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Residual effect of plant biomass on the performance of mustard

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Abstract: A field experiment was carried out at the Agroforestry Farm, Department of Agroforestry, Bangladesh Agricultural University, Mymensingh during November 2006 to February 2007 to investigate the residual effect of plant biomass on the performance of mustard (*Brassica campestris*) cv. Shambal. The experiment included six treatments earlier applied in Aman season of 2006 were T_0 (control), T_1 (Minjiri), T_2 (Ipil-ipil), T_3 (Akashmoni), T_4 (Eucalyptus) and T_5 (Mahogoni). The experiment was conducted in RCBD with 3 replications. Different plant biomass showed significant variation in respect of all the crop characters studied. The yield and yield component such as plant height, number of primary branches plant^{-1}, number of pods plant^{-1}, number of seeds pod^{-1}, grain yield plant^{-1}, oil content, 1000-grain weight, straw yield plant^{-1}, biological yield and harvest index were found highest and the values were 130.52 cm, 4.57, 133.20, 11.60, 3.92 g, 44.34%, 2.84 g, 10.54 g, 14.47 g and 27.17%, respectively at T_0 treatment (control). Among the plant biomass T_5 treatment (Mahogoni) resulted the best performance in terms of plant height (130.30 cm), number of primary branches plant^{-1} (4.43), number of pods plant^{-1} (132.15), number of seeds pod^{-1} (10.94), grain yield plant^{-1} (3.77 g), oil content (44.15%), 1000-grain weight (2.67 g), straw yield plant^{-1} (10.45 g), biological yield (14.22 g) and harvest index (26.51%) and the lowest grain yield plant^{-1} (2.30 g) was obtained from T_2 treatment (Ipil-ipil). Nutrient content of initial and post harvest soil status were the maximum in T_5 treatment (Mahogoni) and minimum in T_0 treatment (control). Therefore, broad and thick leaves of tree like Mahogoni decompose/releases nutrient slowly and residual effect of plant biomass produced almost similar yield as compared to control where recommended fertilizers were used.

Keywords: Leaf biomass, Residual effect, Yield contributing parameters, Mustard.

Introduction

Mustard (*Brassica spp*.) is one of the most important oil crops of the world after Soybean and Groundnut (FAO, 2002) and it tops the list among the oilseed crops grown in Bangladesh in respect of both production and acreage (BBS, 2001). Bangladesh has been in short 65-70% of the demand of the edible oil. As a result, a huge amount of foreign currency is being drained out every year for importing oil and oilseeds from abroad. Most of the soils of Bangladesh have less than 1.5% organic matter and in some cases less than 1% (BARC, 1997). Continuous use of chemical fertilizers for long time may cause the depletion of soil organic matter in addition to cause micronutrient deficiencies. Organic matter plays a very important role in preserving the fertilizer and productivity of soil. It acts as a reservoir of plant nutrient (mainly for N, P, K and S) and prevents leaching of the elements which are vital to plant growth. The most important requirement of mustard production is to supply N and to regulate the immobilization and mineralization of N in the soil. The addition of organic matter is useful in maintaining or increasing the organic substances or nitrogenous compounds in soil which are decomposed slowly but steadily. The use of plant biomass and the proper management may reduce the need for chemical fertilizers thus allowing the small farmers to save in part the cost of the production. In addition to being good sources of plants nutrients, plant biomasses improves the physical, chemical and biological properties of soil and thus helps increase and conserve the soil productivity. The combined use of organic and inorganic fertilizers might be helpful for sustainable crop production and maintenance of soil fertility. Nambian (1991) indicated that integrated use of organic manures and chemical NPK fertilizers would be quite promising not only providing greater stability in production, but also in maintaining higher soil fertility status. Plant biomass is a good source of organic matter. It contains 0.35% N, 0.25% P_2O_5 and 0.15% K_2O. Plant biomass releases nutrient slowly so that nutrient loss is less followed by more plant uptake. Plant biomass and its residual effect is a good source of nutrient and provide an opportunity to uptake nutrients by plant for a long time. The addition of plant biomass and its residual effect accelerates the development of the mustard root system which elongates both at the surface level and in deep soil and produces many branches having a large active surface. Plant biomass and its residual effect may play a vital role in solving the problem of nutrient deficiency in soil as well as in improving soil health. Its residual effect may reduce the need for chemical fertilizers allowing the small farmers to save a part of the cost of production. Keeping the above points in view, an experiment was conducted to determine the residual effect of plant biomass on the yield and yield contributing characters of mustard and find out the suitable tree species with possible residual effect in the crop land Agroforestry.

Materials and Methods

The research work was undertaken to examine the residual effect of plant biomass on the performance of mustard cv. Shambal at the Agroforestry Field Laboratory of Bangladesh Agricultural University, Mymensingh, during the period of November 2006 through February 2007. The plant biomass i.e. plant leaf was incorporated in the previous crops grown in Aman season @ 5 t ha^{-1} which considered as the treatments namely T_1 = Minjiri leaves (*Cassia siamea*), T_2 = Ipil-ipil leaves (*Leucaena leucocephala*), T_3 = Akashmoni leaves (*Acacia auriculiformis*), T_4 = Eucalyptus leaves (*Eucalyptus camaldulensis*), T_5 = Mahogoni leaves (*Swietenia macrophylla*) along with a control (T_0) where only recommended fertilizers were used. The leaf of locally grown tress viz. Mahogoni, Eucalyptus, Ipil-ipil, Minjiri and Akashmoni were collected and dried prior to incorporation. The date to incorporation of leaf biomass was 15th July, 2006 and it was done at random in each block. The plant biomass was well mixed with the soil and then left to decompose. The entire experimental area was divided into three blocks representing three replications to reduce soil heterogeneity and each block was sub-divided into 6 unit plots with raised bunds as per treatments. Thus, the total number of unit plots was 18 (6 treatments × 3 replications). The unit plot size was 1 m × 1 m. The treatments were randomly distributed to each block. The experiment was designed in RCBD and the plots were maintained as permanent plot over previous three cropping cycles. Seeds of mustard were shown on the 16 November, 2006 at the rate of 7 kg/ha by broadcasting method. Intercultural operation was maintained properly and the crop was harvested plot wise when 90% siliqua were matured. Ten plants plot^{-1} were selected randomly for data collection and the parameters were Plant Height, Branches plant^{-1}, Pods plant^{-1}, Seeds pod^{-1}, Weight of 1000-seeds, Seed yield, Stover yield, Biological yield and Harvest index. Initial and final soil sample was analyzed in the year 2007. The mechanical and chemical analysis of the initial soil was done following the standard methods viz. total nitrogen (Page *et al*., 1989), available P (Olsen *et al*., 1954) and exchangeable K (Page *et al*., 1989). Post harvest soil was collected from each plot separately from a depth of 0-15 cm and cleaned, air-dried, ground and sieved through a 2 mm (10 mesh) sieve. The soil samples were analyzed for total nitrogen, available P and exchangeable K as per the following methods: The collected data were analyzed statistically by using the ANOVA technique and the mean comparison was carried out by DMRT (Gomez and Gomez, 1984).

Results and Discussion

Plant height

The result reveals that the tallest plant (130.52 cm) was found in the treatment T_0 (control) (Table 1). Among the five plant biomass treatments T_5 treatment (Mahogoni) produced the tallest plant (130.3 cm). The shortest plant (114.53 cm) was recorded in the T_2 (Ipil-ipil) as compared to T_0 treatment (control). Rich nutrient content (NPK) of the plots with T_5 (Mahogoni) might has a positive effect on plant height. Singh *et al*. (1998) studied the direct and residual effect of nutrient management practices on mustard. They reported that use of plant biomass which contain higher amount of NPK gave significantly highest plant height.

Number of pods plant^{-1}

The result reveals that maximum number of pods plant^{-1} (133.2) was produced under T_0 treatment (Table 1) and among the different plant biomass treatment T_5 treatment (Mahogoni) produced the best number of pods plant^{-1} (132.15) and the minimum number of pods plant^{-1} (107.46) was observed at T_2 treatment (Ipil-ipil).

Number of seeds pod^{-1}

The result showed that the highest number of seeds pod^{-1} (11.6) produced by the T_0 treatment (Table 1) and among the different plant biomass treatments T_5 (Mahogoni) recorded the highest number of seeds pod^{-1} (10.94). The lowest number of seeds pod^{-1} (8.8) was found under T_2 treatment (Ipil-ipil).

1000-grain weight

Residual effect of plant biomass on 1000-grain weight was significantly influenced (Table 1). The result observed that the highest 1000-grain weight (2.84 g) was produced under T_0 (control) treatment. Among the plant biomass treatments T_5 (Mahogoni) produced the highest 1000-grain weight (2.67 g) and the lowest 1000-grain weight (2.47 g) was obtained from T_2 treatment (Ipil-ipil).

Straw yield plant^{-1}

Residual effect of plant biomass influenced significantly on straw yield plant^{-1} (Table 1). Among the treatments the highest straw yield plant^{-1} (10.54 g) was obtained from T_0 treatment (control) but incase of residual plant biomass the highest straw yield (10.45 g). The lowest straw yield plant^{-1} (8.85 g) was found in T_2 treatment (Ipil-ipil).

Table 1: Residual effect of plant biomass on the yield and yield contributing characters of mustard

Treatment	Plant height (cm)	No. of pods plant^{-1}	No. of seeds pod^{-1}	1000-grain weight (g)	Straw yield plant^{-1} (g)	Yield t ha^{-1}	Harvest index (%)
T_0 (Control)	130.52 a	133.20 a	11.60 a	2.84 a	10.54 a	1.96 a	27.17 a
T_1 (Minjiri)	123.87 ab	121.07 b	9.20 b	2.52 bc	9.36 bc	1.49 b	24.09 b
T_2 (Ipil-ipil)	114.53 b	107.46 c	8.80 b	2.47 c	8.85 c	1.15 c	20.63 c
T_3 (Akashmoni)	127.27 a	125.36 b	9.43 b	2.61 bc	10.02 ab	1.6 b	24.27 b
T_4 (Eucalyptus)	126.47 a	123.70 b	9.27 b	2.6 bc	9.7 abc	1.59 b	24.65 ab
T_5 (Mahogoni)	130.30 a	132.15 a	10.94 a	2.67 b	10.45 a	1.89 a	26.51 ab

In a column, figures having similar letter(s) or without letter do not differ significantly whereas figures bearing dissimilar letter differ significantly (as per DMRT).

Total grain yield

It was observed that the residual effect of plant biomass on total grain yield was statistically significant (Fig. 1). The highest grain yield (1.96 t ha^{-1}) was found at T_0 (control) treatment which was also statistically significant with T_5 treatment. Among the plant biomass T_5 treatment (Mahogoni) produced the highest (1.89 t ha^{-1}) and T_2 treatment (Ipil-ipil) produced (1.15 t ha^{-1}) the lowest grain yield $plant^{-1}$. Rajput and Warsi (1992) reported that residual plant biomass increase the grain yield. The present findings are in agreement with the findings of Naklang *et al.* (1999), Meelu and Morris (1984), Chaphale and Badole (1999); Ahmed and Rahman (1991).

Harvest index

Harvest index was significantly affected by residual plant biomass (Table 1). Among the treatments the highest harvest index (27.17%) was found in T_0 treatment (control) but incase of residual plant biomass, the highest harvest index was recorded from T_5 treatment (Mahogoni). The lowest harvest index (20.63%) was obtained from T_2 treatment (Ipil-ipil).

Residual effects of plant biomass as supplement of chemical fertilizer (NPK)

Total nitrogen content of soil: The result showed that in initial soil the highest N content (0.175%) was observed in T_5 (Mahogoni) and the lowest (0.063%) was in T_0 treatment (control); while in the post harvest soil, the highest N content (0.151%) was obtained from T_5 treatment (Mahogoni) and the minimum at T_0 treatment (control) (Fig. 1). Residual effect of five plant biomass treatments was found to increase in N content and they were in the order $T_5 > T_3 > T_4 > T_1 > T_2$ (Fig. 1). The N content of the post harvest soil were found to be decreased in all the treatment as compared to the initial soil. The decreasing trend of soil N content observed in the present study might be due to final decomposition of organic matter and its uptake by mustard crop. Similar results were obtained by Biswas (1979) in their study on the effect of plant biomass on soil aggression.

Exchangeable potassium in the soil: the exchangeable potassium in the initial soil status was found highest (0.298 meq/100 g) in T_5 treatment (Mahogoni) and the lowest (0.185 meq/100g) at control (T_0) treatment and the post harvest soil, the exchangeable K found the soil ranges from 0.185 to 0.288 me/100 g. The maximum value of exchangeable K (0.288 me/100 g) was observed T_5 treatment (Mahogoni) and minimum value where as T_0 treatment (control) (Fig. 3). Prasad *et al.* (1991) reported that K availability increased significantly by the incorporation of organic wastes. The amount of K mineralized increased significantly and raised the available K pool in soil due to release of more organically bound potassium in course of decomposition of organic wastes.

From the present study, it appears that thick leaves releases nutrient slowly and has residual effect on the succeeding crops.

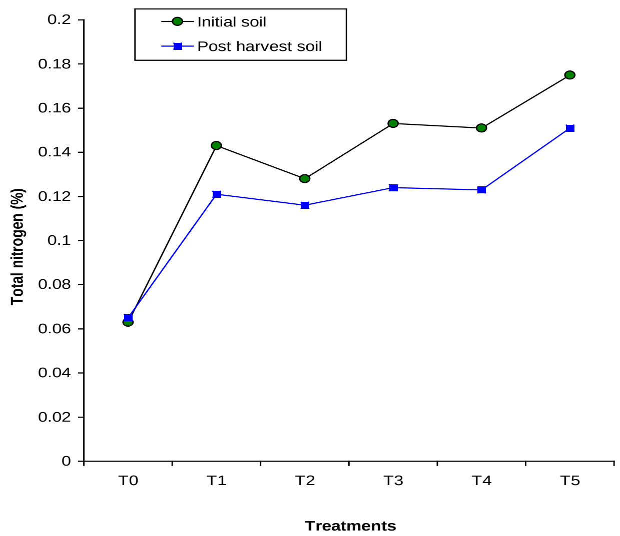

Fig. 1: Residual effect of plant biomass on total nitrogen (%) in soils

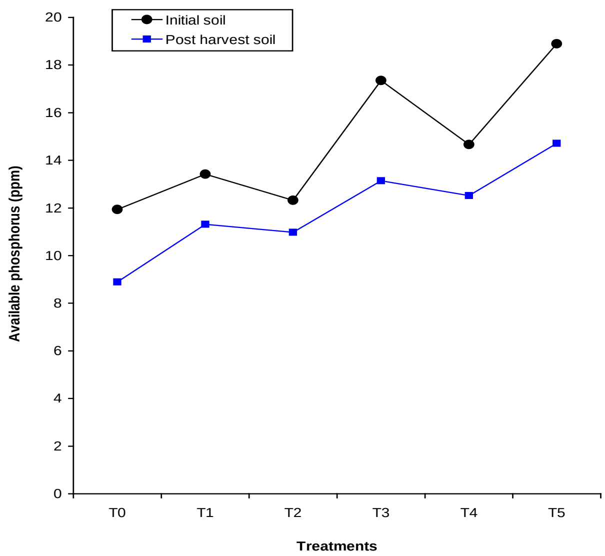

Fig. 2: Residual effect of plant biomass on available phosphorus (ppm) in soils

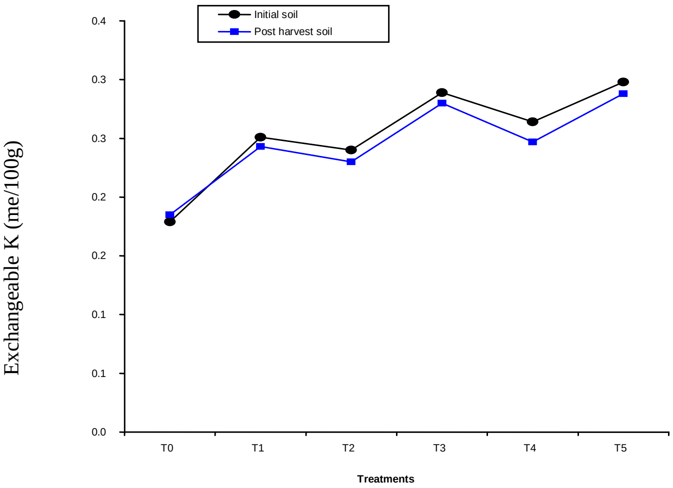

Fig. 3: Residual effect of plant biomass on exchangeable potassium (me/100 g) in soils

Available phosphorus in the soil: The result presented in the Fig. 2 indicated that the residual effect of five plant biomass treatment as regard to the available P content in the initial and post harvest soil was maximum at T_5 treatment (Mahogoni), 18.89 ppm and 14.71 ppm, respectively and minimum at T_0 treatment (control), 11.93 ppm and 8.89 ppm, respectively. Singh *et al*. (1998) found that the amounts of literfall and the soil composition, organic carbon as well as available P increased by application of plant biomass.

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