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INFLUENCE OF GREEN MANURING CROPS ON DRY MATTER PRODUCTION AND SOIL HEALTH IMPROVEMENT

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Abstract

The field experiment was conducted at the Agronomy farm of Sher-e-Bangla Agricultural University to evaluate the impact of different kind of green manures on soil nutrient balance through adding biomass and N,P and K accumulation. Green manuring crops were incorporated after *in situ* cultivation and results showed that, the biomass incorporation increased the N production in soil. The biomass from *Sesbania rostrata, Sesbania aculeata* and *Crotalaria juncea* gave the higher dry matter and nutrient status. Incorporation of *Sesbania rostrata* and *Sesbania aculeata* added more organic matter and nitrogen to the soil after green manure incorporation than the prior soil. However, the improved soil quality was recorded with *S. rostrata* and *S. aculeata* followed by *C. juncea* and *V. unguiculata* incorporation as compared to control (no green manure) and other green manuring crops. The nutrient balance of soil after incorporation of different green manuring crops specially *S. rostrata*, *S. aculeata* and *C. juncea* showed positive balance of nutrients than other green manures.

Introduction

Soil is fundamental to crop production and constitutes the natural resources that provide mankind the most of its food and nutrients. Food production levels of Bangladesh will have to increase rapidly without deteriorating soil quality, if the increasing population of Bangladesh will feed itself by following a suitable eco-friendly cropping pattern.

Green manuring crops are one of the effective measures for soil improvement. Green manures could have benefits for soil N dynamics by recovering residual mineral N in soil, by fixing N from the atmosphere for leguminous green manures, and thereby contributing to subsequent crop N nutrition. Crops legumes are believed to have the potential to enhance yields of subsequent crops through atmospheric nitrogen fixation as well as enhanced mineralization of soil organic N during legume residues decomposition (Jenkinson *et al.*, 1985). According to Biswas *et al.* (1996), incorporation of green manuring crop to the soil reduced 50 percent of recommended N-levels of subsequent rice. Introducing green manure crops in a cropping pattern are not only improving soil nitrogen quality but also helps to reduce fertilizer cost. After harvesting of Boro rice, a large area remains fallow for about 2-3 months. This period could be used to raise green manures without sacrificing main crops. Improve soil and crop productivity, integration of legume cover crops in cropping systems is now being highly emphasized among farmers in the tropics (Odhiambo *et al.*, 2010). Considering the above facts, the present experiment was undertaken to study the feasibility of improving soil quality through green manuring.

Materials and Methods

The field experiment was conducted at the Agronomy farm of Sher-e-Bangla Agricultural University during April - June,2015 to evaluate the impact of different kinds of green manures on soil nutrient balance through adding biomass and N,K and P accumulation. The green manure crops *viz.* Deshi dhaincha (*Sesbania aculeata*), African dhaincha (*Sesbania rostrata*), Sunnhemp (*Crotolaria juncea* L.), Mungbean (*Vigna radiata*), Blackgram (*Vigna mungo*), Cowpea (*Vigna unguiculata*), Ipil-ipil (*Leucaen aleucocephala*) and Mimosa (*Mimosa pudica*) were grown for improving soil fertility along with a control (no green manuring crop). The initial soil of the experimental field (0-15 cm) was collected for analyzing physical and chemical properties before setting the experiment. The experiment was laid out in a Randomized Complete Block Design with three replications. There were eight different green manuring crops along with a control as treatments having three replications. The experimental plots (except control) were fertilized with 20-17.6-24.9 kg N, P and K ha^{-1} from their sources of Urea, TSP and MoP. Fifty days-old green manuring crops were incorporated after *in situ* cultivation. Thirty days after incorporation of green manuring crops, the final soil samples of each experimental plot (0-15 cm) was collected for analyzing physical and chemical properties. The collected data were analyzed statistically by using the Statistic-10 computer package. The mean comparison of all parameters were done with Tukey's W- procedure (Gomez and Gomez, 1984).

Results and Discussion

Fresh biomass

Fresh biomass was significantly varied among different green manure crops (Figure1). The fresh biomass of green manure crops ranged from 20.33 to 35.00 t ha^{-1}. *Crotalaria juncea* produced significantly higher fresh biomass (35.00 t ha^{-1}) that followed by *Sesbania rostrata* (29.33 t ha^{-1}) and *Sesbania aculeata* (28.12 t ha^{-1}). The minimum fresh biomass was noted in *Vigna mungo* (20.33 t ha^{-1}). It was observed that, *Sesbania rostrata* and *C. juncea* recorded significantly higher fresh biomass compared with *S. aculeata* during the time. Again *S. aculeata* recorded significantly higher fresh biomass over *Vigna unguiculata, Mimosa pudica* and *Leucaen aleucocephala*. Singh and Shivay (2014) stated that the increased of biomass accumulation of *Sesbania* might be due to its fast and determinate growth habit leading to enhanced biomass incorporation/addition and nutrient availability in soil. 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 and cowpea in their two consecutive researches.

Dry biomass

The dry biomass of green manuring crops varied significant where the highest dry matter was obtained from *Crotalaria juncea* (5.25t ha^{-1}) followed by *Sesbania rostrata* (5.12 t ha^{-1}) (Figure 1). The significantly lowest biomass (2.60 and 2.86 t ha^{-1}) was recorded in *Vigna mungo* and *Vigna radiata, r*espectively. However, differences in dry biomass between these treatments were statistically significant. Becker *et al.* (1995) was found that the growth of *S. rotrasta* was more vigorous in the wet season (long day period) than in the dry season. 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*, Sunnhemp, and

Cowpea in descending order. Zaman *et al.* (1995) opined that in Bangladesh condition, 60 days old dhaincha (*S. aculeata*) plants produced 5.2 t ha^{-1} dry matters which yielded 135 kg N/ha. It was observed that in case of *S. rostrata, S. aculeata* and *C. juncea* dry biomass yield increased rapidly apparently with the age of plant compared to other green manuring crops. This variation of dry biomass yield may be due to individual genetic makeup of the green manuring crop.

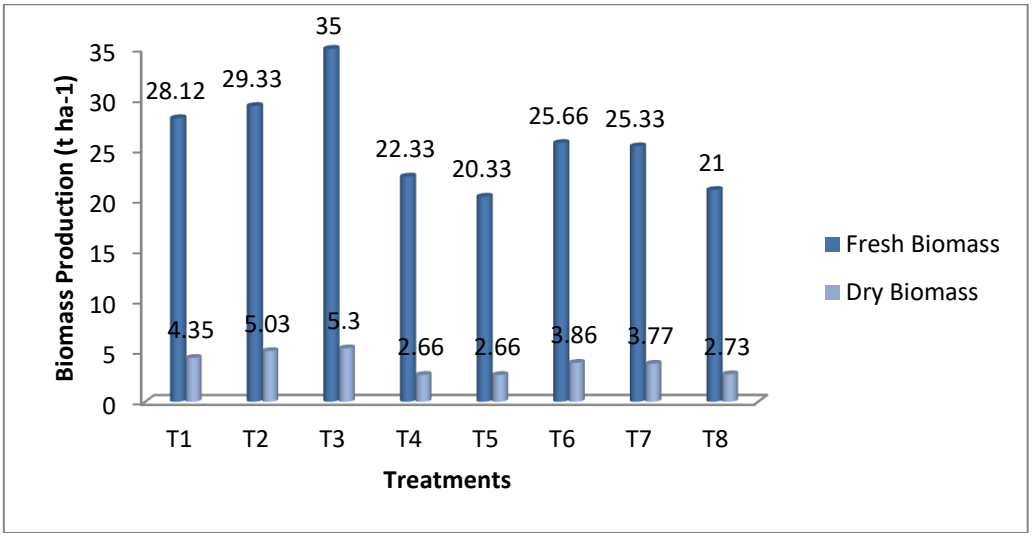

Fig. 1. Fresh and Dry biomass production of different green manuring crops (SE (±) = 0.20). Here, T_1=*S. aculeata*, T_2=*S. rostrata*, T_3= *C. juncea*, T_4=*V. radiata*, T_5=*V. mungo*, T_6=*V. unguiculata*, T_7=*L. leucocephala*, T_8=*M. pudica*

Soil organic matter

Incorporation of eight different green manures, some of them increased the soil organic matter from 1.01 % (initial) level to 1.08 %. The highest organic matter (1.08 % & 1.02 %) was found in T_2 (*S. rostrata*) and T_1 *(S. aculeata*), respectively. Soil organic matter decreased in control plot along with other green manuring plot due to lack of legumes and slow releasing activities of other green manuring crops. *Sesbania aculeata* and *Sesbania rostata* incorporation in soil increased 1 and 7% organic matter compared to control. Higher organic matter and N contents were present because of incorporation of green manures (Biswas and Mukherjee, 1991). Similar results were also observed by Mondal *et al.* (2003). Rahman *et al.* (2013) stated that, after incorporation of dhaincha, the organic matter status of the soils was found slight increase compared to control (organic matter and total N status of soil from dhaincha ranged from 1.42 to 1.58%). Sarwar *et al.* (2017) reported that, both the organic matter content and total nitrogen (%) were increased due to dhaincha incorporation in soil and the amount of organic matter (%) varied from 1.582 to 2.133 before incorporation and 1.995 to 2.271 after incorporation of dhaincha biomass in soil.

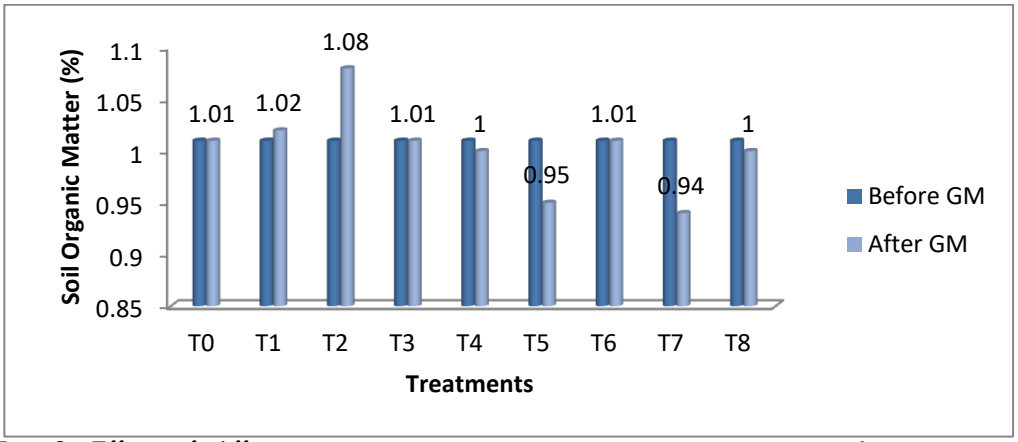

Fig. 2. Effect of different green manuring crops on organic matter changes in soil.

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*

Total Nitrogen

Total N status of soil ranged from 0.04 to 0.084 %. The results pertaining to total nutrients in soil of legumes treated plot is presented in Figure 3. The highest N content of 0.08% was found in T_2 (*Sesbania rostrata)* followed by T_6 (*Vigna unguiculata*). The lowest N content of 0.03% was obtained for T_5 (*Vigna mungo),* which was much lower than its initial soil. The other green manures showed very little increased of total available N in soil. A gradual increasing trend was T_2> T_6>T_7>T_8>T_3>T_1. The lowest N content of 0.041% was obtained from control plot. *S. rostrata* increased 166 % total nitrogen in comparison to *V. mungo* and control. These results suggested that green manuring of *Sesbania* would have increased N fertility of soil because of greatest N contents in their biomass. The increase in total N content of soil due to application of organic manure may be attributed to the mineralization of N by organic manure in soil and greater multiplication of soil microbes, which could convert organically bound N to inorganic form. Actually plant materials used as a green manure differed in their chemical composition, rate of decomposition and nutrient element released to the soil. Other studies have also reported that green manure legumes contain substantial amount of N and other nutrients. Rinaudo *et al.* (1983) reported that N_2 fixed by *Sesbania rostrata* was about 267 kg N ha^{-1}, one third was transferred to the crop and two third to soil. Mann *et al.* (2000) reported that *Sesbania* incorporated plot increased soil N (0.60%) from initial soil (0.48%). Onim (1986) reported that *sesbania* can fixed upto 250 kg N ha^{-1} in six month. Palaniappan (1990) also reported that at 45 days *Sesbania aculeata* and *Sesbania rostrata* accumulated 185 and 219 kg N ha^{-1} respectively. Rahman *et al.* (2013) stated that total N status of soil ranged from 0.075 to 0.098% (initial level 0.078%) after three years of continuous dhaincha biomass incorporation.

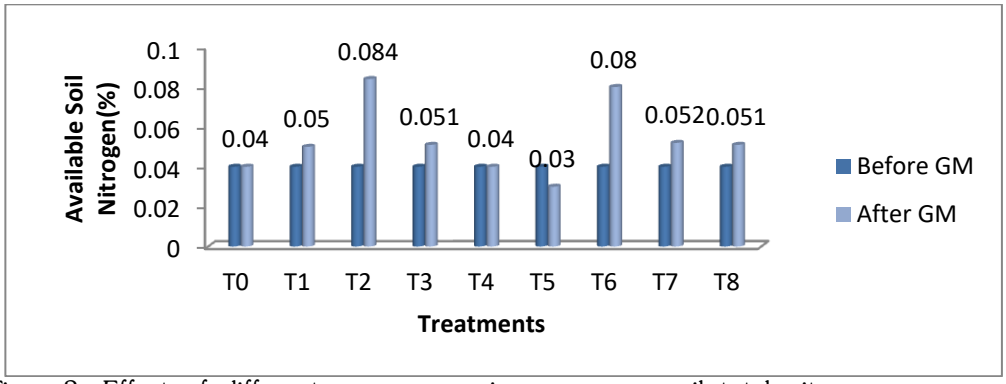

Fig. 3. Effect of different green manuring crops on soil total nitrogen.

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*

Other nutrients (K and P)

Among other nutrients K showed slightly increasing trends (0.22meq/100g) from initial soil (0.18meq/100g) after incorporation of green manures. The highest K content (0.22meq/100g) was found from T_1 (*S. aculeata*) and T_2 (*S. rostrata*) followed by T_3 (0.21meq /100g) and T_4 (0.20 meq/100g) that was superior to initial soils (Table 1). Increased K availability after green manuring has been reported by Kute and Mann (1969), and Debnath and Hajra (1972). In case of P in soil, a declined trend was found compared to initial soil (15.83 ppm). Losses of phosphorous are normally thought to be mainly by surface run off and erosion but sometimes it can be lost through leaching also. Georgantas and Grigoropoulou (2006) opined that, in pH values less than 6 create a chemical bond between aluminum (Al) and phosphate; whereas in higher values of soil pH (6-8), adsorption of phosphate ions occur on solid Al or Fe hydroxide. The P valued decrease may be due to the low pH and P fixation in soil.

Table 1. Changes of soil fertility status of P and K for the incorporation of different green manuring crops

Treatments	P (ppm) level		K (meq $100g^{-1}$) level	
	Initial soil	After GM incorporation	Initial soil	After GM incorporation
T_0	15.83	15.83	0.18	0.18
T_1		12.22		0.22
T_2		15.00		0.22
T_3		14.90		0.21
T_4		11.45		0.20
T_5		12.09		0.18
T_6		11.86		0.18
T_7		12.01		0.19
T_8		13.54		0.20

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=*L.leucocephala*,T_8=*M. pudica*

Conclusion

Four green manuring crops*viz. S. rostrata, S. aculeata, C. juncea* and *V. unguiculata* were found effective for green manuring in terms of their dry matter production, organic matter, nitrogen and potassium contribution. These green manures could be beneficial for nutrient exhaustive different cropping pattern through nitrogen as well as NK fertilizer saving and increase the soil fertility.

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