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Bitter gourd cultivation along with three timber yielding tree species under agroforestry system

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Abstract: The experiment was conducted at the Char Kalibari which is situated by the side of Brahmaputra River Sadar Upazila, Mymensingh, during the period from November 2012 to March 2013 to study performance of bitter gourd in combination with three different timber species as agroforestry system. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications having four treatments. Different distances from the tree base were considered as different treatments. There was a control treatment i.e. bitter gourd was cultivated in the open field condition (without tree). Four treatments of this study were viz., T_0 (open field condition referred as control), T_1 (< 50 cm distance from the tree base), T_2 (50-100 cm distance from the tree base) and T_3 (>100 cm distance from the tree base). Three timber tree species are Mahogony (*Swietenia macrophylla*), Lambu (*Khya spp.*) and Karanja (*Pongamia pinnata*). All of these trees used in this experiment were 3 years old. Growth and yield of bitter gourd and growth of associated trees in this study was recorded which was significantly influenced by different timber trees in different distances from the tree base. It was found that growth and yield of bitter gourd was relatively better in the open field condition compare to in association with all tested timber tree species. All growth parameter of bitter gourd viz. Vine length, number of primary branches per plant, number of leaves per primary branch, number of fruit per plant, individual fruit weight etc. was better in open field condition but among the different timber species growth of bitter gourd was relatively lower in combination with Lambu tree species. In combination with all of these timber tree species growths of bitter gourd gradually decreased with decreasing distances towards the tree base. Similar trend of variation was also found in case of yield of bitter gourd in combination with these timber tree species. Highest fresh of bitter gourd was obtained in open field condition which was 4.1 tha^{-1}. Among the different distances viz. < 50 cm, 50-100 cm and >100 cm distance from the tree base, yield of bitter gourd was decreased towards the tree base. Fresh yield of bitter gourd in these distances (<50 cm, 50-100 cm and >100 cm) from tree base in combination with Mahogony, Lambu and Karanja species were 2.5, 3.4 & 3.9 tha^{-1}, 2.1, 2.6 & 3.2 tha^{-1} and 2.7, 3.2 & 4.0 tha^{-1}, respectively. It was found that on an average 40.7, 25.12 and 9.76% yield of bittter gourd was decreased in <50 cm, 50-100 cm and >100 cm distances from tree base compare to open field condition.

Key words: Brinjal, Chilli, Lohakath, *Xylia dolabriformis*, intercropping, Agroforestry system.

Introduction

Bangladesh is a subtropical country and its land area only 14.39 million hectares, but due to the ever increasing population, per capita land area is decreasing at an average rate of 0.005 ha/cap./year since 1989 (Hossain and Bari, 1996). In Bangladesh the total forest area covers about 17% of the land area (BBS, 2010) but the actual tree covered area is estimated at around 9.4% which is decreasing at an alarming rate (Hossain and Bari, 1996). Due to continuous transformation of forest land to agricultural land, aquaculture, homestead and other purposes about 8000 ha of forest land is decreasing per year (FAO, 1981). Another 99,000 ha of reserved forest lands were encroached or subjected to shifting cultivation. Village forest, mainly covered by homesteads accounts only 0.27 million ha. Out of 64 districts, as estimated, 28 districts have no public forest land (Islam, 1991). So, the effective area of forest (9.4%) in Bangladesh is neither in a position to fulfill the requirements of the people's demand for fuel, fodder and timber nor to stabilize the climatic condition. Under these alarming situations, agricultural production as well as forest resources must be increased by using modern or new techniques.

In Bangladesh scope of Agroforestry is vast. The major venues of agroforestry are homestead, roadside, railway side, embankment side, charland, coastal area, deforested area, institutional premises, riverside etc. Among them charland is the most important venue for practicing agroforestry systems. 'Char' a tract of land surrounded by the waters of an ocean, sea, lake, or stream; it usually means any accretion in a river course or estuary (Chowdhury, 1988). Chars in Bangladesh have been distributed into five sub-areas: the Jamuna, the Ganges, the Padma, the Upper Meghna and the Lower Meghna rivers. There are other areas of riverine chars in Bangladesh, along the Old Brahmaputra and the Tista rivers. But compared to the chars in the major rivers, these constitute much less land area. It is estimated that in 1993 the total area covered by chars in Bangladesh was 1,722 sq km. A large number of populations are living in these char areas and maintaining their livelihood through char based farming systems. Therefore, for increasing production, maintaining ecological balance and improving socio-economic condition of the charland people, integrated approach with crops/vegetables and trees is necessary.

Moreover, need for fuel wood and timber are increased in Bangladesh day by day. Tree is the major source for collecting fuel wood and timber in this country. So, for this purpose increased pressure on natural forest as a result natural forest become denuded at an alarming rate. In this regards, Fast growing and multipurpose trees will very helpful for solving this problem. Mahogony (*Swietenia macrophylla*) and Lambu (*Khya spp.*) are the two tree species which are obviously fast growing and also used as various purposes. On the other hand, there is a common problem in the char areas of Bangladesh is lack of soil conserving/binding tree species. Karanja (*Pongamia pinnata*), a tree species which can survive in the water logged condition and also can stabilized or and However, the fertility of our land is decreasing rapidly due to intensive cropping and use of high input technologies. Under this alarming cond bind the soil in the above circumtances.

In Bangladesh, a large number of vegetables are grown in the charland areas during winter season as sole crops but seldom found in association with trees as agroforestry system. Due to increase demand of fuel wood and timber tree plantation is the prime necessity in Bangladesh. For maintaining ecological balance and biodiversity aforestation activities is also the prime requirement in

Bangladesh. During winter season charland is a unique area for vegetables production where land is fertile due to siltation and irrigation requirement is less or easy. For this reason present study was undertaken to observe the performance of bitter gourd in association with three different tree species in the Char Kalibari in the bank of Old Brahmaputra River.

Materials and Methods

Location of the study area: The experiment was carried out at char Kalibari belongs to the Mymensingh sadar upazila during the period from November 2012 to March 2013. The district Mymensingh is located between 24˚38'3" North and 90˚16'4" East Latitude. Total area of this district is 4363.48 km^2 and situated on the west bank of Brahmaputra River. The geographical position of char Kalibari located between 24˚45' - 24˚45'40" North and 90˚24'4"- 90˚24'44" East Latitude.

Tree and plant materials: In this study the three years old previously established Mahogoni (*Swietenia mahagoni*), Lambu (*Khya* spp.) Karanja (*Pongamia pinnata*), trees were used as test tree components and Bitter gourd (*Momordica charantia*) were used as plant materials. On the others hand the seeds of bitter gourd were collected from International Seed Fair in Bangladesh Agricultural University Campus.

Tree management: The study was done under 3 years old Mahogoni, Lambu, Karanja tree saplings. At first soils of the base of trees were loosening very well. Weeds were removed from the surrounding of the tree base; insect infected leaves were also removed. Irrigation was done two times in a day by the watering cane.

Experimental design and treatment combination: The Experimental design was Randomized Complete Block Design (RCBD) with three replications. Four treatments were used in this study which are: T_0 = Open field referred to as control, T_1 = < 50 cm distance from the tree, T_2 = 50-100 cm distance from the tree, and T_3 = > 100 cm distance from the tree.

Harvesting: The fruits were harvested at tender stage and before 100 % maturity when they are still green. However, bitter gourd was harvest after 120 days after sowing. Delay in harvesting causes the fruit to become unit for marketing. Harvesting is done by hand picking. Bitter gourd was harvested at several picking. After harvest size and weight of the each fruit was measured.

Sampling and data collection:

Bitter gourd: Five plants were randomly selected for data collection. The parameters studies were plant height (cm), number of primary branches/plant, number of leaves/primary branches, number of fruits/plant, weight/fruits (g), fresh and dry weight of fruits (t/ha). Yield was determined as per plant (g) and it was also converted as t/ha.

Mahogoni, Lambu, Karanja tree: Ten tree samples were selected randomly from all treatments of the plots for data collection. Sample trees were selected at before and after of vegetables cultivation. Tree height (cm) and Tree girth (cm) were recorded.

Statistical analysis: Compiling and analyzing the recorded data were done by using RCBD design to find out the experimental results with the statistical significance. The means for all recorded data were calculated and the analysis of variance for all the characters were performed. The mean differences were evaluated by Duncan's New Multiple Range Test (DMRT) (Gomez and Gomez, 1984) and also by Least Significant Difference (LSD) test.

Results and Discussion

Performance of bitter gourd in association with three timber (Mahogony, Lambu and Karanja) trees was observed in study. Growth and yield of bitter gourd and tree species under this study was as:

Growth and yield of Bitter gourd:

Vine length: Vine length of bitter gourd was significantly affected by Mahogony, Lambu and Karanja tree at different distance from tree base (Tables 1, 2 and 3). It grew more vigorously in the open field than those grew close distance to the all tree species. Largest average vine length was found in control condition i.e., without tree condition and the value was 129.5 cm. Among the different distances from Mahogony, Lambu and Karanja tree base larger vine length was recorded in treatment T_3 (> 100 cm distance) and the value were 121.5, 114.5 and 128.5 cm, respectively, followed by 50-100 cm and < 50 cm distances from tree base and the vine length in these areas were 97.2, 90.5, 101.51 and 80.19, 75.57, 84.81cm, respectively (Tables 1, 2 and 3). Vine length recorded in T_1, T_2 and T_3 treatments was 35-40, 25-28 and 6-8% lower in association with Mahogony, Lambu and Karanja compare to control condition i.e., with tree combination. From this study it was found that vine length of bitter gourd gradually increased with increasing distance from mahogony tree base, it may be due to higher competition for moisture and nutrients very near the mahogony tree base. Similar type of height growth was observed by Mallick *et al.,* (2013) in strawberry plants along with *Xylia dolabriformis* tree.

Primary branches per plant: Number of Primary branches of bitter gourd is directly affected by the Mahogony, Lambu and Karanja tree in different distances from tree base (Tables 1, 2 and 3). It was recorded that number of primary branches per plant in open field condition was maximum and it value was 8.7. Among the different distances from Mahogony, Lambu and Karanja tree base highest number of branches was recorded with the treatment T_3 (> 100 cm distance) and its value was 7.2, 6.1 and 8.3 per plant followed by treatment T_2 (5.83, 4.88 and 6.64) and T_1 (4.82, 4.09 and 5.56). No. of primary branches per plant may also reduced due to shortage of moisture and nutrients very near the tree base where competition between tree and crop roots is occurred. This type of observation was also recorded by Tanni *et al.*, (2010) in soybean along with Lohakat tree.

Number of leaves per primary branch: Number of leaves per primary branch of bitter gourd was significantly affected by Mahogony, Lambu and Karanja tree by different distance from tree base (Tables 1, 2 and 3). It grew more vigorously in the open field than those grew close distance to the Mahogony, Lambu and Karanja tree species. The highest number of leaves was recorded as

45.3 per primary branch in the treatment T_0 i.e., open field condition. The second highest number of leaves per primary branch was recorded as 40.5, 37.2 and 44.9 in treatment T_3 (> 100 cm from tree base) followed by treatment T_2 (50-100cm from the tree base) and treatment T_1 (< 50 cm from the tree base.) where number of leaves per primary branch were 33.21, 30.13, 36.67 and 27.54, 25.29, 30.53 respectively. Lowest number of leaves per primary branch recorded in very near the tree base i.e., < 50 cm from the tree base and these values are 45-50% lower compare to open field condition. From this study it was found that number of leaves per primary branch of bitter gourd was gradually increased with increasing distance from mahogony tree base, it may be due to the above and below ground negative interaction effect between mahogony and bitter gourd plant. Similar type of effect was observed by Hasan *et al.,*(2012) in an agroforestry practice with Indian spinach, Okra and *Khya spp.* tree.

Table 1. Morphological characteristics of bitter gourd in association with mahogony treee

Treatments	Morphological Characteristics				
	Vine length (cm)	No. of primary branches /plant	No. of leaves /primary branch	No. of fruit /plant	Weight /fruit (g)
T_0	129.5a	8.7a	45.3a	28.5a	45.5a
T_1	80.19c	4.82c	27.54d	17.04d	28.35d
T_2	97.2b	5.83bc	33.21c	20.5c	34.02c
T_3	121.5a	7.2b	40.5b	24.7b	40.5b

Means in column followed by the different letter are significantly different by DMRT at $P \leq 0.05$, T_0 = Control, T_1 = <50 cm from tree base, T_2 = 50-100 cm from tree base, T_3 = > 100 cm from tree base.

Table 2. Morphological characteristics of bitter gourd in association with lambu treee

Treatments	Morphological Characteristics				
	Vine length (cm)	No. of primary branches /plant	No. of leaves /primary branch	No. of fruit /plant	Weight /fruit (g)
T_0	129.5a	8.7a	45.3a	28.5a	45.5a
T_1	75.57d	4.09c	25.29d	16.42d	26.11c
T_2	90.45c	4.88bc	30.13c	19.75c	31.33bc
T_3	114.5b	6.1b	37.2b	23.8b	37.3b

Means in column followed by the different letter are significantly different by DMRT at $P \leq 0.05$, T_0 = Control, T_1 = <50 cm from tree base, T_2 = 50-100 cm from tree base, T_3 = > 100 cm from tree base.

Table 3. Morphological characteristics of bitter gourd in association with karanja treee

Treatments	Morphological Characteristics				
	Vine length (cm)	No. of primary branches /plant	No. of leaves /primary branch	No. of fruit /plant	Weight /fruit (g)
T_0	129.5a	8.7a	45.3a	28.5a	45.5a
T_1	84.81c	5.56c	30.53c	19.18c	31.29c
T_2	101.51b	6.64b	36.67b	23.07b	37.55b
T_3	128.5a	8.3a	44.9a	27.8a	44.7a

Means in column followed by the different letter are significantly different by DMRT at $P \leq 0.05$, T_0 = Control, T_1 = <50 cm from tree base, T_2 = 50-100 cm from tree base, T_3 = > 100 cm from tree base.

Number of fruits plant^{-1}: Fruit of bitter gourd was also influenced by Mahogony, Lambu and Karanja tree by different distance from tree base (Tables 1, 2 and 3). Highest average number of fruit was found in control condition i.e., without tree condition and it was 28.5 fruit per plant. Among the different distances from Mahogony,

Lambu and Karanja tree base highest number of fruit was recorded in treatment T_3 (> 100 cm distance) and it was 24.7, 23.8 and 27.8 followed by treatment T_2 (20.5, 19.75 and 23.07) and T_1 (17.04, 16.42 and 19.18). From this study it was found that the fruit production of bitter gourd gradually increased with increasing distance from mahogony tree base, it may be due to higher competition for moisture and nutrients very near the mahogony tree base. Similar type of production was observed by Rahaman *et al.*, (2013) in sweet gourd when grown in association with Akashmoni saplings.

Average weight fruit^{-1}: Fruit weight is the most efficient factor of bitter gourd cultivation but the weight per fruit is significantly influenced when it was grown in association with Mahogony, Lambu and Karanja tree species. Average highest weight per fruit is recorded with out tree condition and it was 45.5g per fruit. Among the different distances from Mahogony, Lambu and Karanja tree base single fruit weight of bitter gourd gradually decreased towards the tree base (Tables 1, 2 and 3). Highest single fruit weight was recorded in open field condition and it was 45.5 g. Single fruit weight bitter gourd was 35-40, 25-28 and 10-13% lower in the treatments T_1, T_2 and T_3, respectively in association with Mahogony, Lambu and Karanja tree speciescompare to open field condition. This lower of bitter gourd in association with mahogony tree may be due to higher competition for moisture and nutrients very near the mahogony tree base. Similar type of effect was observed by Bali *et al*., (2013) in okra under guava and lemon based agroforestry system.

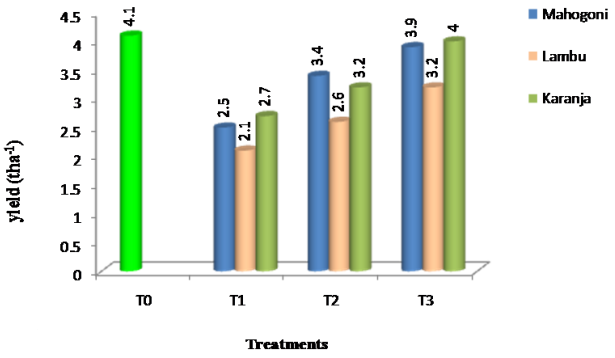

Fig. 1. Comparative yield of bitter gourd along with mahogoni, lambu and karanja tree

Yield of bitter gourd along with mahogoni, lambu and karanja tree: Yield of bitter gourd significantly influenced by mahogoni, lambu and karanja tree in different treatments at different rate (Fig. 1). Fresh yield of bitter gourd gradually decreased with decreasing distance towards the base of mahogoni, lambu and karanja tree. In all treatments it was found that lowest yield of bitter gourd was recorded in association with lambu tree and almost similar trend of yield variation was found in association with mahogony and karanja tree. Gradually yield reduction may be due to competition for nutrients and moisture towards tree base of these trees but fresh yield reduction rate was more in association with lambu tree may be due its very fast growth habit. Due its fast growing habit obviously it required more moisture and water for its growth and development. Rakib *et al.*, (2013) was observed yield variation in sweet gourd production in association with different fruit trees and Hasan (2013) was also found reduced bitter gourd yield towards eucalyptus tree base.

Tree growth observation: As growth and yield of bitter gourd was influenced by mahogoni, lambu and karanja tree, growth of mahagony, lambu and karanja tree was also significantly influenced by bitter gourd (Table 4). Growth of these trees was observed by measuring height and girth before and after of this study. Both height and girth of these trees were bit better in combination with bitter gourd. Average height increment of mahogony, lambu and karanja tree with and without bitter gourd combination were 17.7, 16.4, 20.9 cm and 14.2, 14.3, 16.9 cm, respectively (Table 4). Average girth increment of mahogony, lambu and karanja tree with and without bitter gourd combination were 2.9, 2.3, 2.3 cm and 2.3, 2.0, 1.9 cm, respectively (Table 4). This better growth of these trees along with bitter gourd might be due to different cultural management like fertilization, irrigation and pest control for bitter gourd which also influenced the tree growth during winter season. During winter season tree management was very rare in Bangladesh especially charland it was scanty. Similar type of observation was also found by Rakib *et al.*, (2013) in different fruit trees along with sweet gourd cultivation in the same charland areas.

Table 4. Growth of Mahagoni, Lambu and Karanja in association with Bitter gourd and control condition

Tree Species	Condition	Height (cm)			Girth(cm)		
		Before	After	Increment	Before	After	Increment
Mahagoni	With bitter gourd	235.8	253.5	17.7	16.9	19.8	2.9
	Without bitter gourd	244.3	258.5	14.2	17.6	19.9	2.3
Lambu	With bitter gourd	230.6	247	16.4	16.9	19.2	2.3
	Without bitter gourd	241.1	255.4	14.3	17.8	19.8	2
Karanja	With bitter gourd	244.8	265.7	20.9	11.8	14.1	2.3
	Without bitter gourd	259.9	276.8	16.9	12.5	14.4	1.9

This result indicates growth and yield of bitter gourd gradually decreased with decreasing distances towards the tree base. Gowth of any vegetables are directly related with moisture availability in soil, in agroforestry system where a competition occurred between tree and crop for moisture beneath the tree canopy. For this reason, may be growth and yield of bitter gourd remarkably reduced beneath the tree canopy or near the tree base. Finally, it

may be concluded that bitter gourd can successfully grown in combination with different timber trees in char based farming system of bangladesh during the the establishment period of trees i.e., upto 6-7 years from transplantation of timber tree saplings.

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