Performance of bitter gourd in assosiation with three fruit trees during winter season

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Abstract The present investigation was conducted at Char Kalibari, which is situated by the side of Brahmaputra River adjacent to the Bangladesh Agricultural University, Mymensingh during the period from October 2012 to March 2013. The experiment was conducted to evaluate the performance of Bitter gourd (*Momordica charantia*) in association with mango, guava, and lemon tree at different distance. The experiment was consisted of four different treatments viz. T_0 (open field 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). The experiment was laid out in a Randomized Complete Block Design with three replications. Data were collected on morphological and yield contributing characters of the vegetables and were analyzed for evaluation of the treatment effects. In this study, different growth parameters viz. Vine length, number of primary branches per plant, number of leaves per primary baranch, number of fruit per plant, individual fruit weight etc. and yield (fresh and dry) of bitter gourd was observed separately with mango, guava, and lemon trees. 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 fruit tree species. Among the different fruit species, growth of bitter gourd was relatively lower in combination with lemon tree species. In combination with all of these fruit tree species growth 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 fruit 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. It was found that on an average 47.15, 34.15 and 20.33% yield of bittter gourd was decreased in <50 cm, 50-100 cm and >100 cm distances from tree base compare to open field condition. As growth and yield of bitter gourd was influenced by mango, guava, and lemon tree, growth of these trees was also significantly influenced by bitter gourd. It was recorded that both height and girth increment of these trees were bit better in combination with bitter gourd.
Key words: Bitter gourd, fruit trees, winter season, char land, agroforestry.

Introduction

Bangladesh is a densely populated and small country with an area of 147,570 km^2. According to the latest census in 2011, the population of the country was 160 million with an average growing rate of 1.34%, and the density of human population is 1020 per sq. (UNFPA, 2011). As a result, there is a tremendous pressure on the natural resources of the country. Consequently, poverty has become a serious issue. In Bangladesh the massive growth rate of population has intensified pressure on forest resources throughout the country. Population of Bangladesh is increasing rapidly, therefore, demand for vegetable is increasing simultaneously whereas the areas under vegetable production including tuber crops are 7,14,000 ha that produce 10.30 million metric tons of vegetable yearly (BBS, 2009). In spite of many policy and project efforts, the afforestation process are still lingers at a low level, overall. Agroforestry is a promising alternative. Project experiences and research, have shown that Agroforestry presents one of the very few options that can protect and sustainably manage the degrading forest resources Rahman *et al*. (2010). 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. 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.

In Bangladesh a large number of vegetables are grown of which most of them are grown in winter season. Financial returns from vegetables showed that winter vegetables production is more profitable than the production of most field crops (BBS, 1998). Among the different winter vegetables, bitter gourd is an important winter vegetable in Bangladesh. Bitter gourd is important for its quick growing nature and high yielding potential. Even these vegetables can successfully growing in association with Agroforestry trees viz. timber, fruit, fuel, foddder and medicinal trees. Present study investigate the the peroformance of bitter gourd in association with different fruit trees in the char land based agroforestry system.

Materials and Methods

Location of the experimental site and season: 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 km2 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 previously established 2.5 years old Mango (Mangifera indicia L.), Guava (Psidium guajava), Lemon (Citrus lemon) trees were used as tree components and one crop Bitter gourd (Momordica charantia) was used as plant materials. The seeds of bitter gourd were collected from International Seed Fair in Bangladesh Agricultural University Campus.

Tree management: The study was done under 2.5 years old Mango, Guava and Lemon tree. At first soils of the base of trees were loosening very well and made friable. 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.

Design and layout of the experiment: Bitter gourd was laid out following the Randomized Complete Block Design (RCBD) with single factorial arrangement of multistoried production system. Four treatments were used in this study and three replications were followed for each treatment for each crop. Each plot was 4.5 m width and 2.0 m length at both sides of selected tree species. Different treatments of this study were; T0= Open field

referred to as control, T1= < 50 cm distance from the tree base, T2= 50 – 100 cm distance from the tree base, and T3= > 100 cm distance from the tree base.

Crop establishment: Bitter gourd seeds were sown in the experimental plot on 25 October in separated small seed bed of each plot where each seed bed distance was 0.5 × 0.5 m length and width, respectively. Ten to twelve seeds of bitter gourd were sown in each seed bed.

Management practices Only cow dung was applied as manure. The full amount of cow dung was applied at the time of final land preparation. The experimental plots were kept weed free by weeding frequently. The land was irrigated wherever needed by using hose pipe and watering cane to supply sufficient soil moisture for the vegetables. Emergence of bitter gourd seedling was started after 15 days from the date of sowing. Seedlings were thinned out for three times where second and third thinning out was done at 5 days interval from first thinning. After emergence, bitter gourd was thinned out at three times while first thinning was done at 15 days after sowing. No pesticide and fungicide were used in the field for tree-vegetable association.

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

Methods of data collection

Bitter gourd: Five plants were randomly selected for data collection. The parameters studies were Vine length, number of primary branches/plant, number of leaves/primary branches, number of fruits/plant, weight/fruits (kg) and fresh and Dry weight of fruits (t/ha).

Fruit trees: 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: The data on various growth and yield contributing characters of the vegetables was statistically analyzed to examine the significant variation of the results due to different parameters. The analysis of variance for each of the character under study was done by F (variance ratio) test for Randomized Complete Block Design (RCBD). The treatments means were compared by DMRT (Duncan's Multiple Range Test) at 5% level of significance.

Results and Discussion

Morphological characteristics of bitter gourd along with mango, guava and lemon tree:

Vine length: Vine length of bitter gourd was affected significantly by the effect of different mango, guava and lemon trees (Tables 1, 2 and 3). It was found that the maximum height of bitter gourd was produced by T_0 (open field without treatment) which was statistically close to T_3 (> 100 cm distance from the tree base) follwed by treatment T_2 (50-100 cm distance from the tree base).The lowest height of bitter gourd plants was observed in T_1 (<50 cm distance from the tree base). From this study it was found that vine length of bitter gourd gradually increased with increasing distance from guava tree base, it may be due to higher competition for moisture and nutrients very near the guava tree base. Similar type of height growth was observed by Farhana *et al.* (2013) in spinach plants along with *Xylia dolabriformis* tree.

Table 1. Morphological characteristics of bitter gourd in association with mango tree

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	79.53d	4.82d	28.02d	17.59d	28.28d
T_2	95.19c	5.76c	33.37c	20.91c	33.94c
T_3	120.5b	7.2b	41.2b	25.5b	40.4b

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

Table 2. Morphological characteristics of bitter gourd in association with Guava tree

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	79.27d	4.89c	28.63d	17.11d	28.7d
T_2	94.88c	5.84bc	34.1c	20.34c	34.0c
T_3	120.1b	7.3b	42.1b	24.8b	41.0b

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

Number of primary branches/plant: Number of primary branches/plant of bitter gourd was affected significantly by the effect of different mango, guava and lemon trees (Tables 1, 2 and 3). Maximum average number of primary branches was observed in T_0 (Open field referred as control or without associated tree) while treatment T_3 (> 100 cm distance from the tree base) produces statistically similar number of primary branches along with all fruit trees follwed by treatment T_2 (50-100 cm distance from the tree base) and minimun average number of branches

was recorded in the treatment T_1 (<50 cm distance from the tree base). This type of observation was also recorded by Tanni *et al.* (2010) in soybean along with Lohakat tree.

No. of leaves/primary branch: No. of leaves/primary branch of bitter gourd was affected significantly by the effect of different mango, guava and lemon trees (Tables 1, 2 and 3). The result revealed that the maximum number of leaves per primary branch of bitter gourd was produced by T_0 treatment (open field or without treatment) while second highest number of leaves per primary branch was produced under T_3 treatment (> 100 cm distance from the tree base). However, treatment T_2 (50-100 cm distance from the tree base) produced third highest number of leaves per primary branch but it was statistically close with T_3.along with all of these fruit trees and minimum in very near the tree base i.e. treatment T_1 (<50 cm distance from the tree base). Similar type of effect was observed by Hasan *et al.* (2013) in an agroforestry practice with Indian spinach, Okra and Lombu tree.

Table 3. Morphological characteristics of bitter gourd in association with Lemon tree

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	72.27d	3.62c	22.51d	14.69d	24.01c
T_2	86.51c	4.32bc	26.81c	17.47c	28.47bc
T_3	109.5b	5.4b	33.1b	21.3b	34.3b

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.

Number of fruit/plant: Number of fruits/plant is the most important yield contributing character, which was significantly influenced by different distance of growing bitter gourd in association with mango, guava and lemon tree (Tables 1, 2 and 3). The maximum number of fruits/plant was found in T_0 (open field referred as control) while treatment T_3 (> 100 cm distance from the tree base) produces the second highest number of fruits/plant. Treatment T_2 (50-100 cm distance from the tree base) recorded the third highest number of fruits/plant along with of these three fruit trees. The lower number of fruits/plant was found under close contact of the tree condition and it was probably due to poor photosynthetic capacity and nutrients competition between trees and studied bitter gourd. Similar type of production was observed by Rahaman *et al.* (2013) sweet gourd grown in association with Akashmoni saplings.

Weight/fruit: Weight of single fruits of bitter gourd was also significantly influenced by different planting distance from all of these three fruit trees (Tables 1, 2 and 3). The trend of weight of single fruit was almost similar to that of number of fruits plant^{-1}. Due to high competition between tree and crop the lowest weight of single fruit was found in T_1 (<50 cm distance from the tree base). From this study it was found that the fruit weight of bitter gourd was gradually decreased with decreasing distance from mango, guava and lemon tree base, it may be due to higher competition for moisture and nutrients very near the guava tree base and the shade effect of guava tree.

Yield of bitter gourd along with mango, guava and lemon tree: Yiled of bitter gourd (t/ha) was also significantly influenced by different treatments in association with mango, guava and lemon trees (Fig. 1). Highest fresh yield (4.1 t/ha) of bitter gourd were obtained from the treatment T_0 (Open field referred as control) and 2nd highest in the treatment T_3 (> 100 cm distance from the tree base) where the yield were 3.5, 3.4 and 2.9 t/ha respectively along with mango, guava and lemon trees (Fig. 1) follwed by T_2 (50-100 cm distance from the tree base) where the yield values of bitter gourd were 2.9, 2.8 & 2.4 and 2.3, 2.3 & 1.9 t/ha, respectively, along with mango, guava and lemon trees (Fig. 1). Tanni *et al.,* (2010), Habib *et al.* (2012), Mallick *et al.* (2013) recorded reduced fresh yield very near the *Xylia dolabriformis* tree base in lettuce, amaranth and strawberry, respectively. These results indicate fresh yield under tree i.e. partial shade condition content more water than open field condition.

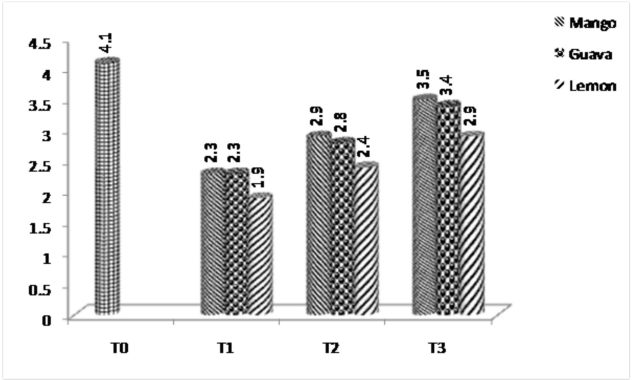

Fig. 1. Yield of bitter gourd in association with mango, guava, and lemon trees

Growth of Mango, Guava and Lemon in Association with Bitter Gourd and Control Condition: The morphological performances of mango, guava and lemon were significantly influenced by the interaction of bitter gourd. Growth of all fruit trees was observed as height and girth increment. It depends on the minimum competition of tree and crops as well as the less allelopathic effect on tree and crops each other. The growth of Mango, Guava and Lemon was also significantly influenced in association with bitter gourd compare to without bitter gourd combination (Table 4).

Table 4. Growth of Mango, Lemon and Guava in association with Bitter gourd and control

Tree Species	Condition	Height (cm)			Girth(cm)		
		Before	After	Increment	Before	After	Increment
Mango	With bitter gourd	198.8	221.5	22.7	15.2	16.3	1.1
	Without bitter gourd	212.3	230.9	18.6	16.1	17	0.9
Guava	With bitter gourd	177.9	196.8	18.9	15.1	16.5	1.4
	Without bitter gourd	193.3	205.6	12.3	16	17.2	1.2
Lemon	With bitter gourd	212.7	235.6	22.9	16.6	19.1	2.5
	Without bitter gourd	230.1	247.5	17.4	17.7	19.8	2.1

Average height increment of mango, guava and lemon tree with and without bitter gourd combination were 22.7, 18.9, 22.9 cm and 18.6, 12.3, 17.4 cm, respectively (Table 4). Average girth increment of mango, guava and lemon tree with and without bitter gourd combination were 1.1, 1.4, 2.5 cm and 0.9, 1.2, 2.1 cm, respectively (Table 4). Height and girth increment of Mango, guava and lemon tree was bit better under without bitter gourd combination (Table 4). Similar result also observed by Tanni *et al.,* (2010) in *Xylia dolabriformis* in association with winter vegetables and Rakib *et al.* (2013) in different fruit trees along with sweet gourd cultivation in the same char land areas.

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