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EFFECTS OF DIFFERENT TREE LEAF LITTERS ON GROWTH AND YIELD OF OKRA IN MODHUPUR FOREST SOIL

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ABSTRACT

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A pot experiment was conducted in the open net house of the department of agricultural chemistry, Bangladesh Agricultural University, during 20th March to 15th July 2006, to study the effects of different tree leaf litters and chemical fertilizer on the growth and yield of okra in Modhupur soil**.** The experiment was laid out in Completely Randomized Design (CRD) with three replications and twelve treatments viz. T_A: Acacia (*Acacia auriculiformis*), T_B: Bohera (*Terminalia bellirica*), T_G: Gamer (*Gmelina arborea*), T_F: Chemical fertilizer, T_S: Sal (*Shorea robusta*) and T_0: Control (No leaf litter i.e. soil only) and also two varieties were V_1: Local dherosh and V_2: BARI dherosh-1. All the leaf litters were applied @ 20 ton per hectare and recommended dose (N_{69} P_{30} K_{60} S_{20} kg ha^{-1}) of chemical fertilizers. Different leaf litters had significant effect on the growth and yield of okra. The performance of BARI dheros-1 was better than the local one. Among the treatments fertilizers gave highest (13.08 t ha^{-1}) yield and lowest (5.79 t ha^{-1}) in control treatment. The interaction effect (T_FV_2) gave highest yield (14.78 t ha^{-1}) and the lowest (5.76 t ha^{-1}) in T_AV_1 treatment. In some cases Acacia and Bohera showed identical result with chemical fertilizers.

Key words*: tree leaf litters, growth, yield and okra*

INTRODUCTION

Bangladesh occupies 17.5% forest areas of the total land and Modhupur is one of the largest forest covering 0.12 million ha have great scope to increase soil health by using different tree leaf litters which fall much amount every day. Litter plays a fundamental role in the nutrient turnover and in the transfer of energy between plants and soil, the source of the nutrient being accumulated in the upper most layers of the soil (Singh 1971). Through decomposition, the nutrients within leaf litter are converted into a form available for uptake by vegetation and thereby exercising a critical control on vegetation productivity (Mitch and Gosselink, 1993; Groffman *et al.* 1996). Modhupur evergreen forest which located in Madhupur plays an important role in both ecological and economic terms of Bangladesh. This forest helps us to restore the productivity of the area and to reduce the weed populations after the agricultural use of the site.

They are also source of a variety of products, which vary from edible plants to plants used for handicrafts. These forests are usually located close to human settlements and are particularly suitable for the extraction of forest products. Sal, Teak, Acacia, Gorgon, Eucalyptus, Koroi, Mahogany etc. are the major tree species in tropical deciduous Sal forest in Bangladesh. A lot of leaf liters, twigs are fallen on the ground of this forest soil every year which play a vital role to enrich the forest soil with organic matter content and are naturally decomposed and released nutrients for forest plants. These forest tree leaf litters contain higher amount of organic mater, N, P, K, Ca, Mg, S and other trace element can be applied for the production of agricultural crops in the surrounding areas of the forest.

Okra (*Abelmoschus esculentus*) is one of the most important pod vegetables in sub-tropical and tropical regions belonging to the family of Malvaceae. It plays an important role in vegetable market during summer season when the supply of vegetable is acute. But unfortunately the production of this popular vegetable is very low according to our demand. So the production of this vegetable should be increased to meet up our increasing demand. The decomposed leaf litters are considered as the promising alternative of nutrient source of cowdung for successful crop production in the concerned areas. The decomposition of Sal, Bohera, Gamer, and Acacia tree leaf litters need more delving research attention and by using this asset can be compensated different organic and chemical fertilizers. Unfortunately no work has been done in the past on our forest and the effect of leaf litter on the growth, yield and quality of crops. Considering above facts, an experiment was conducted on okra to see the performance of some tree leaf litters of Modhupur forest in Modhupur soil with the objective, to observe the effects of different forest tree leaf litter and chemical fertilizer on the growth and yield of okra.

MATERIALS AND METHODS

A pot experiment was carried out on okra during 20th March to 15th July 2006, in the open net house of the Department of Agro-forestry, Bangladesh Agricultural University (BAU), Mymensingh. The experiment was laid out in Completely Randomized Design (CBD) with three replications. Twelve treatment combinations were used in

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this experiment. The treatments were T_A: Acacia (*Acacia auriculiformis*), T_B: Bohera (*Terminalia bellirica*), T_G: Gamer (*Gmelina arborea*), T_F: Chemical fertilizer (N_{69} P_{30} K_{60} S_{20} kg ha^{-1} as recommended dose), T_S: Sal (*Shorea robusta*) and T_0: Control (No leaf litter i.e. soil only). Different leaf litter and their applied form (ground) are presented in Fig. 1a-4b. Varieties were V_1: Local dherosh and V_2: BARI dherosh-1. All the leaf litters were applied @ 20 ton per hectare and chemical fertilizers were applied @ recommended (N_{69} P_{30} K_{60} S_{20} kg ha^{-1}) dose.

Fig. 1a. Leaf litter of Acacia *(Acacia auriculiformis)*

Fig. 1b. Ground leaf litter of Acacia used as amendments

Fig. 2a. Leaf litter of Bohera (*Terminalia bellirica*)

Fig. 2b. Ground leaf litter of Bohera used as amendments

Fig. 3a. Leaf litter of Gamar (*Gmelina arborea*)

Fig. 3b. Ground leaf litter of Gamar used as amendments

Fig. 4a. Leaf litter of Sal (*Shorea robusta*)

Fig. 4b. Ground leaf litter of Sal used as amendments

In order to conduct the study, Modhupur Sal forest, Talky, Modhupur was selected to conduct the study. The soil used in this experiment was collected from this selected area of the concern forest. The initial surface soils of 0-15 cm depth were collected from there on 10th March of 2007. The land was fallow when soil samples were collected. The soil samples were put into bags and were taken to the laboratory. The collected soils were air dried, sun dried for several days, ground, plant residues and other extraneous materials were removed and were sieved through 10-mesh sieve and mixed thoroughly. This whole process was done several times until adequate amount of soil was prepared for the experiment. Acacia (*Acacia auriculiformis*), Bohera (*Terminalia bellirica*), and Gamer (*Gmelina arborea*), Sal (*Shorea robusta*) leaf litter were collected from different locations of Modhupur Sal forest. The samples were then brought to the laboratory of the department of Agricultural Chemistry. The composite samples were washed and dried under open sunlight followed by oven drying at 60^0C for 48 hours and ground in a steel grinding mill containing a fine sieve. Prepared samples were stored in desiccators before using. Before use of these leaf litters, chemical analysis was done by using standard methods of analysis in Soil Science Division, BARI, Gazipur. To conduct the experiment BARI dherosh-1 and local variety were selected and seeds were collected from the Bangladesh Agricultural Research Institute (BARI), Joydebpur and (12 x 12 $inch^2$) earthen pots were arranged and each pot was poured with 8 kg finely ground sieved soil. The ground leaf litter were added to the pot and mixed with the soil very well and then the soil was saturated with water and allowed to keep for 15 days for the well decomposition of the leaf litter. After 15 days 3 seeds were sown uniformly in each pot. The chemical fertilizers were mixed with soil in the previous day of sowing. The urea fertilizer was applied at two installments. Thinning was done at 7 DAS and finally one healthy plant was kept in each pot. Irrigation and other intercultural operations were done if where necessary.

Table 1. Chemistry of different leaf litters and initial soil status of Madhupur experimental site

Samples No.	pH	OM %	Ca	Mg	K	Total N %	P	S	Cu	Fe	Mn	Zn
			meq100g^{-1}				µg g^{-1}					
Sal	-	5.92	0.78	0.35	0.66	0.98	0.05	0.08	24	630	360	62
Bohera	-	8.98	3.42	0.50	0.78	1.12	0.13	0.12	15	330	159	38
Acacia	-	7.87	1.32	0.28	0.72	1.96	0.04	0.12	12	450	135	34
Gamar	-	6.63	1.82	0.34	0.72	1.68	0.14	0.14	12	510	116	75
Initial soil	4.7	1.54	2.1	1.2	0.35	0.082	20.0	25.0	0.28	422	60.0	2.0

Note: meq = Melli-equivalent

Data were collected on plant height (cm), number of branch per plant, date of first harvest (DAS), fruit length (cm), fruit diameter (cm), total number of fruits per plant, weight of individual fruit (g), yield (t ha^{-1}) and total biomass (t ha^{-1}). The harvesting was done during 80 to145 days after sowing. The collected data viz. yields parameters were statistically analyzed by F-test to examine the treatment effects and the mean differences were adjudged by Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984). The software package MSTAT was followed for statistical analysis.

RESULTS AND DISCUSSION

Effect of different tree leaf litters and chemical fertilizers on the yield and yield contributing characters have given below:

Plant height

The different tree leaf litters significantly influenced the plant height of okra (Table 2). The tallest plants (154.3 cm) were found from the application of chemical fertilizers, which is followed by Acacia leaf litter (140.3 cm) whereas the shortest was found from Sal leaf litter (122.7 cm). Giller *et al*. (1998) reported that Acacia as a leguminous tree fixes higher amount of atmospheric N_2 in soil which might be reflected on the height of okra. Results also showed that plant height of okra was varied significantly with crop variety (Table 3). Local variety (134.83 cm) was found taller than BARI dherosh-1 (127.88 cm). The results revealed that different tree leaf litter and okra variety did not interact significantly with each other in plant height (Table 4). Chemical fertilizers when applied to the local variety produced the tallest plant (156.7 cm) followed by fertilizer with BARI dherosh-1 (152.0 cm). The shortest plants (95.67 cm) were produced from BARI dherosh-1 when grown in control. The highest dose of nitrogen might have enhanced cell division and formation of more tissues resulting in luxuriant vegetative growth and thereby increased plant height (Meyer and Anderson, 2003).

Table 2. Effect of different tree leaf litters on the yield and yield attributes of okra

Treatments	Plant height (cm)	Branch plant^{-1} (no.)	Days to 1st harvest	Fruit length (cm)	Fruit diameter (cm)	Fruits plant^{-1} (no.)	Individual fruit wt. (g)	Yield pot^{-1} (g)	Total yield (t ha^{-1})	Total biomass (t ha^{-1})
Acacia	140.3	6.33	68.83	9.16	1.58	10.17	12.17	123.3	5.79	3.75
Bohera	137.0	6.33	69.00	11.17	1.60	13.67	16.50	200.7	10.20	4.39
Gamer	134.5	6.33	69.50	9.16	1.41	13.33	15.83	198.8	9.38	4.30
Fertilizer	154.3	7.50	65.67	13.17	1.68	16.83	19.50	278.5	13.08	4.94
Sal	122.7	4.16	75.00	8.17	1.28	9.00	11.33	102.8	4.87	3.80
Control	99.33	2.66	81.17	4.51	1.23	7.00	9.16	64.67	2.00	3.48
LSD (0.05)	4.097	1.129	2.836	1.456	1.1258	1.635	1.630	21.63	1.207	0.1258
CV%	5.86	6.75	4.90	6.48	7.79	7.95	8.11	6.39	6.48	5.21
Sig. Level	**	*	*	*	*	**	*	*	*	*

Number of branches per plant

Results showed that number of branches per plant was also differed significantly by the application of different leaf litters (Table 2). Maximum number of branches (7.5) was obtained from the treatment where chemical fertilizers used and the second highest number of branches (6.33) was given by Acacia leaf litter application which is identical with the treatment where Bohera and Gamer leaf litters were used. Giller *et al.* (1998) also observed that leguminous trees like Acacia (*Acacia auriculiformis)* are widely used as the N_2 fixing species and have potential for restoration of soil fertility as wel as increase the number of branches per plant. The minimum number of branches (2.66) was observed in control treatment (T_0).

High significant variation was observed in branch number per plant due to varietal variation (Table 3). BARI dherosh-1 produces more branches (6.33) than the local one (4.77). No significant variation was observed in interaction effect on number of branches per plant (Table 4). Maximum branches (9.0) were found in fertilizer treated pot with BARI dherosh-1 (T_FV_2) and minimum in local variety when grown in control (T_0V_1).

Days to first harvest

The treatment subjective significantly the harvest time of okra (Table 2). Earliest harvest was done in the pot treated with chemical fertilizer (65.67 DAS), whereas it was identical Acacia, Bohera and Gamar leaf litters. Plants treated with Sal leaf litters took the maximum days to harvest (81.17 DAS). Earliness in harvesting was varied significantly due to varietal differences (Table 3). Early harvesting was done in BARI dherosh-1 than local variety. Interaction effects were significant in days to first harvest (Table 4). BARI dherosh-1 with fertilizer (T_FV_2) required the minimum days to 1st harvest (61.33 DAS), while maximum days (82.67 DAS) to first harvest was found in local variety with control (T_0V_1) treatment.

Table 3. Effects of varieties on the yield and yield attributing characters of okra

Variety	Plant height (cm)	Branch plant^{-1} (no.)	Days to 1st harvest	Fruit length (cm)	Fruit diameter (cm)	Fruits plant^{-1} (no.)	Individual fruit wt. (g)	Yield plant^{-1} (g)	Total yield (t ha^{-1})	Total biomass (t ha^{-1})
Local	134.8	4.77	74.33	8.13	1.38	10.27	12.72	138.1	6.45	3.88
BARI Dherosh-1	127.9	6.33	68.72	10.31	1.55	13.05	15.44	184.9	8.65	4.32
LSD (0.05)	6.483	0.347	2.161	0.609	0.155	3.922	0.718	14.830	0.319	1.194
CV%	5.86	6.75	4.90	6.48	7.79	7.95	8.11	6.39	6.48	5.21
Sig. Level	**	*	*	*	*	**	*	**	*	*

Table 4. Interaction effects of different leaf litters and varieties on the yield and yield contributing characteristics of okra

Interaction	Plant height (cm)	Branch plant^{-1} (no.)	Days to 1st harvest	Fruit length (cm)	Fruit diameter (cm)	Fruits plant^{-1} (no.)	Individual fruit wt. (g)	Total yield (t ha^{-1})	Total biomass (t ha^{-1})
T_AV_1	144.3	5.33	71.67	8.33	1.46	9.00	11.33	4.76	3.55
T_AV_2	136.3	7.33	66.00	10.00	1.70	11.33	13.00	6.82	3.90
T_BV_1	141.3	5.33	72.67	10.00	1.50	12.00	14.00	8.65	4.18
T_BV_2	132.7	7.33	65.33	12.33	1.70	15.33	19.00	11.83	4.60
T_GV_1	138.3	5.67	73.00	8.00	1.36	11.67	14.00	7.94	4.06
T_GV_2	130.7	7.00	66.00	10.32	1.46	15.00	17.67	10.82	4.54
T_FV_1	156.7	6.01	70.00	11.00	1.60	15.33	17.33	11.38	4.67
T_FV_2	152.0	9.00	61.33	15.34	1.76	18.33	21.67	14.78	5.20
T_SV_1	125.3	4.03	76.00	8.00	1.13	7.66	10.67	4.07	3.54
T_SV_2	120.0	4.33	74.00	8.33	1.33	10.33	12.00	5.67	4.06
T_0V_1	103.0	2.34	82.67	3.50	1.23	6.00	9.00	1.98	3.33
T_0V_2	95.97	3.00	79.65	5.53	1.33	8.00	9.34	2.02	3.64
LSD(0.05)	5.025	1.101	1.924	1.613	0.2028	1.650	2.033	1.891	1.401
CV%	5.86	6.75	4.90	6.48	7.79	7.95	8.11	6.48	5.21
Sig. Level	NS	NS	**	**	NS	*	**	**	NS

Fruit length (cm)

The length of fruit was recorded by the different treatments (Table 2). The longest fruits (13.17 cm) were found in plants treated with chemical fertilizers followed by Bohera leaf litters (11.17 cm). The shortest fruits (4.52 cm) were observed in the plants provided no treatment (control). The remaining other treatments gave the similar fruit length. Gupta *et al.* (1981) reported that nitrogen and phosphorus fertilizer increased fruit size. The fruit length of BARI dherosh-1 was significantly higher (10.31 cm) than the local variety (8.13 cm) (Table 3).

The result of the interaction effects shows that significant changes occurred in fruit length due to variety and treatment combination (Table 4). Maximum length (15.34 cm) was found in the combination of BARI dherosh-1 and fertilizer (T_FV_2) followed by dherosh-1 and Bohera leaf litters combination (T_BV_2). Minimum length (3.5 cm) was found from local variety when grown in control. Gupta *et al.* (1981) also reported that nitrogen and phosphorus fertilization increased length.

Fruit diameter (cm)

Fruit diameter was differed significantly by the application of different leaf litters. Maximum diameter of (1.68 cm) was found in chemical fertilizer treated pot which is statistically identical with Bohera and Acacia and the minimum diameter in Sal and control (Table 2). Gupta *et al.* (1981) also reported that nitrogen and phosphorus fertilization increased length as well as diameter fruit.

Significant variation was also found in fruit diameter among the varieties (Table 3). Maximum diameter (1.55 cm) was found in BARI dherosh-1 followed by local variety (1.38 cm). Variation in fruit diameter of okra was found insignificant due to interaction of different tree leaf litters and okra variety (Table 4). Maximum fruit diameter (1.76 cm) was noticed in BARI dherosh-1 and fertilizer (T_FV_2), followed by dherosh-1 and Bohera leaf litter (T_BV_2) and BARI dherosh-1 with Acacia leaf litter (T_AV_2, 1.7 cm). Minimum diameter (1.13 cm) was found in local dherosh with Sal leaf litters (T_SV_1).

Number of fruits per plant

Results revealed that the treatments have highly significant effect on number of fruits per plant of okra (Table 2). The highest number of fruits per plant (16.83) was observed in fertilizer treatment followed by Bohera and Gamer (13.62 and 13.33), respectively. The lowest number of fruits per plant was found in control (7.0). Anjum and Amjad (1999) reported that different combination of N, P, K fertilizers increased number of fruits per plant. Fruit number per plant was also significantly differed among the two varieties (Table 3). Maximum number of fruits was yielded by BARI dherosh-1 (13.05) whereas local variety yielded the minimum (10.27).

Interaction effect was also significant in fruit number per plant (Table 4). Maximum fruits per plant (18.33) were obtained from BARI dherosh-1 and fertilizer (T_FV_2). Second highest number of fruits per plant was found in T_BV_2 and T_FV_1 (15.33) which are statistically identical with T_GV_2 (15.00). Fatokun and Chheda, (1980) also observed that the increase in fruit yield was primarily due to an increase in the number of fruits per plant when the highest levels of phosphorus and nitrogen were applied. Minimum number of fruits per plant (6.0) was noticed in local variety with control (T_0V_1).

Individual fruit weight (g)

The heaviest fruits of okra were produced by fertilizer treatment (19.50 g) significantly followed by Bohera (16.50 g) and Gamer (15.83 g). The lowest fruit weight was (Table 2) obtained from control (9.16 g). Heaviest fruits were produced by BARI dherosh-1 (15.44 g) which was significantly higher than the local variety (12.72 g) (Table 3). Significant variation was found in individual fruit weight of okra in the interaction of variety and leaf litter (Table 4). BARI dherosh-1in combination with fertilizer (T_FV_2) produced the heaviest individual fruits (21.67 g) followed by T_BV_2 (19.0 g). Lowest individual fruit weight (9.0 g) was marked in local variety when grown in control. Birbal *et al.* (1995) found that application of nitrogen at the rate of 100 kg ha^{-1} significantly improved the weight of individual fruit over control.¨

Yield per plant (g)

The highest yield per plant was obtained from fertilizer treatment (278.5 g) followed by Bohera and Gamer (200.7g and 198.8g) respectively, whereas the lowest fruit yield per plant (64.67 g) was observed in control (Table 2). Yield per plant shows significant differences between two varieties (Table 3). The highest yield per plant was found in BARI dherosh-1 (184.88 g) than local variety (138.05 g). Total yield per plant was varied significantly due to interaction (Fig. 5). Maximum yield per plant (314.7 g) was noticed in the combination of BARI dherosh-1 and fertilizer (T_FV_2) significantly followed by T_FV_1 (242.3 g). Minimum yield (54.67 g) was harvested by the combination of local variety and control (T_0V_1). Among the tree leaf litters Bohera was superior. Adequate supply of nitrogen (N), phosphorus (P) and Potassium (K) are essential for maximizing the yield of okra (Verma *et al.* 1970).

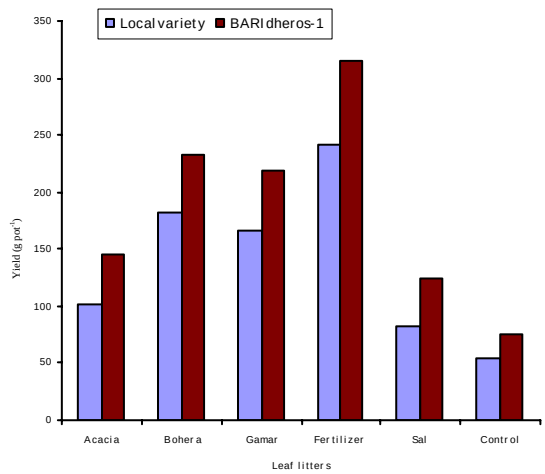

Fig. 5. Effect of different leaf litters on the yield of okra

Yield (t ha^{-1})

The results showed that tree leaf litters have significant influence on the yield of Okra on Modhupur soil (Table 2). Highest yield of okra was produced from the application of fertilizers (13.08 t ha^{-1}) followed by Bohera and Gamer (10.20 and 9.38 t ha^{-1}), respectively. Verma *et al.* (1970) mentioned that adequate supply of nitrogen (N), phosphorus (P) and Potassium (K) are essential for augmenting the yield of okra.

Yield of okra was significantly varied due to varietal difference (Table 3). BARI dherosh-1 was found high yielder (8.65 t ha^{-1}) as compared with the local variety (6.45 t ha^{-1}). Marked significant variation was noticed in the yield of okra due to interaction of different variety and leaf litter (Table 4). The highest yield (14.78 t ha^{-1}) was given by the combination of BARI dherosh-1 and fertilizers (T_FV_2). Second highest yield (11.83 t ha^{-1}) was found in the combination of BARI dherosh-1 and Bohera leaf litter (T_BV_2) which is statistically similar with other two combinations namely, BARI dherosh-1 and Gamer leaf litter (T_GV_2) and local variety with fertilizer (T_FV_1) whereas, lowest yield (1.98 t ha^{-1}) was found in local variety when grown in control (T_0V_1) conditions.

Total biomass (t ha^{-1})

The result showed that maximum biomass was produced by the application of fertilizer (4.9 t ha^{-1}) and the minimum from control (3.48 t ha^{-1}) (Table 2). Maximum biomass was also produced by BARI dherosh-1 (4.32 t ha^{-1}) which was significantly differs with the local variety (3.88 t ha^{-1}) (Table 3). No significant variation was observed in total biomass production due to interaction of variety and leaf litter application (Table 4). Chauhan and Gupta (1973) reported that application of high dose Nitrogen fertilizer increased dry matter but not yielded significant variations.

CONCLUSION

From the findings of this study, fertilizers showed better performance to cultivate okra but tree leaf litters have significant influence on the growth and yield of okra. Among the four leaf litters the performance of Bohera was better than others. Instantly, leaf litters may not be a substitute of chemical fertilizer and can not compensate solely. Therefore, to sustain soil fertility for vegetable production, the people of Madhupur can use these natural resources as combination with leaf litters and fertilizers which found balance according to nutrition demand and to sustain soil health.

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