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RESEARCH PAPER

Growth and Yield Performance of Bitter Gourd along with Mango Tree as Silviagricultural System

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ABSTRACT

An experiment was conducted at the Germplasm Centre, Department of Horticulture, Patuakhali Science and Technology University during November 2016 to April 2017 with the aim of evaluating the growth and yield performance of bitter gourd (*Momordica charantia*) in association with mango (*Mangifera indica*) tree at different distances from tree base. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Data were collected on morphological characteristics namely vine length, no. of primary branches per plant, no. of leaves per primary branches and yield contributing characteristics namely no. of fruits per plant, weight of fruits per plant, fresh and dry weight of fruit. The experiment consisted of four treatments viz. T_0 (open field as control), T_1 (50 cm distance from tree base), T_2 (100 cm distance from tree base) and T_3 (150 cm distance from tree base). Result showed that the morphological and yield contributing characteristics of bitter gourd were increased gradually in treatments where distance was more from mango tree base. The highest values of all morphological parameters of bitter gourd were observed under T_0. Among all the different distances from mango tree base, highest values of different growth parameters was recorded in treatment T_3 followed by T_2 and lowest values were recorded in T_1. The highest yield of bitter gourd (3.9 tha^{-1}) was recorded in control condition. Yield of bitter gourd was found decreasing trend in different distances from tree base where minimum (7.7%), moderately (20.51%) and maximum (43.59%) yield reduction were found in T_3, T_2 and T_1, respectively compare to T_0. Therefore, the growth and yield of bitter gourd were influencing by the mango tree and the study concluded that bitter gourd can successfully be grown in association with mango tree as a silviagricultural system in Bangladesh perspective.

Key words: Bitter gourd, growth, mango, silviagriculture, yield

Introduction

Forestry with agricultural crop can provide a sound ecological basis for increased crop and animal productivity, more dependable economic returns, and greater diversity in social benefits on a sustained basis. Silviagricultural system is way of cultivation of agricultural crops along with woody perennial tree. Well planned and well managed agroforestry can play an important role in solving acute problem of food, fuelwood, fodder, soil fertility and ecology; agroforestry system practices are highly profitable and play significant role in improving the economic status of the farmers as well (Hafizul, 2007). A country needs 25% forest land of its total area for ecological stability and sustainability. Bangladesh is endowed with only 17.08% (BBS, 2011) of unevenly distributed forests but actual tree cover is less than 10% (Akter *et al*., 1989).

Bangladesh is a highly populated country in south Asia with an area of 147,570 km2. The population of the country is over 160 million with 1.6% of annual growth rate and the density of population is 1033.5/km2 (BBS, 2011). If the current population growth rate continues, population will increase to 180 million by the year 2025, and the country will face enormous problem for nursing her population. The country has only a land area of

14.39 million hectares, but to the ever-growing population per capita land area is decreasing at an alarming rate of 0.005ha/capita/year since 1989 (Hossain and Bari, 1996). Unfortunately these limited areas are decreasing due to increasing the area of other crops. The capacity of our land is decreasing day by day due to intensive cropping and use of high input technologies. About 31.60% of the gross domestic product of Bangladesh is contributed from agriculture. Of the total agricultural product about 22.80% comes from various crops, 3.2% from livestock, 3.27% from fishes and 2.32% from forests (BBS, 2006).

The average consumption of vegetable in Bangladesh is only 70g per head per day including potato and sweet potato. Except tuber crops, it is only 30g as against the FAO recommendation of 200g. To supply the minimum daily requirement of 200g vegetable/head/day, national production of vegetable should be over 10 million tons in addition. 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 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). Bitter gourd is important for its quick growing nature and high yielding potential. It is easily cultivated as a companion crop or inter crop. Even this vegetable can successfully grow in association with Agroforestry trees. Fresh bitter gourd is an excellent source of vitamin-C (100 g of raw fruit provides 84 mg or about 140% of RDI). Its vegetable is also good source of niacin (vitamin B-3), pantothenic acid (vitamin B-5), pyridoxine (vitamin B-6) and minerals such as iron, zinc, potassium, manganese and magnesium. Moreover bitter gourd is more effective for treating HIV infection (USDA, 2013).

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. In agroforestry systems several multipurpose trees are introduced throughout the South Asia. Of them, Mango tree is very popular and profitable too. Mango tree is a common multipurpose tree and it found everywhere in Bangladesh. The mangoes are rich as a source of Vitamins (Especially vitamins A and C) minerals and total soluble solids (Pramanik, 1995). It is also a medium source of carbohydrates (16.9%) (Salunkhe and Desai, 1984). The minimum dietary requirement of fruit per head per day is 85g; whereas the availability is only 30- 35 g which is much lower than the recommended daily requirement.

In Bangladesh, a large number of vegetables are grown during winter season as sole crops but seldom found in association with trees as agroforestry system. Due to increase demand of vegetables and fruit, cultivation of vegetables and fruit tree plantation is the prime necessity in Bangladesh. For maintaining ecological balance and biodiversity aforestation activities is also the prime requirement in Bangladesh. As a result, there is a tremendous pressure on the natural resources of the country. Consequently, poverty has become a serious issue. There is, naturally, a crying demand for wood for the over growing population. Considering the two dominant development paths–rapid economic growth through industrialization and agriculture, forests are continuously depleted at an alarming rate. This put heavy pressure on land for human habitation and crop production. Considering the above points and keeping in view of the crop importance, the specific objectives of this study were: (1) To evaluate the morphological characteristics and yield of bitter gourd along with mango trees and (2) To identify the optimum distance from the mango tree base so as to know the optimum growth and yield of bitter gourd.

Materials and Methods

Location of the study area: The location of the study area was Germplasm Centre, Department of Horticulture, Patuakhali Science and Technology University, Dumki, Patuakhali. Geographically the experimental area is located at 22.354 N latitude and 90.318 E longitudes.

Soil: The soil of the experimental field belongs to the Barisal soil series of the Ganges Tidal Floodplain (Agro ecological Zone AEZ-13). The general soil type of the experimental field is silty clay loam. Topsoil is silty clay in texture. Organic matter content is very low and soil pH value 6.8.

Climate and weather: The experimental area is situated in the sub–tropical climatic zone and characterized by heavy rainfall during the months of April to September (Kharif Season) and scanty rainfall during the rest period of the year. The Rabi season (October to March) is characterized by comparatively low temperature and plenty of sunshine from November to February. The detailed meteorological data in respect of air temperature, relative humidity, total rainfall and soil temperature have been collecting from Radar Station, Khepupara, Patuakhali.

Tree and plant material: Previously established mango (*Mangifera indicia* L.) trees were used as tree component and bitter gourd (*Momordica charantia*) was used as vegetable component. Bitter gourd is tender tendril bearing and vine like plant from genus Cucurbits belongings to the family Cucurbitaceae or gourd family.

Tree management: The study was done under 4.5 year's old Mango tree. At first soils at the base of tree were loosening very well and made friable. Weeds were removed from the surrounding area of the tree base; insect infected leaves of stems were also removed.

Experimental design and treatment combination: The experiments were done following Randomized Complete Block Design (RCBD) with three replications. Different treatments in this study were; T_0=open field referred to as control, T_1=50cm distance from the tree base, T_2=100cm distance from the tree base and T_3=150cm distance from the tree base.

Land preparation: The experimental land was first opened on November 2, 2016 and the operation was done by spade. Weeds and stubble were removed from the field and then left exposed to natural weather for several days before the land was finally prepared for sowing seeds of bitter gourd. Pits of 45x45x40 cm size are prepared 2 m apart in a single row along the bed.

Crop establishment: Seeds of bitter gourd were sown in polybag on 6 November 2016 and then seedlings were transplanted on 20 November 2016 in the experimental pit by transplanting according to treatments.

Management practices: Different management practices such as fertilizer and manures application, weeding, irrigation, thinning or filling, pest and disease management etc. were done for better growth of the plants. The management practices were done describe as follows:

***Application of fertilizer and manures*:** The recommended doses of cow dung/compost 10-12kg pit^{-1}, TSP 50g pit^{-1}, MOP 60g pit^{-1} and Urea 130g pit^{-1} were applied. Full amount of well decomposed cow dung/compost and TSP were incorporated during the final land preparation.

***Weeding and irrigation*:** Weeding was done three times in experimental pits as well as control pits to keep the pits free from weeds. The pits were irrigated by using watering can to supply sufficient soil moisture for the vegetable.

***Thinning or filling*:** 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 were done at 5 days interval from first thinning. After emergence, bitter gourds were thinned out at three times while first thinning was done at 15 days after sowing.

***Pest and disease control*:** No diseases and pests were observed as no insecticide and fungicide were used in the field for tree-crop association.

Harvesting: The fruits were harvested at tender stage and before 85% maturity. They were harvested at 100 days after seedlings transplanting stage. Harvesting was done by hand picking at several picking.

Data collection: Data of different morphological characteristics were collected at different stages namely vegetative, flowering and harvesting. The average data were collected form data each pit. The recorded parameters were as follows:

***Vine length*:** The length from the base of main vine to the tip was recorded at harvesting time. Vine length was measured using measuring tape expressed in centimeter (cm).

***Number of primary branches per plant*:** All leaves of the selected plants were counted separately at harvest time. Only the smallest young leaves at growing point of the plant were excluded from the counting.

***Number of leaves per primary branches*:** At harvest time of the plant, total number of branches per plant was recorded.

***Number of fruits per plant*:** The number of fruits per plant was calculated by dividing the total number of fruits harvested per plant by the number of plants per plot.

***Weight of fruits per plant*:** The individual fruit harvested was weighed and the total weight of all fruits of each plant was considered as yield per plant and expressed in gram (g).

***Fresh and dry weight of fruit yield*:** The average yield of one plant per replication was multiplied by total number of plants accommodated per hectare to find out yield per hectare expressed in tha^{-1}.

Data analysis: The data were collected from the experiment at different stages of various growths and then analyzed statistically by using PC wasp2 software package to find out the statistical significance of the experimental results. The analysis of variance (ANOVA) for each of the recorded character was done by F (variance ratio) test. The mean differences were evaluated by Least Significant Difference (LSD) test. 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

Morphological characteristics of bitter gourd were affected significantly by increasing distance from mango tree base. The data on various characteristics of morphological and yield traits viz. plant height, number of primary branches/plant, number of leaves/primary branch, number of leaves/plant, number of fruits per plant, weight of fruits, fresh and dry weight of yield of fruits were discussed based on findings.

Vine length: There was significant variation in vine length of bitter gourd grown with mango tree (Tables 1 and 2). Among different distances the highest vine length of bitter gourd was 76.35 and 97.20 cm at 60 DAS and harvesting stage, respectively found in T_0 (open field referred as control), following 64.91 and 85.37 cm at 60 DAS and harvesting stage, respectively found in T_3 (150 cm distance from tree base). Similarly the lowest vine length of bitter gourd was found 32.23 and 65.47 cm at 60 DAS and harvesting stage, respectively in T_1 (50 cm distance from tree base). It was found that vine length of bitter gourd gradually increased with increasing distance from mango tree base, it might be due to higher competition for natural resources like moisture, nutrient, sunlight etc. for very near the mango tree base. Results are consistent with the findings of Masfikha (2013) and Rahman (2013), they studied on bitter gourd cultivation in association with fruit trees and three selected tree species during winter season. This is also comparable with the observation by Momtaz (2013) in bitter gourd plants in association with mango, guava and lemon tree**,** Taher (2014) in bitter gourd plants along with lambu tree.

Table 1: Morphological characteristics of bitter gourd in association with mango tree at 60 DAS

Treatment	Vine length (cm)	No. of primary branches plant^{-1}	No. of leaves primary branch^{-1}
T_0 (open field)	76.35 a	4.29 a	30.90 a
T_1 (50cm distance)	32.23 d	1.86 d	11.13 d
T_2 (100cm distance)	43.60 c	2.76 c	19.95 c
T_3 (150cm distance)	64.91 b	3.70 b	24.97 b
Level of significance	**	**	**
CV (%)	1.72	6.90	5.32

Different latter followed by mean value within a column indicate statistically different by LSD at $P \leq 0.01$, T_0 = control, T_1 = 50cm from tree base, T_2 = 100 cm from tree base, T_3 = 150 cm from tree base. CV = Coefficient of Variation and ** = 1% level of significance.

Table 2: Morphological characteristics of bitter gourd in association with mango tree at harvesting stage

Treatments	Vine length (cm)	No. of primary branches plant^{-1}	No. leaves primary branch^{-1}	No. of fruits plant^{-1}	Individual fruit weight (g)
T_0 (open field)	97.20 a	5.87 a	39.67 a	20.00 a	34.33 a
T_1 (50cm distance)	65.47 d	2.40 d	19.67 d	10.00 d	20.67 d
T_2 (100cm distance)	76.50 c	3.86 c	27.67 c	15.67 c	28.33 c
T_3 (150cm distance)	85.37 b	5.03 b	29.33 b	18.67 b	31.33 b
Level of significance	**	**	**	**	**
CV (%)	2.01	6.08	6.34	10.82	4.61

Different latter followed by mean value within a column indicate statistically different by LSD at $P \leq 0.01$, T_0 = control, T_1 = 50cm from tree base, T_2 = 100 cm from tree base, T_3 = 150 cm from tree base. CV = Coefficient of Variation and ** = 1% level of significance.

Number of primary branches per plant: There was significant variation in number of primary branches per plant of bitter gourd grown association with mango tree (Tables 1 and 2). The result revealed that the highest number of primary branches per plant (4.29) at 60 DAS and (5.87) at harvest was produced by T_0 (open field referred as control). Among the different distances from mango tree the highest number of primary branches per plant (3.70) at 60 DAS and (5.03) at harvest was produced under T_3 (150 cm distance from the tree base) and the lowest (1.86) at 60 DAS and (2.40) at harvest were observed in T_1 (50 cm distance from the tree base). This result indicated that the open field or control condition noticed the maximum branch than other distance treatment with associated tree. Results are comparable with the findings of Rahman *et al.* (2013) who conducted an experiment to see the performance of sweet gourd grown in association with akashmon. Similarly, Islam *et al.* (2009) reported that morphological characteristics of vegetables namely number of leaf, leaf length and diameter, stem girth, fresh and dry weight etc. decreased consistently with the decrease of distance from the tree base.

Number of leaves per primary branch: There was significant variation at 1% level in number of leaves per primary branch of bitter gourd grown under mango tree. The result showed that the highest no. of leaves per primary branch (30.90) at 60 DAS and (39.67) at harvest were recorded in T_0 (open field referred as control) and the lowest (11.13) at 60 DAS and (19.67) at harvest was recorded at T1 (50 cm distance from the tree). The highest number of leaves per primary branch (24.97) at 60 DAS and (29.33) at harvest was produced under T_3 (150 cm distance from the tree) among the different distances from the tree base. Control produces the best result might be due to the absence of shading effect which is comparable with the findings of Sharif *et al.* (2010). The no. of leaves per primary branch of bitter gourd was increased consistently with the increase of distance from tree base that observed by Taher (2014), Roy (2014) and Khan & Hasan (2015) in bitter gourd.

Number of fruits per plant: Number of fruits/plant is the most important yield contributing characteristic, which was significantly influenced by different distance of growing bitter gourd from the mango tree base. The maximum number of fruits/plant (20.00) was found in T_0 (open field referred as control) while treatment T_3 (150 cm distance from the tree base) produces the second highest (18.67). The lowest number of fruits/plant (10.00) was found under close contact from the tree base and it was probably due to poor photosynthetic capacity and higher competition for natural resources like nutrients, light, water, etc. between mango tree and studied bitter gourd. Similar findings was also observed by Basak *et al.* (2009) who found that the yield contributing characteristics of vegetables increased gradually with the increase of planting distance from the tree base. Similar result was also reported by Khatun *et al.* (2009) and Khan & Hasan (2015) for bitter gourd cultivation.

Individual fruit weight: Weight of fruit of bitter gourd was significantly influenced by different planting distance from tree base. The trend of fruit weight of single fruit was almost similar to that of number of fruits plant^{-1}. The highest weight of single fruit (34.33g) was recorded in T_0 (open field referred as control) while the

weight of single fruit (31.33 g) was produced at 150 cm distance from the tree base in treatment T_3. Due to high competition between tree and crop the lowest weight of single fruit (20.67g) was found in T_1 (50 cm distance from the tree base). Similar observation was also obtained by Rahman (2004), who reported that except plant height all others morphological characters viz., no. of branches plant-1, no. of fruit plant-1, fruit length, fruit diameter and fruit weight of three vegetables (tomato, brinjal and chilli) were highest in open field condition.

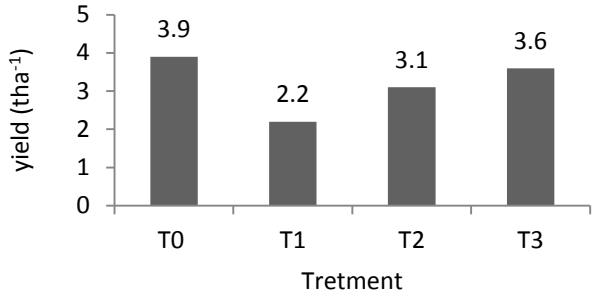

Figure 1. Fresh yield of bitter gourd in association with mango tree

Note: T_0= Control, T_1= 50cm from tree base, T_2= 100 cm from tree base, T_3= 150 cm from tree base. Different letter followed by mean value indicate statistically different.

Fresh Yield of bitter gourd: The variation in yield of bitter gourd (t/ha) was affected significantly due to effect of different treatments (Figure 1). The highest fresh yield (3.9 t/ha) of bitter gourd were obtained from the treatment T_0 (Open field referred as control) following 3.6 t/ha was found in treatment T_3 (150 cm distance from the tree base). On the other hand, the lowest fresh yield (2.20 t/ha) were found from closest distance in treatment T_1 (50 cm distance from the tree base). Results are comparable with the findings of Basak *et al.* (2009) where 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 increased with the increase of planting distance from the tree base.

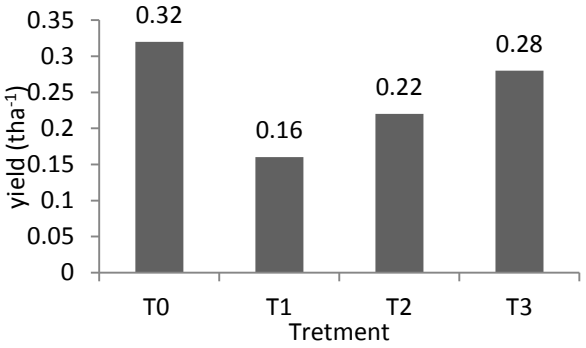

Figure 2. Dry yield of bitter gourd in association with mango tree

Note: T_0= Control, T_1= 50cm from tree base, T_2= 100 cm from tree base, T_3= 150 cm from tree base. Different letter followed by mean value indicate statistically different.

Dry weight of bitter gourd: The highest (0.32 tha^{-1}) and lowest (0.16 tha^{-1}) dry weight of bitter gourd were obtained from the treatment T_0 referred as control or open field condition and treatment T_1 (50 cm distance from mango tree base), respectively (Figure 2). Among the distance treatments, T_3 (150 cm distances from the tree base) produced the highest dry weight of yield (0.28 tha^{1}). Results are comparable with the findings of Masfikha (2013), Rahman (2013) and Khan & Hasan (2015) where they found the similar findings in case of dry weight of yield of bitter gourd. Mallick *et al*. (2013) and Rahman *et al*. (2013) also observed the consistent results of this present study.

Conclusion

Significant influence of different distance from mango tree base on morphological characteristics as well as the yield of bitter gourd was observed. Yield performance of bitter gourd was better under open field condition compared to tree-crop base may be due to less competition for natural resources. From this experiment it was observed that, yield of bitter gourd at open field condition gave the best result. Among the distances from the tree base, the long distance gave the best production of vegetable. The short distance showed less production due to competition for nutrient, water and other growth factors in agroforestry system. For this reason, growth and yield of bitter gourd reduced beneath the tree canopy or near the tree base. But the agroforestry practice is profitable for farmer because same land produces vegetable and fruit at the same time. It may be concluded that bitter gourd can successfully grow in cultivation with mango tree as silviagricultural system of Bangladesh perspective. However further research can be done in this regard including more treatment effect at different location before suggest for farmers field.

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References

Akter MS, Abedin Mz, Quddus MA (1989) Why farmers grow trees in agricultural fields: some thoughts, some results. Research Report, 1988-1989. On Farm Research Division, Bangladesh Agricultural Research Institute, pp.75-82.

Basak S, Hasan MK, Islam MS, Wadud MA (2009) Performance of radish, tomato and soybean during the first year of Lohakat (*Xylia dolabriformis*) plantation. *Journal of Environmental Science Natural Resources*, 2(1): 185–189.

BBS (1998) Statistical Yearbook of Bangladesh. Bangladesh Bureau of Statistics (BBS), Statistics and Informatics Division, Ministry of Planning Government of the People's Republic of Bangladesh, Dhaka. p. 145-158.

BBS (2006) Statistical Yearbook of Bangladesh Bureau of Statistics (BBS), Statistics and Informatics Division, Ministry of Planning Government of the People's Republic of Bangladesh, Dhaka.

BBS (2009) Statistical Yearbook of Bangladesh. Bangladesh Bureau of Statistics (BBS), Statistics and Informatics Division, Ministry of Planning Government of the People's Republic of Bangladesh, Dhaka. p.51.

BBS (2011) Statistical Yearbook of Bangladesh. Bangladesh Bureau of Statistics (BBS), Statistics and Informatics Division, Ministry of Planning Government of the People's Republic of Bangladesh, Dhaka.

Gomez, KA, Gomez AA (1984) Statistical Procedure for Agricultural Research Institute. John Wiley and Sons, New York, Chickester Brisbane, Torento, Singapore. pp. 139-240.

Hafizul MH (2007) Study on Homestead agroforestry practices with their contribution to food and fuel wood supply in Gopalpur union of Rangpur District. MS Thesis, Department of Agroforestry, Bangladesh Agricultural University, Mymensingh, Bangladesh.

Hossain SMA, Bari MN (1996) Agroforestry farming system. In: Hoque M.A. (Editor), Agroforestry in Bangladesh, Village and Farm Forestry Project. SDC. Dhaka and Bangladesh Agricultural University, Mymensingh. pp. 21-29.

Islam MS, Wadud MA, Hasan MK, Rahman MM, Rahman GMM (2009) Performance of three winter vegetables in association with Telsur (*Hopea odorata*). *Journal of Agroforestry and Environment*, 3(1):73-76.

Khan MNU, Hasan MK (2015) Performance of bitter gourd in association with karanja (*Pongamia pinnata* L.) tree. *Research in Agriculture, Livestock and Fisheries*, 2(1): 63-73.

Khatun MA, Wadud MA, Yasmin R, Sayed MKI, Rahman GMM (2009) Agroforestry practices with three wintyer vegetables during early eastablishment period of civit (*Swintonia floribunda*) plantation. *Journal of Agroforestry and Environment*, 3(1): 1-4.

Mallick E, Wadud MA, Rahman GMM (2013) Strawberry cultivation along with Lohakat (*Xylia dolabriformis*) tree as agroforestry system. *Journal of Agroforestry and Environment*, 7: 1-6.

Masifkha M (2013) Performance of bitter gourd in association with three fruit trees during winter season. M.S. Thesis, Department of Agroforestry Bangladesh Agricultural University, Mymensingh.

Momtaz M (2013) Performance of bitter gourd in association with three fruit trees during winter season. MS Thesis, Department of Agroforestry, Bangladesh Agricultural University, Mymensingh, Bangladesh.

Pramanik MAJ (1995) Effects of Different Post Harvest treatments on physico-chemical changes during storage and shelf life of mango. M.S. Thesis, Department of Horticulture, BAU, Mymensingh.

Rahaman A, Hossain MI, Akter A, Wadud MA, Rahman GMM (2013) Performance sweet gourd grown in association with akashmoni saplings. *Journal of Agroforestry and Environment*, 7: 61-64.

Rahman KM (2004) Performance of summer tomato, brinjal and chilli under multistoried Agroforestry System. MS Thesis, Department of Agroforestry, Bangladesh Agricultural University, Mymensingh, Bangladesh.

Rahman MM (2013) Effect of two years old Akashmoni tree on three winter vegetables grown in Agroforestry system. MS Thesis, Department of Agroforestry, Bangladesh Agricultural University, Mymensingh, Bangladesh.

Roy I (2014) Performance of mango-sweet gourd based agroforestry system. MS Thesis, Department of Agroforestry, Bangladesh Agricultural University, Mymensingh, Bangladesh.

Salunkhe DK, Desai B (1984) Post-harvest biotechnology of fruits. Vol-1, 168pp.CRC press florida, U.S.A.

Sayed MKI, Wadud MA, Khatun MA, Yasmin R, Rahman GMM (2009) Interaction effects of vegetables in association with two years old (*Hopea odorata*) sapling. *Journal of Agroforestry and Environment*, 3(2): 103–106.

Sharif MO, Wadud MA, Mondol MA, Tanni AD, Rahman GMM (2010) Effect of shade of different trees on growth and yield of aman rice. *Journal of Agroforestry and Environment*, 4(2): 167- 172.

Taher MA (2014) Performance of sweet gourd and bitter gourd in char land based agroforestry farming system. MS Thesis, Department of Agroforestry, Bangladesh Agricultural University, Mymensingh, Bangladesh.

USDA (2013) National Nutrient data base of USDA (cucumber nutrition facts). Online available at:http:perperwww.nutrition–and–you.com perradish.html.