

# Performance of bitter gourd in association with four years old eucalyptus tree (*Eucalyptus camaldulensis*) in agroforestry system

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**Abstract:** An experiment was conducted at the Kalibari char which is situated along the bank of old Brahmaputra river adjacent to the Bangladesh Agricultural University, Mymensingh, during the period from mid October 2013 to March 2014 with the aim of evaluating the growth performance of winter vegetable (bitter gourd) (*Momordica charantia*) grown under four years old Eucalyptus (*Eucalyptus camaldulensis*) tree at different distances around the tree base. The experiment was laid out in a Randomized Complete Block Design with three replications. Data were collected on morphological characters and yield contributing characters of tree-crops and were analyzed for evaluation to see the treatment effects. The experiment consisted of four treatments viz. T<sub>0</sub> (Open field as control), T<sub>1</sub> (<50 cm distances from the tree base), T<sub>2</sub> (50-100 cm distances from the tree base) and T<sub>3</sub> (> 100 cm distances from the tree base). The result showed that the morphological characters and also yield contributing characters were increased gradually in treatments where distance was more from Eucalyptus (*Eucalyptus camaldulensis*) tree base. The highest values were observed under T<sub>0</sub> (open field as control) treatment and the lowest value was recorded under the close distance T<sub>1</sub> (<50 cm from tree base). Different characteristics of bitter gourd such as vine length, number of primary branches/plant, number of leaves/primary branch, number of leaves/plant, weight/fruit and fresh and dry yield were recorded. As a result, fresh and dry yield of bitter gourd had also higher (3.92 and 0.31 t/ha, respectively) in the treatment T<sub>0</sub> (control) whereas both yield viz. fresh and dry (3.55 and 0.28 t/ha) were statistically similar to that of the treatment T<sub>3</sub> (> 100 cm distance from the tree base). Height and girth of Eucalyptus was also significantly influenced by the interaction with bitter gourd where the highest increment of tree height (56.67 cm) and girth (4.50 cm) was recorded under tree-bitter gourd combination while the lowest increment of tree height (65.70 cm) and girth (4.95 cm) was found in without vegetable condition. Therefore, finally, it is clear that control (T<sub>0</sub>) and long distance (T<sub>3</sub>) would be optimum distance for higher production of bitter gourd in agroforestry system.

**Key words:** Bitter gourd, eucalyptus, Agroforestry system.

## Introduction

Agroforestry can help to overcome shortcomings of traditional agriculture that are often characterized by low output, relatively high investment and a deterioration of the environment. Forestry plays an important role in maintaining environmental equilibrium and socio-economic upliftment of the people. A country needs 25% forest land of its total area for ecological stability and sustainability.

In agroforestry systems several multipurpose trees are introduced throughout the South Asia. Of them, Eucalyptus is very popular and profitable too. Eucalyptus tree was introduced in India from Australia about 200 years ago. During 18<sup>th</sup> century a few trees were planted in the Nilgiri's hills of Tamilnadu. Around 1956, a hybrid Eucalyptus, known as "Mysore gum" became more popular in Mysore. Large scale plantations of this species were taken up in Uttar Pradesh. *Eucalyptus grandis* which was first introduced in Kerala for afforesting the grass lands of high ranges has emerged as the 'most important species for pulpwood plantations in Kerala. The other Eucalyptus species that are grown in India are *E. tereticornis*, *E. globulus* and *E. grandis*. Eucalyptus is a fast growing tree and has about 625 species and sub-species with several varieties and hybrids. It can be planted on agricultural lands both as monoculture and as a component of agro-forestry programs. One of the principal factors for its widespread introduction is the ease of cultivation. Besides this, easily obtainable seed supplies, good germination and its adaptability to varying soil and climatic conditions are the other important characteristics of Eucalyptus.

It has a rich history of development and has been practiced in some parts of the world for more than 6,000 years. Agroforestry is an old concept but the term is new. Though agroforestry is an age old practice in Bangladesh, further improvement may be brought for harvesting maximum

benefit by identification of appropriate tree-crop combination.

## Materials and Methods

**Location and time of the study:** The experiment was carried out at Char Kalibari belongs to the Mymensingh sadar upazila during the period from October 2013 to March 2014. The district Mymensingh is located between 24°38'3" North and 90°16'4" East Latitude (Fig.1). Total area of this district is 4363.48 km<sup>2</sup> 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 four years old previously established Eucalyptus (*E. camaldulensis*) trees were used as tree component and one winter vegetable crop Bitter gourd (*Momordica charantia*) was used as plant material.

**Design and layout of the experiment:** The experiment was laid out following Randomized Complete Block Design (RCBD) with three replications. Four treatments were used in this study. 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; T<sub>0</sub>= Open field referred to as control, T<sub>1</sub>= < 50 cm distance from the tree base, T<sub>2</sub>= 50 – 100 cm distance from the tree base, T<sub>3</sub>= > 100 cm distance from the tree base.

## Sampling and data collection

**Bitter gourd:** The parameters selected for data recording were as follows: (i) Vine length (cm), (ii) Number of primary branches/plant, (iii) Number of leaves/primary branches, (iv) Number of fruits/plant, (v) Weight/fruits (kg), (vi) Fresh yield (t/ha), (vii) Dry yield (t/ha)

**Eucalyptus tree (*Eucalyptus camaldulensis*):** Tree growth was determined taking nine tree selected randomly from all treatments of the research plots. Tree height (cm) and

girth (cm) were recorded at before and after vegetables cultivation.

**Data analysis:** The analysis of variance for each of the studied character was done by F (variance ratio) test following Randomized Complete Block Design. The mean differences were evaluated finally by Duncan Multiple Range Test (DMRT) at % level of significance.

### Results and Discussion

This chapter comprises the presentation and discussion of the results from the experiment carried out to study the performance of bitter gourd under eucalyptus (*Eucalyptus camaldulensis*) tree. The results of each parameter have been discussed and possible interpretations wherever necessary have been given under the following headings.

**Table 1.** Morphological characteristics of bitter gourd during vegetative stage in association with eucalyptus tree

Treatment	Vine length (cm)	Total leaves/plant	No. of primary branches/plant
T <sub>0</sub>	44.00 a	25.00 a	3.00 a
T <sub>1</sub>	36.00 c	15.00 c	0.00 c
T <sub>2</sub>	39.00 b	18.00 b	0.00 c
T <sub>3</sub>	40.33 b	19.33 b	1.00 b
Cv	2.405	4.952	50.00
LSD (1%)	2.898	2.898	1.513
LSD (5%)	1.919	1.919	0.999
Level of significance	**	**	**

T<sub>0</sub>=Control condition, T<sub>1</sub>= <50 cm from tree base, T<sub>2</sub>= 50-100 cm from tree base, T<sub>3</sub>= >100cm from tree base

**Total leaves/plant:** Different treatments showed significant effect on number of leaves per plant of bitter gourd (Table 1). The result revealed that the maximum number of leaves per plant of bitter gourd (25.00) was produced by T<sub>0</sub> treatment (open field or without tree condition) while second maximum number of leaves per plant (19.33) was produced under T<sub>3</sub> treatment (> 100 cm distance from the tree base) where they were statistically close. In contrast, the minimum number of leaves per plant (15.00) was observed at T<sub>1</sub> treatment (<50 cm distance from the tree base) which was statistically different from other treatments. However, treatment T<sub>2</sub> (50-100 cm distance from the tree base) produced third maximum number of leaves per plant (18.00) but it was statistically close with T<sub>3</sub>. Good foliage indicates higher growth, development and productivity of plant. The result of the experiment showed that the number of leaves per plant gradually increased with the increasing distance from the tree base.

**Number of primary branches/plant:** Bitter gourd was cultivated under different distance from the eucalyptus tree (Table 1). Branching and growth of bitter gourd was more vigorous in the open field than that of other closest distance to the associated eucalyptus tree in this study. As a result, the maximum average number of primary branches (3.00/plant) was observed in T<sub>0</sub> (Open field referred as control or without associated tree) while treatment T<sub>3</sub> (> 100 cm distance from the tree base) produces statistically close number of primary branches (1.00/plant). However, treatment T<sub>2</sub> (50-100 cm distance from the tree base) produced significantly the third maximum primary branches (0/plant) but it was also statistically close to T<sub>3</sub>. The minimum average number of branches (0/plant) was obtained from the treatment T<sub>1</sub> (<50 cm distance from the tree base). This result indicated

### (i) Morphological characteristics of bitter gourd at vegetative stage

**Vine length:** Length of bitter gourd was affected significantly by the effect of different treatment in this study (Table 1). From the Table 1, it was found that the maximum length of bitter gourd (44.00cm) was produced by T<sub>0</sub> (open field without tree) which was statistically close (40.33cm) to T<sub>3</sub> (> 100 cm distance from the tree base). Treatment T<sub>2</sub> (50-100 cm distance from the tree base) observed the statistically third highest or second lowest length (39.00 cm) of bitter gourd which was also statistically close to the treatment T<sub>3</sub>. The lowest length of bitter gourd (36.00cm) was observed in T<sub>1</sub> (<50 cm distance from the tree base).

that the open field or control condition produced the maximum branch number than other distance treatment with associated tree.

### (ii) Morphological characteristics of bitter gourd at harvesting stage

**Vine length:** Length of bitter gourd was affected significantly by the effect of different treatment in this study (Table 2). From the Table 2, it was found that the maximum length of bitter gourd (96.00cm) was produced by T<sub>0</sub> (open field without treatment) which was statistically close (72.66cm) to T<sub>3</sub> (> 100 cm distance from the tree base). Treatment T<sub>2</sub> (50-100 cm distance from the tree base) observed the statistically third highest or second lowest length (72.66cm) which was also statistically close to the treatment T<sub>3</sub>. The lowest length of bitter gourd (65.00cm) was observed in T<sub>1</sub> (<50 cm distance from the tree base).

**Number of primary branches/plant:** Bitter gourd was cultivated under different distance from the eucalyptus tree (Table 2). Branching and growth of bitter gourd was more vigorously in the open field than that of other closest distance to the associated eucalyptus tree in this study. As a result, the maximum average number of primary branches (5.00/plant) was observed in T<sub>0</sub> (Open field referred as control or without associated tree) while treatment T<sub>3</sub> (> 100 cm distance from the tree base) produces statistically close number of primary branches (4.33/plant). However, treatment T<sub>2</sub> (50-100 cm distance from the tree base) produced significantly the third maximum primary branches (3.66/plant) but it was also statistically close to T<sub>3</sub>. The minimum average number of branches (1.33/plant) was obtained from the treatment T<sub>1</sub> (<50 cm distance from the tree base). This result indicated that the open field or control condition noticed the

maximum branch number than other distance treatment with associated tree.

**No. of leaves/primary branch:** Different treatments showed significant effect on number of leaves per primary branch of bitter gourd (Table 2). The result revealed that the maximum number of leaves per primary branch of bitter gourd (32.00) was produced by T<sub>0</sub> treatment (open field or without treatment) while second maximum number of leaves per plant (29.66) was produced under T<sub>3</sub> treatment (> 100 cm distance from the tree base) where they were statistically close. In contrast, the minimum number of leaves per primary branch (19.66) was observed at T<sub>1</sub> treatment (<50 cm distance from the tree base) which was statistically differed from other treatments.

**Table 2.** Morphological characteristics of bitter gourd during harvesting stage in association with eucalyptus tree

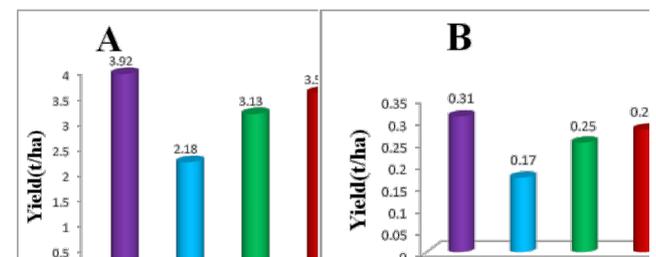
Treatments	Morphological characteristics				
	Vine length (cm)	No. of primary branches/plant	No. of leaves/primary branch	No. of fruit/plant	Weight/fruit (g)
T <sub>0</sub>	96.00 a	5.00 a	32.00 a	20.00a	33.50 a
T <sub>1</sub>	65.00 d	1.33 c	19.66 c	11.00 c	20.47 c
T <sub>2</sub>	72.66 c	3.66 b	27.00 b	15.33 b	29.22 b
T <sub>3</sub>	72.66 c	4.33 ab	29.66 ab	17.33 ab	32.00 ab
Cv	1.51	15.42	8.14	9.65	6.02
Lsd(1%)	3.63	1.67	6.67	4.65	5.24
Lsd(5%)	2.40	1.10	4.40	3.07	3.46
Level of sign.	**	**	**	**	**

**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 from the sample eucalyptus tree (Table 2). The maximum number of fruits/plant (20.00) was found in T<sub>0</sub> (open field referred as control) while treatment T<sub>3</sub> (> 100 cm distance from the treebase) produces the second maximum and statistically close number of fruits/plant (17.33). Treatment T<sub>2</sub> (50-100 cm distance from the tree base) recorded the third maximum number of fruits/plant (15.33) which was also statistically close to T<sub>3</sub>. The lower number of fruits/plant (11.00) 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 findings was also observed by Basak *et al.* (2009) who found that the yield contributing characters of the vegetables increased gradually with the increase of planting distance from the tree. Similar result was also reported by Khatun *et al.* (2009).

**Weight/fruit:** Weight of single fruits of bitter gourd was also significantly influenced by different planting distance from the tree. The trend of weight of single fruit was almost similar to that of number of fruits Plant<sup>-1</sup> (Table 2). The highest weight of single fruit (33.50 g) was recorded in T<sub>0</sub> (open field referred as control) while statistically similar weight of single fruit (32.00 g) was produced at > 100 cm distance from the sample tree plant. Due to high competition between tree and crop the lowest weight of single fruit (20.47 g) was found in T<sub>1</sub> (<50 cm distance from the tree base) while treatment T<sub>2</sub> (50-100 cm distance from the tree base) observed the third highest weight of single fruit (29.22 g). Similar observation was also obtained by Rahman (2008), who reported that except plant height all others morphological characters viz., no. of

branches Plant<sup>-1</sup>, no. of fruit Plant<sup>-1</sup>, fruit length, fruit diameter and fruit weight of three vegetables (tomato, brinjal and chilli) were highest in open field condition. However, treatment T<sub>2</sub> (50-100 cm distance from the tree base) produced third maximum number of leaves per primary branch (27.00) but it was statistically close with T<sub>3</sub>. Good foliage indicates higher growth, development and productivity of plant. The result of the experiment showed that the number of leaves per primary branch gradually increased with the increasing distance from the sample tree. Chipungahelo *et al.* (2007) reported that leaf morphological characteristics showed light intensity strongly influenced growth and development of sweet potato. Specific leaf area values in full light were smaller than those in under heavy shade. Arun *et al.* (2005) also reported similarly findings.

branches Plant<sup>-1</sup>, no. of fruit Plant<sup>-1</sup>, fruit length, fruit diameter and fruit weight of three vegetables (tomato, brinjal and chilli) were highest in open field condition.



**Fig. 1.** Yield of bitter gourd along with eucalyptus tree fresh yield (A) and dry yield (B)

#### Yield of bitter gourd

The variation in yield of bitter gourd (t/ha) was affected significantly due to effect of different treatments (Fig.1). As evident from the observation of Fig. 1, the highest fresh (3.8 t/ha) and dry (0.29 t/h) yield of bitter gourd were obtained from the treatment T<sub>0</sub> (Open field referred as control) (Fig. 1) where both yield viz. fresh (0.36 t/ha) and dry (0.29 t/ha) were statistically similar to that of the treatment T<sub>3</sub> (> 100 cm distance from the tree base). On the other hand, the lowest fresh (2.20 t/ha) and dry (0.16 t/ha) were found from closest distance treatment T<sub>1</sub> (<50 cm distance from the tree base). The second lowest yield of bitter gourd (3.10 and 0.23 t/ha) was obtained from T<sub>2</sub> (50-100 cm distance from the tree base) as fresh and dry yield of bitter gourd, respectively (Fig. 5a and 5b). Suranjit (2009) and Basak *et al.* (2009) reported similar findings. They found that the yield contributing characters of the vegetables increased gradually with the increase of

planting distance from the tree. Similarly Sayed *et al.* (2009) reported that the highest production of vegetables was recorded in control condition (without tree) and tomato, radish and soybean vegetable yield gradually with the increase of planting distance of the tree.

From this experiment it was found that, the treatment T<sub>0</sub> (open field referred as control) or long distance (T<sub>3</sub>: > 100 cm distance from the tree base) had positive significant effect on morphological, yield and yield attributing traits of bitter gourd. However, short distance (T<sub>1</sub> : <50 cm distance from the tree base) showed less growth and yield of this vegetable. Because of Eucalyptus had tall height growth, big stem girth, vigorous root with numerous lateral root systems, more shading and lighting effect. So, therefore, open field (without eucalyptus) which was referred as control (T<sub>0</sub>) or long distance (T<sub>3</sub>) would be more successful cultivation techniques for higher production of bitter gourd in agroforestry system.

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