manure crops throughout the growth period (Fig. 1). At 15 DAS, *C. juncea* (34.04 cm) and *V. unguiculata* produced the tallest plant which was statistically similar with *S. aculeata* and *S. rostrata.* Again, *Leucaena leucocephala* and *M. pudica* showed the shortest plant height at 15 DAS. At 45 DAS, the plant height of *Sesbania rostrata* , *S. aculeata, V. unguiculata, L. leucocephala C. juncea* was 149.25% ,102% ,98%, 84%, and 53% higher than that of *Vigna mungo*. The lowest plant height was shown by *V. radiata* and *V. mungo* along with *Mimosa pudica .* It was observed that plant height *S. rostrata* showed slow growth rate at early stage but at 45 DAS it superseded rest of the green manures whereas *C. juncea* showed reverse behaviour as was observed with *S. rostrata.* Variation of plant height over the growth period occurred probably due to individual genetic makeup of the green manure. Pramanik *et al.* (2009) also obtained the similar result, reporting higher plant height in *Sesbania* among evaluating different green manuring crops and stated that, *S. rostrata* gave the highest height followed by S. *aculeata* and *C. juncea.* Romulo *et al.* (2013) studied with different green manuring crops and found that *C. juncea* had the longer height than the other ones. Srivastava and Girjesh (2013) stated that the maximum plant height was observed with *Sesbania spp.* as 111.60 cm at the density level of 50 plants pot^{-1} at 45DAS.



Here, T_1=*S. aculeata*, T_2=*S. rostrata*, T_3= *C. juncea*, T_4=*V. radiata*, T_5=*V. mungo*, T_6=*V. unguiculata*, T_7=*L. leucocephala*, T_8=*M. pudica*

Figure 1. Plant height of different green manuring crops at different days after sowing (DAS) (SE (±) = 2.25 for 15 DAS, 4.08 and 30 DAS and 19.83 for 45 DAS at 2016

Number of leaves plant^{-1}

There was a significant difference in leaves number was observed among the different green manure crops throughout the growth period (Table 1). The leaves of these plants are easily decomposable and reported to contain more protein, and rich sources of nitrogen and phosphorus when used as green manure. At 15 DAS, *Leucaena leucocephala* and *Mimosa pudica,* produced the highest number of leaves whereas *V. mungo* gave the lowest number of leaves plant^{-1} which was similar to *Vigna radiata*. At 30 DAS to 45 DAS, *S. rostrata* produced the highest number of leaves plant^{-1} followed by *Sesbania aculeatea* and the trend was as follows (highest to lowest) *S. rostrata > S. aculeata >V. radiata >L. leucocephala >M. pudica>V. unguiculata > V. radiata.* The *Sesbania rostrata* showed slow growth rate at early stage but at the later stages it superseded all others at 45 DAS. With the time of maturity *Sesbania* species contained lots of branches in comparison to others. *Crotalaria. juncea* showed reverse behaviour as was observed in *S. rostrata.* Variation of leaves number over the growth period occurred probably due to individual genetic makeup of the green manure crops.

Table 1. Number of leaves and dry matter (g/plant) of green manuring crops at different days after sowing (DAS) in two Years

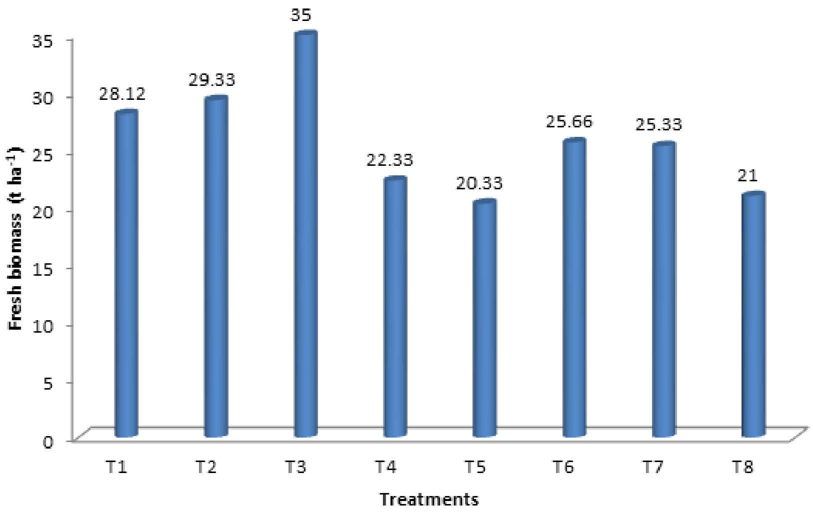
Treatments	**Number of leaves**			**Dry matter (g/plant) at**		
	15DAS	**30DAS**	**45DAS**	**20DAS**	**35DAS**	**50DAS**
T_1	36.12bc	1005.3b	1054.00b	0.89bc	7.11a	9.61ab
T_2	42.38b	1168.00a	1204.70a	1.50ab	7.06a	10.87a
T_3	14.44bc	45.90e	59.50e	.99ab	5.38ab	7.33cd
T_4	12.57bc	469.00c	515.70c	.94ab	5.47ab	6.23de
T_5	11.190c	40.70e	59.70e	.71b	4.66ab	6.00e
T_6	22.70bc	56.70e	58.70e	2.20a	6.44a	8.33bc
T_7	148.00a	315.00d	326.30d	.230b	3.33b	6.60de
T_8	150.00a	320.00d	333.00d	.250b	3.40b	5.86e
SE (±)	**8.45**	**35.70**	**39.46**	**.37**	**.76**	**0.37**
CV(%)	**18.93**	**10.22**	**10.71**	**46.85**	**17.46**	**6.03**

Here, T_1=S. aculeata, T_2=S. rostrata, T_3= C. juncea, T_4=V. radiata, T_5=V. mungo, T_6=V. unguiculata,T_7=L. leucocephala,T_8=M. pudica
In a column, figure(s) followed by the same letter do not differ significantly at 5% level.

Biomass production of green manure crops

Fresh biomass

Fresh biomass was significantly varied among different green manure crops (Fig. 2). At 45DAS, the fresh biomass of green manure crops ranged from 20.33 to 35.00 t ha^{-1} in 2016. *Crotalaria juncea* produced significantly higher fresh biomass (35.00 t ha^{-1}) in 2016 that followed by *Sesbania rostrata* (29.33 t ha^{-1}) and *Sesbania aculeata* (28.12 t ha^{-1}) whereas the minimum fresh biomass was noted in *Vigna mungo* (20.33 t ha^{-1}). It was observed that, *C. juncea Sesbania rostrata, S. aculeata* , *V. unguiculata* and *L.leucocephala* recorded significantly higher (72%,44% 26% and 24%) fresh biomass compared with *V. mungo.* The increase of biomass accumulation of *Sesbania* and *C. juncea* might be due to its fast and determinate growth habit which will enhance soil fertility. Khind *et al.* (1987) opined that Sesbania *aculeata* could produce 21.1 t ha^{-1} of green biomass and accumulate about 133 kg N ha^{-1}. Sanjay *et al*. (2015) reported that among the summer green manuring crops, dhaincha recorded significantly higher total fresh and dry matter accumulation compared with sunhemp.

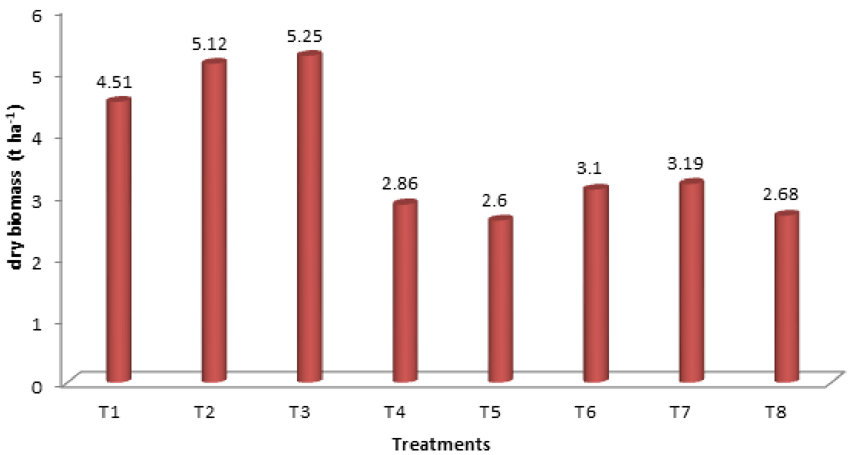


Here, T_1=*S. aculeata*, T_2=*S. rostrata*, T_3= *C. juncea*, T_4=*V. radiata*, T_5=*V. mungo*, T_6=*V. unguiculata*, T_7=*L. leucocephala*, T_8=*M. pudica*

Figure 2. Fresh biomass of different green manuring crops (SE (±) = 0.90 in 2016 year

Dry biomass

The dry biomass of different green manuring crops varied significantly. At 45DAS, the highest dry matter (DM) biomass was obtained from *Crotalaria juncea* (5.25t ha^{-1}) followed by *Sesbania rostrata* and *S. aculeate* (5.12 t ha^{-1} and 4.51 t/ha)) (Fig. 3). The significantly lowest biomass (2.86 t/ha and 2.66 t ha^{-1}) was recorded in *Vigna radiata* and *Vigna mungo.* However, differences in dry biomass between these treatments were statistically significant (P< 0.01). The biomass production might be depending on plant height, number of leaves of the genotype. It appeared that *S.Species, C. juncea* was more efficient for biomass production compared to other green manuring crops. Singh (1981) also agreed with the findings and reported that the most productive green manure crops yielded about 4-5 tha^{-1} of dry biomass in 50-60 days and cluster bean has generally been less productive than *Sesbania*, sunn hemp, and cowpea in descending order. Zaman *et al*. (1995) opined that in Bangladeshi condition, 60 days old dhaincha (*S. aculeata*) plants produced 5.2 t ha^{-1} dry matters which yielded 135 kg N/ha.



Here, T1=*S. aculeata*, T2=*S. rostrata*, T3= *C. juncea*, T4=*V. radiata*, T5=*V. mungo*, T6=*V. unguiculata*, T7=*L. leucocephala*, T8=*M. pudica*

Figure 3. Dry biomass of different green manuring crops (SE (±) = 0.20)

Dry matter production pattern

The pattern of dry matter production of different green manuring crops was studied at 20, 35 and 50 DAS (Table 1). At 20 DAS, *Vigna unguiculata* produced the highest dry matter (2.20 g plant^{-1}) that similar to *Sesbania rostrata* (1.50 g plant^{-1}) and *Crotalaria juncea* but with the advance of time both the *Sesbania spp* along with *Crotalaria juncea* produced the highest dry matter plant^{-1} and it was 60% to 83% compared to *Mimosa pudica.* and *Leucaena leucocephala*. This is due to the vigorous early growth of *sesbania,* which leads to a high amount of biomass being produced within two month before planting any crop. Paisancharoen *et al.* (1990) found that cowpea was the most promising green manure crop, followed by *Crotalaria juncea* and pigeon pea for biomass production.

Nodule production

There was significant variation on nodule production plant^{-1} was observed among green manuring crops up to 50 DAS (Table 2). At 30 DAS, the highest number of nodules plant^{-1} was observed in *S. rostrata* followed by *S. aculeata*, *V.unguiculata,* and *Vigna radiata* and the lowest number of nodules plant^{-1} was observed in *Leucaena leucocephala and Crotalaria juncea*. At 50 DAS, the highest number of nodules plant^{-1} was observed in *S. rostrata* and *S. aculeate* and *C. juncea* and *V. unguiculata* exhibited similar performance and occupied the second highest position. The lowest number of nodules plant^{-1} was observed in *Mimosa pudica.* Variation of number of nodules plant^{-1} might be due to the individual genetic characteristics of green manure crops and this also helps to increase soil fertility by nitrogen fixation. The results were almost similar to the findings of Pramanik *et al*. (2009) who found the highest number of nodules plant^{-1} from *S. aculeata. C. juncea* and *S. rostrata*.

Table 2. Number of nodules plant^{-1} of different green manure crops at different days after sowing (DAS)

Treatments	Nodule /plant	
	35DAS	**50DAS**
T_1	18.06bc	67.78b
T_2	36.53a	158.33a
T_3	11.66bc	32.67b
T_4	15.33bc	23.33b
T_5	12.66c	23.00b
T_6	23.33b	32.33b
T_7	11.00c	21.67b
T_8	12.00c	19.33b
SE (±)	**2.45**	**20.46**
CV (%)	**17.14**	**3.62**

Here, T_1=*S. aculeata*, T_2=*S. rostrata*, T_3= *C. juncea*, T_4=*V. radiata*,T_5=*V. mungo*,T_6=*V. unguiculata*,T_7=*L. leucocephala*, T_8=*M. pudica*
In a column, figure(s) followed by the same letter do not differ significantly at 5% level.

CONCLUSIONS

The plant which produces more leaves, fresh and dry biomass could be potential to increase soil fertility after incorporation. The results revealed that the highest value of plant height, number of leaf, nodule and biomass yield were found from *S. rostrata, S. aculeatea,V. unguiculata,L. leucocephala* and *C. juncea* and the lowest from *V. radiata* followed by *V. mungo, M.pudica* at 45 DAS. These aforementioned species can be cultivated in our land (as the land remained fallow for two months after boro harvesting) for increasing soil fertility through in situ incorporation.

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CONFLICT OF INTEREST

There is no conflict of interest.

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