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Effect of in situ green manuring crops and chemical fertilizer on yield of T. Aman rice and mustard

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ABSTRACT

The experiment was conducted at the Agronomy farm of Sher-e-Bangla Agricultural University to evaluate the effect of different kinds of in situ green manurings along with chemical fertilizer on yield of T. Aman rice and mustard. Fifty days-old green manure crops were incorporated after in situ cultivation and then T. Aman (subsequent crop) and mustard (succeeding crop) were grown with a recommended dose of fertilizer and half of the recommended dose of fertilizer nitrogen ha^{-1}. The biomass from Sesbania rostrata, Sesbania aculeata and Crotalaria juncea with decreasing levels (half of the recommended dose of N fertilizer) of fertilizer in T. Aman rice and mustard gave the higher yield which was equivalent to increased level (recommended dose) of fertilizer application. The highest grain yield of following T. Aman rice (BRRI dhan66) and succeeding mustard crop was recorded at both from recommended and half of the recommended dose N and NPK with S. rostrata and S. aculeata followed by C. juncea and V. unguiculata incorporation compared to control (no green manures).

Key Words: *Green manuring, Subsequent crop, Succeeding crop, In-situ green manuring and Fertilizer economy*

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I. Introduction

Soil could be a principal substance of life on earth, serving as a reservoir of nutrients that provide mankind the foremost of its food and nutrients. Erosion and denitrification are important causes of nutrients loss from soil. Thus nutrient depletion of our soil adversely affects soil quality and crop productivity also. The soil fertility of our country is deteriorating day by day for excessive use of chemical fertilizer, to satisfy up high food production for an unlimited population. The utilization of chemical fertilizers without nutrient recycling has led to an immense loss of soil fertility and productivity (Nand Ram, 2000). Only cereal-cereal based sequences are more nutrient exhaustive and put an important demand on soil resources as compared to cereal-legume sequences (Singh et al., 2011). Using green manuring crops is one of the simplest practices for soil quality improvement and crop productivity also. Because large amounts of nitrogen are added to the soil by green manuring.

The green manures can fix atmospheric inert nitrogen to plant available form through its nodulation and thereby contributing to subsequent crop N nutrition. Legumes usually decay rapidly and have stimulated microbial activity within the first few months after incorporation than non-leguminous crops. Cover crops legumes are believed to possess the potential to reinforce yields of subsequent crops through the atmospheric organic process also as enhanced mineralization of soil organic N during legume residues decomposition (Jenkinson et. al., 1985). Biswas et al. (1996) stated that the incorporation of green manuring crops to the soil reduced 50 percent of recommended N-levels of subsequent rice. Becker et al. (1995) stated that the common amount of nitrogen accumulated by Sesbania species could entirely substitute the mineral fertilizer N within the subsequent rice crop. Application of manure plus chemical fertilizers are found to supply significantly higher yield than that of sole application of chemical fertilizer (Aktar et al., 1993). By adding nitrogen to the soil, manure can improved soil organic matter and minimized the fertilizer requirement. But farmers failed to show any interest to cultivate green manures as the green manure doesn't give directly any cash return to the farmers. After boro season, an unlimited area of farmer's land remains fallow for about two months and this area may use to raise green manures without sacrificing the main crops. For soil and crop productivity improvement, the inclusion of legume cover crops together with chemical fertilizer in our existing cropping systems is now being highly recommended among farmers. Supported the above facts, the current experiment was undertaken to review the effect of in situ green manuring crops and chemical fertilizer on yield of T. Aman rice and mustard.

II. Materials and Methods

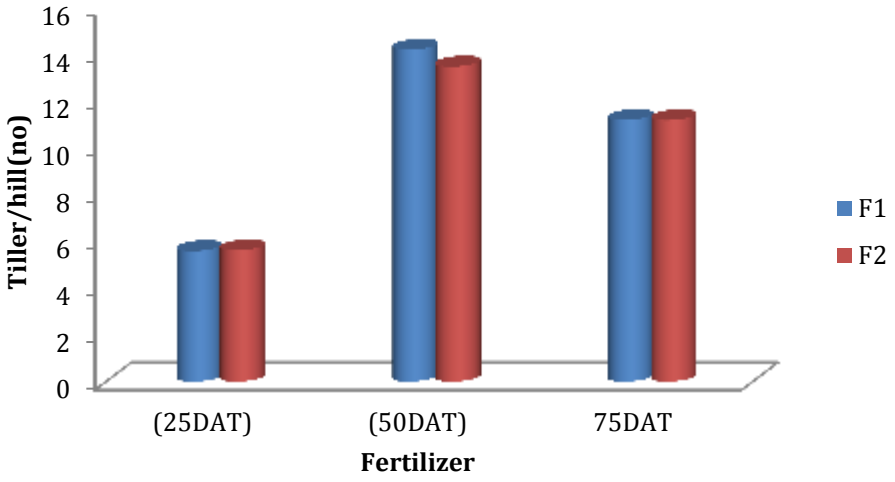
Three field experiments were conducted at the Agronomy farm of Sher-e-Bangla Agricultural University during 2015-2016 to evaluate the effect of different kinds of green manures and chemical fertilizer and finally yield of T. Aman rice (subsequent crop) and Mustard (succeeding crop). The green manure crops viz. Deshi dhaincha (*Sesbania aculeata*), African dhaincha (*Sesbania rostrata*), Sunn Hemp (*Crotalaria juncea* L.), Mungbean (*Vigna radiata*), Blackgram (*Vigna mungo*), Cowpea (*Vigna unguiculata*), Ipil-ipil (*Leucaena leucocephala*) 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 first experiment was laid out in a Randomized Complete Block Design with three replications. There were eight different green manuring crops along with control as treatments having three replications. The total number of the experimental unit was 27 (9 x 3). The experimental plots (except control) 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. Fifty days-old green manure crops were incorporated after in situ cultivation and then T. Aman (subsequent crop) and mustard (succeeding crop) were grown with the recommended dose of fertilizer and half of the recommended dose of nitrogen fertilizer ha^{-1}. The second (T. Aman) and third (Mustard) experiment were laid out in a split-plot design with three replications where fertilizer dose (F_1=100% chemical Fertilizer and F_2=50% Nitrogen along with full dose of PK fertilizer) assigned in the main plots and green manuring crops in the sub-plots. 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). The recommended fertilizer used for the experiments was 200-74-100-67-10 kg N, P, K, S and Zn ha^{-1} from their sources of urea, triple super phosphate, muriate of potash, gypsum and zinc sulphate respectively. The reduction of 50% nitrogen fertilizer was the main basis of the experiment.

III. Results and Discussion

Effect of green manures incorporation and chemical fertilizer on T. Aman yield and yield contributing character

Number of tillers $hill^{-1}$

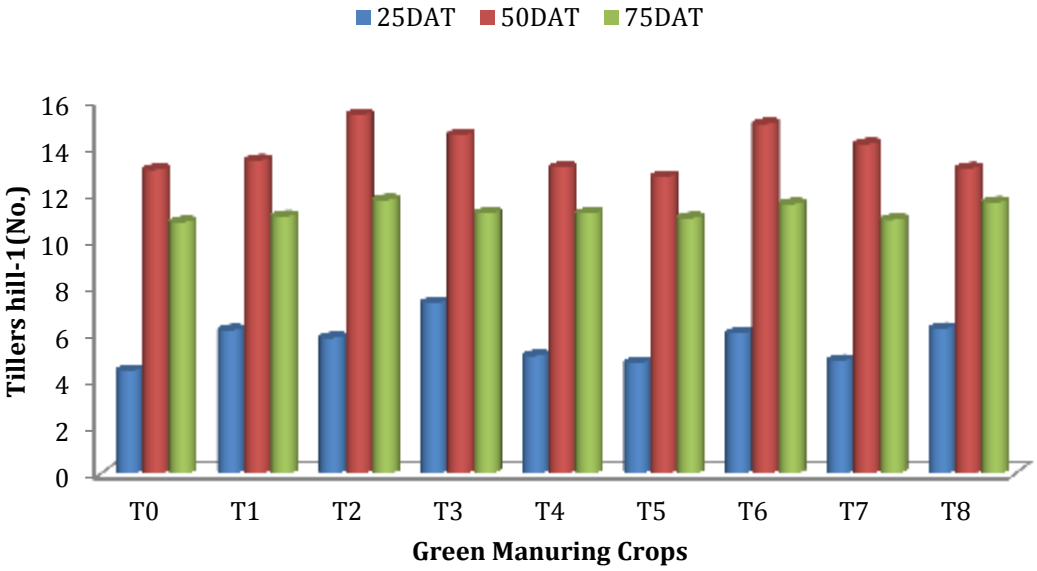
Effect of different levels of N and NPK fertilizers on T. Aman tiller $hill^{-1}$: Number of total tillers $hill^{-1}$ was not influenced significantly due to various levels of nitrogen and NPK at different days after transplanting and the maximum number of total tillers $hill^{-1}$ (5.58, 14.18 and 11.18) was found with 100% NPK ha^{-1} which was statistically similar with 50% N ha^{-1} (5.61, 13.46 and 11.17) at 25, 50 and 75 DAT (Figure 01).



Here, F_1= 100% Fertilizer , F_2= 50% Fertilizer

Figure 01. Effect of fertilizers on tillers hill^{-1} of T. Aman rice at different days after transplanting

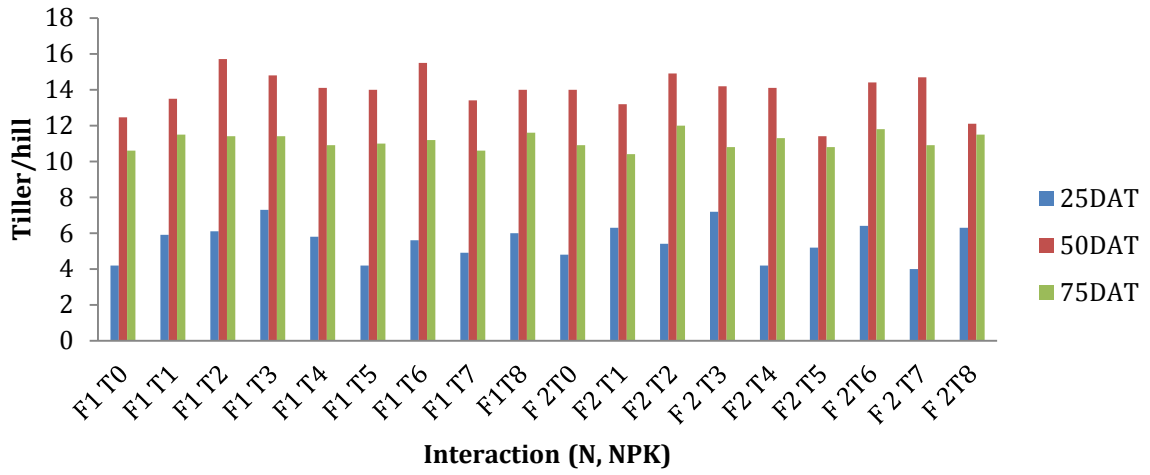
Effect of green manuring crops on tillers hill^{-1} production of T. Aman rice: The maximum number of total tillers hill^{-1} was found from the treatment *S. rostrata* (15.35*)* followed by *Vigna unguiculata* (14.96) and the lowest was from control (13) at 50 and 75 DAT (Figure 02). Bisht et al. (2006) reported that this higher result could be attributed to the higher supply of N and other micronutrient cations through the incorporation of green manures into the soil.



Here, T_0=Control, 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 02. Effect of green manuring crops on tillers hill^1 of transplant Aman rice (SE (±) = 0.525 at 25 DAT)

Interaction effect of green manures and fertilizer (N, NPK) levels: Interaction effect between fertilizer doses and green manuring crops had a significant influence on tiller production hill^{-1} at different days after transplanting (Figure 03). The numerically maximum number of total tillers hill^{-1} was obtained from the variety *S. rostrata* (6.1, 15.7 and 11.4) followed by *Vigna unguiculata* and *C. juncea* (7.3, 14.8 and 11.4) at 25, 50 and 75 DAT when NPK was applied @ 100% ha^{-1} that similar to other interactions with 50% Nha^{-1}. The minimum tillers hill^{-1} (4.2, 12.46 and 10.6) was found from the control in 100% NPK ha^{-1} that was statistically similar to the 50% N ha^{-1} at 25, 50 and 75 DAT. Pramanik et al. (2004) stated that an increasing trend of tillers hill^{-1} was observed from green manuring crops in combination with higher levels of nitrogen.



Here, F_1=100% Fertilizer, F_2=50% Fertilizer; T_0= Control, 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;* NS = Not Significant; In a column, figure(s) followed by same letter do not differ significantly at 5% level.

Figure 03. Interaction effect of fertilizer levels and green manuring crops on the tillers hills^{-1} of T. Aman rice (SE (±) = 0.998)

Number of effective tillers hill^{-1}

Effect of different levels of N and NPK fertilizers: The levels of nitrogen did not significantly influence the number of effective tillers hill^{-1} (Table 01). The maximum number of effective tillers hill^{-1} was recorded in 100% NPK ha^{-1}, which was similar to 50% N ha^{-1}. The results conformed to the findings of Biswas et al. (1996) who stated that the effective tillers hill^{-1} increased with higher nitrogen doses but were similar with 40 kg and 80 kg Nha^{-1}. Additional N was added to the soil through green manuring which helps to make a similar yield from both the fertilizer doses.

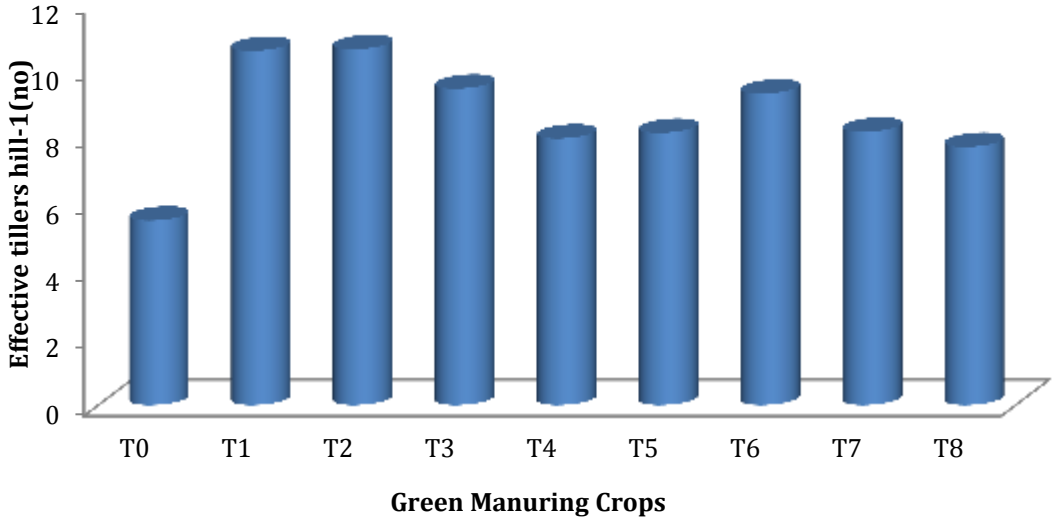
Table 01. Effect of fertilizer levels on number of effective tiller hill^{-1} and number of filled grains panicle^{-1} of transplant Aman rice

Fertilizer levels	No. of effective tillers hill^{-1}	No. of filled grains panicle^{-1}
F_1	8.64	155.01
F_2	8.56	140.03
SE (±)	NS	NS
CV(%)	16.34	10.97

NS = Not Significant, Here, F_1= Recommended dose, F_2= Half of recommended dose

Effect of green manures*:* Number of effective tillers hill^{-1} had shown a significant difference among the green manures (Figure 04). The highest number of effective tillers hill^{-1} (10.63) was recorded inT_2 (*Sesbania rostrata)* plot followed by T_1 (10.58) and the minimum value was found from the control plot (T_0). The T_3 (*C. juncea*) and T_7 (*L. leucocephala*) occupied the third position. As nitrogen encouraged tiller production, so the number of effective tillers hill^{-1} increased with the increase in N fertilization. T_2 (*S. rostrata*), T_1 (*S. aculeata*) and T_6 (*V. unguiculata*) increased soil N through biological N fixation higher than the other green manures. Similar findings were reported by Pramanik et al. (2004) who stated that number of effective tillers hill^{-1} was obtained from the incorporation of *S. rostrata* and *S. aculeata*. The result was in consequence with the findings of Chanda and Sarwar (2017) who stated that number of effective tillers hill^{-1} significantly and positively differed after biomass incorporation of Dhaincha.

Interaction effect of fertilizer (N, NPK) levels and green manuring crops: The effect of interaction between N and NPK levels and green manuring crops was significant in respect of number of effective tillers hill^{-1} throughout the growth period of the crop (Figure 06). The maximum number of effective tillers hill^{-1} was produced by the treatment combination of the *S. aculeata* (10.90 and 10.26) with 50% N ha^{-1} and 100% NPK ha^{-1} which were at par with *S. rostrata* (10.86 and 10.40) with 50% N and 100% NPK dose. The minimum number of effective tillers hill^{-1} was produced in the treatment combination of the control with 50% N ha^{-1} which was statistically similar to 100% NPK ha^{-1}.

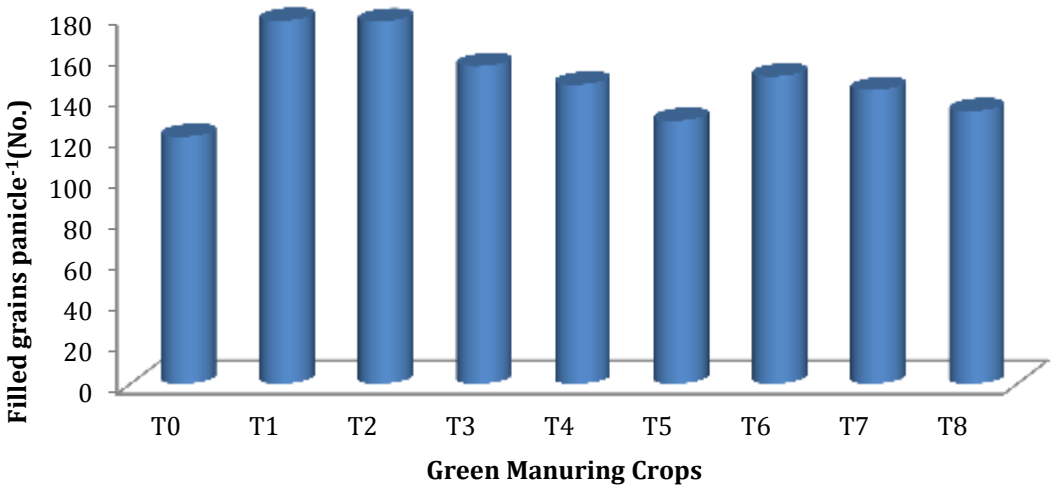


Here, T_0 = Control, T_1=*S. aculeata*, T_2=*S. rostrata*, T_3= *C. juncea*, T_4=*V .radiata*, T_5=*V. mungo*, T_6=*V. unguiculata*, T_7=*L. leucocephala*, T_8=*M. pudica*

Figure 04. Effect of green manuring crops on effective tillers hill^{-1} of T. Aman rice. (SE (±) = 0.812 and 0.678).

Number of filled grains panicle^{-1}

Effect of different levels of N and NPK fertilizers: Number of filled grains panicle^{-1} did not vary significantly due to nitrogen levels (Table 01). The number of grains panicle^{-1} increased with increased levels of N up to 50% to 100% NPK ha^{-1}. The maximum number of grains panicle^{-1} (155.00) was recorded in 100% NPK ha^{-1} which was statistically similar to 50% N (140.03). Biswas et al. (1996) reported a similar finding with the present study where they found that application of 80 kg N ha^{-1} produced the highest filled grains panicle^{-1} but it was similar to 40 kg N ha^{-1}. Similarly, increases of grains panicle^{-1} with increasing nitrogen doses were also reported by (Halepyati and Sheelavantar, 1990).



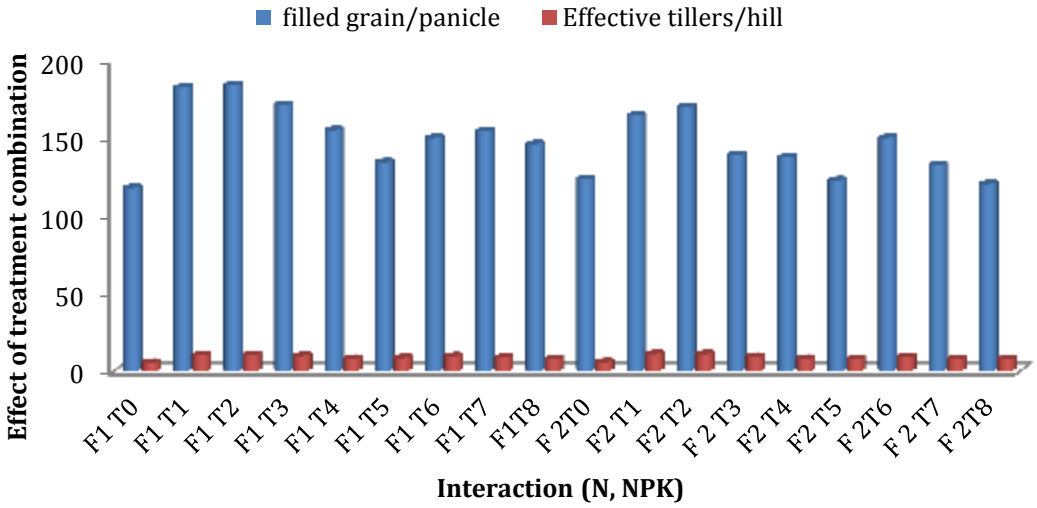
Here, T_0 = Control, T_1=*S. aculeata*, T_2=*S. rostrata*, T_3= *C. juncea*, T_4=*V. radiata*,T_5=*V. mungo*, T_6=*V. unguiculata*, T_7=*L. leucocephala*, T_8=*M. pudica*

Figure 05. Effect of green manuring crops on filled grains panicle^{-1} of T. Aman rice (SE (±) = 9.33 and 4.88)

Effect of green manuring crops: Number of filled grains panicle^{-1} influenced significantly among the green manure treated plots in experimentation (Figure 05). The maximum number of grains panicle^{-1} (177.33) was obtained fromT_1 (*S. aculeata*) followed by T_2 (177) and minimum (120.69) from control.

The variation in filled grains panicle^{-1} production among green manures incorporated plot may be due to their genetic makeup. Rahman et al. (2012) reported similar findings with the present study where they found that the number of filled grain panicle^{-1} obtained from green manuring plot was higher and the lowest from control. The increase in grains panicle^{-1} under green manure might be under additional supply of N in the soil through green manuring. Pramanik (2006) found higher numbers of grains panicle when *S. rostrata* was incorporated in the soil. These results were also in agreement with the findings of some other authors (Hossain et al., 1995; Bhander et al., 1998).

Interaction effect between fertilizer (N, NPK) levels and green manuring crops: Number of grains panicle^{-1} was significantly influenced by the interaction of nitrogen and NPK levels and green manuring crops (Figure 06). The maximum number of grains panicle^{-1} was obtained from the incorporation of *S. rostrata* (184) with 100% NPK ha^{-1} which was statistically at par with the *Sesbania aculeata* in 50% N ha^{-1}. The minimum number of grains panicle^{-1} was obtained from the control where green manure was absent.



Here, F_1= Recommended dose, F_2= Half of recommended dose, NS=Not Significant; T_0=Control, 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.

Figure 06. Interaction effect of fertilizer levels and green manurings crops on the number of filled grains panicle^{-1} and number of effective tiller hill^{-1} of rice

Grain yield

Effect of different levels of N and NPK fertilizers: Nitrogen levels did not vary significantly the grain yield (Table 02). The maximum yield of grain (4.40 t ha^{-1}) was obtained from 50% N ha^{-1} and the minimum yield of grain (4.30 t ha^{-1}) was noted in 100% NPK ha^{-1}. This might be due to the efficient and adequate nutrients supply from dhaincha biomass decomposition and released nutrients for the crop. Again, Bandara and Sangakkara (1993) found that the use of the full complement or 50% of the rate of mineral nitrogen with *Sesbania* produced similar yields. This suggests that the application of in situ mulch with *Sesbania* could reduce the mineral N requirement by 50%, produce rice yields similar to that obtained with the full complement of fertilizers. Beri and Meelu (l98l) also have reported that green manure plus 50% of the recommended fertilizer N resulted in higher rice yields than when recommended N rates were applied.

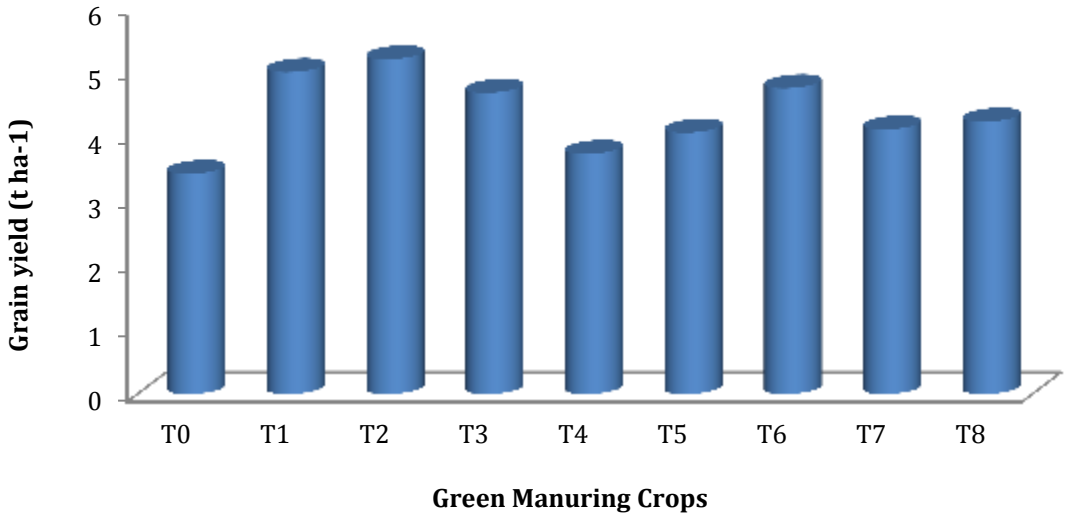
Effect of green manuring crops: Incorporation of green manures had significant influences on grain yield (Figure 07).The highest grain yield was obtained with the incorporation of T_2 (*Sesbania rostrata*) (5.02th^{-1}) followed in order by T_1 (*S. aculeata)* (5.00 t h^{-1}). The T_6 (*V. unguiculata*) and T_3 (*C. juncea*) also produced a higher grain yield of rice. *S. rostrata* increased 52% grain yield compared to control. The increased grain yield may be due to more availability of nitrogen and other nutrients to rice crops released by incorporation of green manure and due to other beneficial effects of green manure. The lowest amount (3.42 t ha^{-1}) of grain yield was obtained without green manure treated plot. Pramanik et al. (2004) stated that the highest grain yield was found with the incorporation of *S. rostrata* followed by *S. aculeata* and *Crotalaria juncea.* Rahman et al. (2012) reported that the incorporation of

green manure *dhaincha* biomass increase rice yield 7 to 39% over control and this might be due to steady and adequate supply of nutrients by the enhanced biochemical activity of microorganisms coupled with large photo synthesizing surface would have helped in the production of more tillers and dry matter with enhanced supply of assimilates to sink resulting in higher yield. Millan et al. (1985) opined that the basal dose of N had been exhausted within 45-50 days and at that time, panicle initiation stage started. They had needed additional nitrogen for their growth and tiller development. The incorporation of *Sesbania* spp. decomposed and supplied extra nutrients to plants that influenced plant growth, yield and yield contributing parameters of rice.

Table 02. Effect of fertilizer levels on grain yield and protein content of transplant Aman rice.

Fertilizer Levels	Grain Yield (t/h)	Protein content
F_1	4.30	8.15
F_2	4.40	8.11
SE (±)	**NS**	NS
CV(%)	**8.87**	1.99

Here, F_1= Recommended dose, F_2= Half of recommended dose, NS = Not Significant



Here, T_0 = Control, 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*

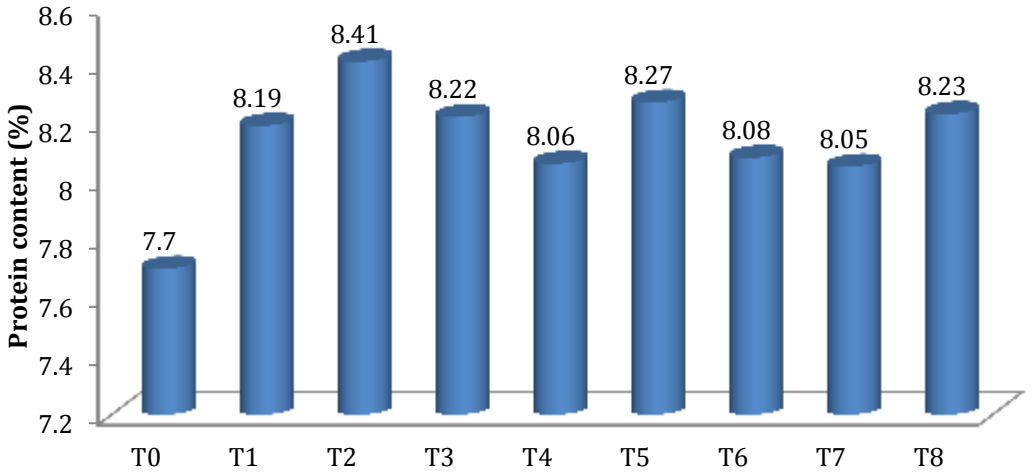
Figure 07. Effect of green manuring crops on grain yield of T. Aman rice (SE (±) =0.223 and 0 .221)

Interaction effect between fertilizers (N/NPK) levels and green manure crops: The combined effect of nitrogen and NPK levels and green manuring crops had a significant influence on grain yield (Table 03). Some green manures (*S. rostrata, S. aculeata, C. juncea*, *V. mungo* and *V. unguiculata)* in combination with 100% NPK dose and rest green manures (*V. radiata*, *L. leucocephala* and *M. pudica*) with 50% N gave better yield over control. The highest grain yield (5.23 t ha^{-1}) was obtained from the treatment combination of the T_2 (*Sesbania rostrata)* followed by T_1 (*Sesbania aculeata*) (5.13 t ha^{-1}) with 100% NPK fertilizer which was statistically similar to the combination of 50% N. On the other hand, the lowest one (3.10 t $ha^{-1}$and 3.68 t ha^{-1}) was obtained by the interaction of the control (absent of green manure) and with the application of 100% and 50% N ha^{-1}. Similar results were found by Hiremath and Patel (1998) reported that nitrogen fertilizer application could be reduced to 50% of the recommended dose due to green manuring. The highest grain yield was recorded in the plot treated with a 75% recommended dose of nitrogen and green manure incorporated at 50 DAS (Islam et al., 2014). Dekamedhi and Medhi (2000) reported that the grain yield of rice was significantly increased due to the application of green manure in combination with fertilizer.

Grain protein content

Effect of different levels of N and NPK fertilizers: Nitrogen had no significant effect on grain protein content. The 8.15% grain protein was obtained from 100% NPK ha^{-1} which was statistically similar (8.11%) with 50% N ha^{-1} (Table 02).

Effect of green manuring crops: The variation in grain protein content was found significant which ranged from 7.70% to 8.41% (Figure 08). The highest grain protein content was recorded in T_2 (*S. rostrata)* (8.41%) followed by T_5 (*V. mungo*) and (8.23%). The lowest result was found in seasonal fallow (no green manures) i.e., control plot (7.70%). Safiqual et al. (2015) reported that the maximum nitrogen and protein content in grain was produced when green manuring crops were incorporated, and that amount was higher than fallow with a higher dose of nitrogen. Singh et al. (1996) opined that N contributed through green manuring might be the reason for increased nitrogen uptake by grain and straw in rice. Pramanik (2006) also reported that higher nitrogen uptake by grain and straw was found with the incorporation of all green manure crops compared to fallow. Pareek et al. (1990) reported that well nodulated *Sesbania* plants may derive up to 90% N from fixation and therefore contribute N to rice. That means the increase in N content was directly related to biological nitrogen fixation and organic matter addition to the soil.



Here, T_0 = Control, 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 08. Grain protein content (%) of T. Aman rice under different green manuring crops (SE (±) = 0.0420).

Interaction effect between fertilizer (N, NPK) levels and green manuring crops: There were significant effects on the interaction of nitrogen and NPK doses and green manuring crops on grain protein content (Table 03). The highest grain protein (8.54%) was in *S. rostrata* with 50% N ha^{-1} followed by *C. juncea* (8.22%) however the value was statistically similar to other crops when subjected to different NPK levels. The lowest one was recorded in the control (7.54%) plot with 50% N ha^{-1}.

Seed yield of Mustard

Effect of different levels of N and NPK fertilizers: Fertilizer dose had a significant effect on seed yield (Figure 09). The numerically maximum seed yield (1209.9 kg ha^{-1} and 11.72 kg ha^{-1}) was produced by 100% recommended fertilizer dose followed by 50 % dose. The cause of yield increment might be due to higher nitrogen consumption and favorable effect of yield contributing characters of mustard. These results conform with that of Mondal and Gaffar (1983) who have observed increased seed yield of mustard by increasing the rate of nitrogen.

Table 03. Interaction effect of fertilizer levels and green manuring crops on the grain yield (t ha^{-1}) and protein content (%) of T. Aman rice

Interactions	Grain yield (t ha^{-1})	Protein content (%)
F_1T_0	3.10 f	7.85 cd
F_1T_1	5.13 a-c	8.17 a
F_1T_2	5.23 a	8.28 a
F_1T_3	4.93 a-d	8.23 a
F_1T_4	3.56 f	8.04 a
F_1T_5	4.20 a-f	8.40 ab
F_1T_6	4.76 a-d	8.10 a-c
F_1T_7	3.96 b-f	8.09 a-c
F_1T_8	3.80 d-f	8.26 a-c
F_2T_0	3.68 d-f	7.54 d
F_2T_1	4.86 a-d	8.21 a-c
F_2T_2	5.16 ab	8.54 a
F_2T_3	4.43 a-e	8.22 a-c
F_2T_4	3.90 d-f	8.04 a-d
F_2T_5	3.93 d-f	8.15 a-c
F_2T_6	4.73 a-e	8.06 a-d
F_2T_7	4.26 a-f	8.01 b-d
F_2T_8	4.66 a-e	8.20 a-c
SE (±)	**0.283**	0.056
CV(%)	**8.87**	1.99

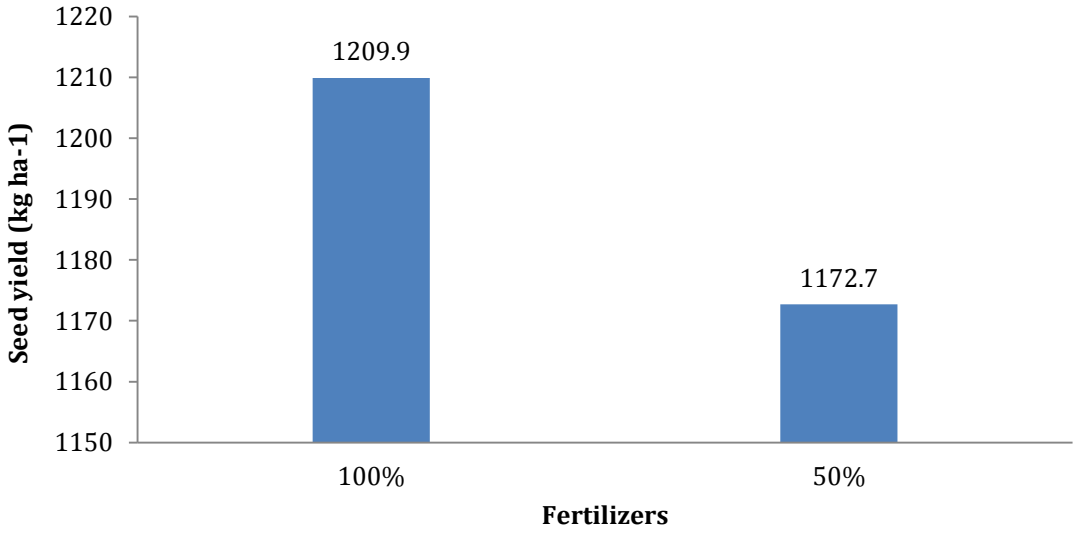


Figure 09. Effect of fertilizer levels on seed yield of mustard

Effect of green manuring crops on mustard seed yield: Green manuring crops had a significant effect on seed yield. Incorporation of T_2 (*S. rostrata)* to the previous rice crop produced higher seed yield of subsequent mustard crop (1594 kg ha^{-1}) and lower yield (837.70 kg ha^{-1}) was produced in control (Figure 10). Production of higher seed yield by the treatments of T_2 (*S. rostrata*) may be due to the contribution of the cumulative favorable effects of the crop characters *viz*- number of siliquae plant^{-1}, seeds siliqua^{-1}, the weight of 1000-seeds. From the experiment, it was observed that the 1st year trial gave maximum yield; it may be due to the residual effect of green manures that provide organic matter after decomposition to the mustard. This organic matter helps in increasing the adsorptive power of the soils for cations and anions. These adsorbed nutrients are released slowly for the benefits of succeeding crops. Aulakh and Pasricha, (1998) stated that the effect of green manuring on enhancing the yield potential of mustard beyond N supply.

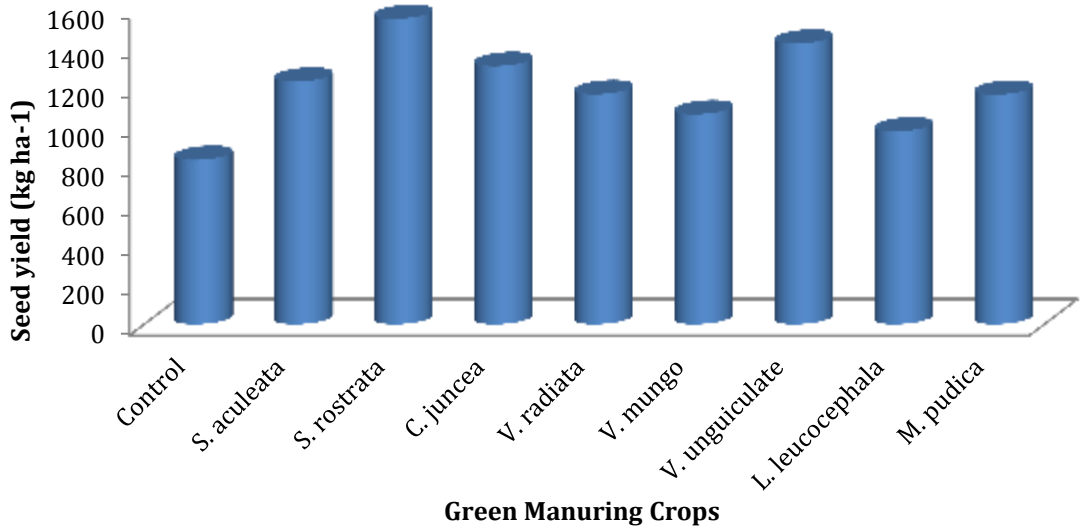
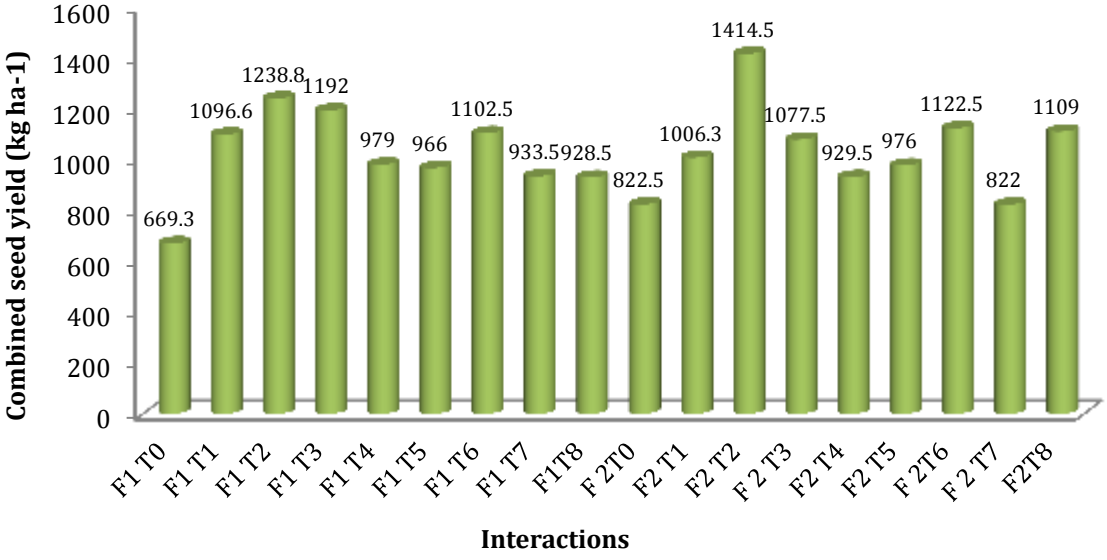


Figure 10. Effect of green manuring crops on seed yield of mustard (SE (±) = 131.69 at 1st year)

Interaction effect of fertilizer and green manuring crops: The highest combined seed yield (1414.5 kg ha^{-1}) by *Sesbania rostrata* with 50% nitrogen fertilizer dose followed by *Vigna unguiculata* and 1238.8.0 kg ha^{-1} with *Sesbania aculeata* by 100% fertilizer dose. The lowest seed yield was obtained from no green manuring treated plots (Figure 11) and *M. pudica* and the seed yield increasing trend $T_2 > T_3 > T_1 > T_6$ with 100 % fertilizer dose. The lowest combined mustard yield was given by control plots.



Here, T_0 = Control, 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 11. Interaction effect of previous fertilizer levels and green manuring crops on seed yield of mustard

V. Conclusion

Considering the above statement, it is concluded that four green manures *viz*. *S. rostrata, S. aculeata, C. juncea* and *V. unguiculata* were found to be effective green manures in terms of nitrogen contribution and specially its incorporation into soil revealed the significant and positive effect of subsequent and succeeding crop yield. The increased rice grain yields (52%) were obtained due to growing and incorporation of *Sesbania rostrata* followed by *S. aculeata* (46%) prior to T. Aman rice. These crops when incorporated into soil with 50% N produced higher and satisfactory yield of T. aman rice compared to that of 100% NPK. The residual effect of *S. rostrata* and *S. aculeata* had also a positive

impact on the following crop mustard. The 50% reduction of chemical fertilizer can be recommended for subsequent T. Aman rice and succeeding mustard crop from followed by growing *Sesbania rostrata, Sesbania aculeata, Crotalaria juncea* or *Vigna unguiculata* as a preceding green manuring crop.

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