J. Agrofor. Environ. 7 (1): 53-56, 2013 ISSN 1995-6983

Effect of guava and lemon on the yield of okra under Agroforestry system

S.C. Bali, M.A. Mondol, A. Akter, Z. Alam and M. A. Wadud
Department of Agroforestry, Bangladesh Agricultural University, Mymensingh, E-mail: sukanto_chandra@yahoo.com

Abstract: A field experiment was conducted to evaluate the growth and yield of Okra vegetable grown in association with Lemon and Guava tree based Agroforestry system. The experiment was located at the Char Kalibari, Mymensingh and the duration of the study was June 2012 to November 2012. This study was conducted using a Randomized Complete Block Design (RCBD) with four replications. Different distance from tree base was treated as different treatment. Three different distance category like 0-2.5 ft, 2.5-5.00ft and 5-7.5 ft from tree base were the three different treatment of the study. There was a control treatment i.e. Okra was cultivated in the open field condition (without tree). So the four treatment of this study were T_0 (open field condition referred as control), T_1 (2.5 ft distance from the tree base), T_2 (5 ft distance from the tree base) and T_3 (7.5 ft distance from the tree base). Growth of Guava and Lemon tree also observed during the Okra growing period. The result showed that yield of Okra was gradually increased with increasing distance from both of the tree base. Yield of Okra was highest in open field condition. However, yield of Okra in association with Guava reduced by 2.25, 22.26 and 38.89% yield in 5-7.5 ft, 2.5-5 ft and 0-2.5 ft distant area, respectively. On the other hand, Okra yield reduced 6.8, 26.6 and 43.7% yield in 5-7.5 ft, 2.5-5 ft and 0-2.5 ft distance from Lemon tree base, respectively. Performance of Okra was relatively better along with Guava compare to Lemon tree. The Okra yield difference was 5-7% higher in association with Guava. Regarding to the tree growth, both Guava and Lemon tree growth were better in open field condition compare to tree-vegetable combined situation. Therefore, different tree-crop based Agroforestry system performance had varied greatly. According to the result of this study, Okra yield was better in Guava-Okra based Agroforestry system; however, the performance of Lemon-Okra was also revealed better result. The tree growth was better in open field condition but the total crop and tree yield showed that Agroforestry system is more prfitable than other monoculture of agriculture or forestry production system.
Key words: Guava, Lemon, Okra, Agroforestry.

Introduction

Agroforestry, the integration of the tree, crop and vegetable on the same piece of land is a promising production system for maximizing yield (Nair, 1990). In agroforestry systems, trees or shrubs are intentionally used within agricultural systems, or non-timber forest products are cultured in forest settings. Knowledge, careful selection of species and good management of trees and crops are needed to optimize the production and positive effects within the system and to minimize negative competitive effects. Bangladesh is a densely populated country with a population growth rate of 1.3% per annum in recent years. Comparing population growth rate production is not increasing. So, the need for maintaining the population-food nutrition balance can hardly be overemphasized. Most of the people of our country suffer from malnutrition specially vitamins and minerals. Okra, Guava and Lemon is a good source of readily up-takeble vitamin and minerals. It is also very cheap and easily available. It is quite hardy, prolific bearer and highly remunerative even without much cares (Bose and Mitra, 1990). These vegetables can specially be grown in homestead areas (the homestead area per household of Bangladesh is 0.28 ha) throughout the country even without or little care. Okra (*Abelmoschus esculentus* L.) is a member of the family Malvaceae, also known as lady's finger. It is originated in the tropical Africa or Asia and is now widely grown as vegetable crop throughout the tropics (Thompson and Kelly, 1959; Purseglove, 1968). It is well distributed throughout the Indian sub-continent and East Asia (Rashid, 1999). Lemon *(Citrus limon)* is one of the popular fruits cultivated in Bangladesh under the family Rutaceae. Lemon originated in north eastern India and Burma (Hodgson, 1967). Guava *(Psidium guajava),* member of the dicotyledonous family Myrtaceae, the apple of the tropics, is one of the most important fruits in Bangladesh. It claims to be the most important fruit in area and production after jackfruit, pineapple, mango and melon in Bangladesh (BBS, 1997). Origin of guava is the tropical America and now it is widely grown all over the tropics and subtropics. In this subcontinent, guava has been in cultivation since early 17th century (Mitra and Bose, 1990). Guava is a very common fruit in Bangladesh. It is popular among the rich and poor people due to its comparative low price than some other fruits, nourishing value and good taste. It is a rich and cheap source of vit. C (560mg/100g) (Phandis, 1970), which is the second after aonla (600mg/100g) and 2 to 5 times higher than fresh orange juice. It is also rich in pectin, which has industrial use for jelly production (Bose and Mitra, 1990). It is a fair source of vit.A and good source of calcium and phosphorus. It also contains much iron, but 80% of it remains in seed (Millar and Bazore, 1945). For identifying the compatible tree-crop combination, i.e. different crops should be screened out in terms of their adaptability and yield in association with fruit tree. For this purpose, the best way of experimentation is to grow different crops at different spacing from the tree. Present study was undertaken to observe the morphological behaviors, yield and yield attributes of the Okra grown in association with Guava and Lemon tree.

Materials and Methods

Location of the study area: The experiment was carried out at Char Kalibari belongs to the Mymensingh Sadar Upazilla during the period from June 2012 to November 2012. The place is geographically located at about 24°75" North latitude and 90°50' East longitudes (FAO, 1988). Total area of this district is 4363.48 km^2 and situated on the west bank of Brahmaputra River. This district has total 12 upazila and the studying area i.e. Char Kalibari belong to the Mymensingh sadar upazila. The geographical position of char kalibari located between 24˚45'- 24˚45'40" North and 90˚24'4"- 90˚24'44" East Latitude (FAO, 1988). It is an attached Char land which has three distinct elevations i.e. upper elevation is relatively stable chnar, while the middle and lower elevation remained inundated during the rainy season in each year. Only upper portion is

suitable for cultivation of vegetables during summer and winter season.

Soil characteristics: The topography of the field was medium high land above flood level belonging to the Old Brahamaputra Floodplain Agro-Ecological Zone-9 (FAO, 1988). It is characterized by non calcareous dark grey flood plain soil having pH value from 6.5 to 6.8 and the soil texture is silty loam. It appeared cold but readily broken when pulverized.

Climate and weather: The climate of the location was characterized by relatively high temperature and heavy rainfall during Kharif or summer season (April to October) and low temperature and little rainfall during Rabi or winter season (November to March).

Tree and plant materials: In this study, previously established 2 years old Lemon and Guava were used as tree components. The seeds of Okra variety BARI Dherosh-1 (summer vegetable) were used as plant materials in this study.

Experimental design and treatment combination: The experiment was laid out following the Randomized Complete Block Design (RCBD) design with single factorial arrangement with three replications. Four treatments (Fig.1) of this study are used such as T_0 (Okra grown without lemon and guava tree base), T_1 (Okra grown 2.5ft distance from the tree base), T_2 (Okra grown 5ft distance from the tree base) and T_3 (Okra grown 7.5ft distance from the tree base).

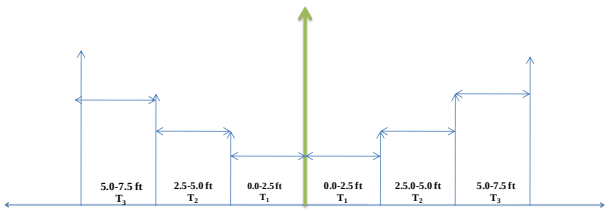

Fig. 1. Layout of the experiment i.e., Different distance from the tree base.

considered for data collection. Dry yield was measured after complete drying the samples in the oven at 70^0 C from representative samples and it was converted as tha^{-1}. Dry yield was calculated using the following formula:

$$\text{Total dry weight} = \frac{\text{subsample oven dried weight}}{\text{subsample fresh weigth}} \times \text{total fresh weight}$$

Statistical analysis: The data were collected from the experiment at different stages of various growths, and analyzed statistically by using MASTATC software package to find out the statistical significance of the experimental results. The means for all the treatments and analysis of variance of yields of the summer vegetables was calculated by Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984).

Results and Discussion

Okra along with Guava:

Different morphological characteristics of okra like plant height (cm)**,** number of leaves $Plant^{-1}$, number of branches $Plant^{-1}$, number of fruits $Plant^{-1}$, single fruit weight (g), length of fruit (cm), fruit girth (cm) and days to first edible fruit harvest were significantly influenced when it was cultivate in association with Guava tree (Table 1). Highest value of all parameters was in open field condition and among the different distances from tree base it was gradually increased with increasing distance from tree base (Table 1).

Yield: Different distance from tree base had significant influence on the both fresh and dry yield of Okra and yield gradually increased with increasing the distance from the Guava tree base (Fig. 2). At every harvesting period the highest both fresh and dry yield were found in open field condition which were statistically alike to second highest were found in 5.0-7.5 feet distance from the Guava tree base (Fig. 2). The lowest both fresh and dry yield is found in 0.0-2.5 feet distance from the Guava tree base at every harvesting period time (Fig. 2).

Table 1. Effect of Guava tree on the morphological behavior of Okra at different distance from tree bsae

Treatment	Morphological characteristics of Okra							
	Plant height (cm)	NO. of leaves/plant	No. of branches/ plant	No. fruit/plant	Single fruit weight (g)	Fruit length (cm)	Fruit girth (cm)	Days to first edible fruit harvest
T0	118.90c	56.31a	3.90a	53.17a	20.52a	16.75a	5.65a	50.39c
T1	128.58a	53.10c	2.94d	46.65d	18.09b	13.69c	4.38d	53.95a
T2	125.83b	54.08b	3.36c	49.96c	18.92b	14.47b	4.93c	52.03b
T3	120.25c	53.17c	3.80b	52.42b	19.85a	16.59a	5.48b	51.07c

Means in different column followed by the different letter are significantly different by DMRT at $P \leq 0.05$; Where, T0 = Open field referred as control, T1= 0.0 feet to 2.5 feet distance from the tree, T2 = 2.5 feet to 5.0 feet distance from the tree, T3 = 5.0 feet to 7.5 feet distance form the tree.

Total fresh yield of Okra in different distance category i.e. in 0.0-2.5 feet, 2.5-5.0 feet and 5.0-7.5 feet from tree base were 36.68%, 22.26% and 2.26% reduced compare to it open field condition. Total dry yield of Okra in different distance category i.e. in 0.0-2.5 feet, 2.5-5.0 feet and 5.0-7.5 feet from tree base were 42.95%, 20.81% and 4.70% reduced compare to it open field condition (Fig. 2). Considering this result it is clear that two years old Guava tree negatively affect the yield of associated crops/ vegetables up to 5 feet distance from the tree base. Similar result also observed by Khatun *et al.* (2009), Tanni *et al*. (2010) and Habib *et al.* (2012) in different winter and summer vegetable grown in association with Lohakat (*Zylia dolabiformis*) tree.

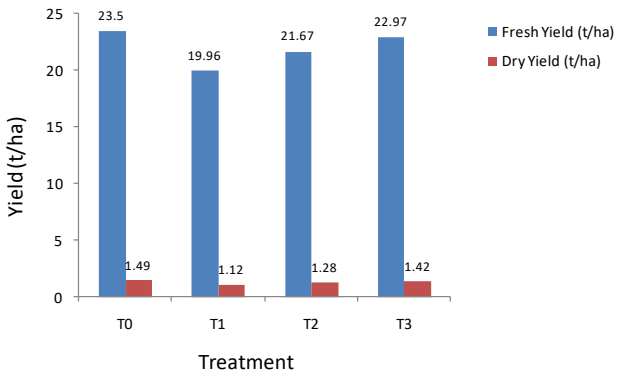

Fig.2. Total fresh and dry yield of Okra association with Guava

Okra in association with Lemon:

Like along with Guava tree, different morphological characteristics of okra like plant height (cm), number of leaves Plant^{-1}, number of branches Plant^{-1}, number of fruits Plant^{-1}, single fruit weight (g), length of fruit (cm), fruit girth (cm) and days to first edible fruit harvest were also significantly influenced when it was cultivate in association with Guava tree (Table 2). Here also highest value of all parameters was in open field condition and among the different distances from tree base it was gradually increased with increasing distance from tree base (Table 2).

Table 2. effect of Lemon tree on the morphological behavior of Okra at different distance from tree base

Treatment	Morphological characteristics of Okra							
	Plant height (cm)	No. of leaves/plant	No. of branches/plant	No. of fruit/plant	Single fruit weight (g)	Fruit length (cm)	Fruit girth (cm)	Days to first edible fruit harvest
T0	112.95c	53.49a	3.70a	50.52a	19.49a	15.91a	5.36a	47.87c
T1	122.16a	50.44c	2.70d	44.31d	17.18b	13.00c	4.16d	51.25a
T2	119.53b	51.37b	3.10c	47.46c	17.97b	13.74b	4.68c	49.42b
T3	114.23c	50.51c	3.61b	49.79b	18.85a	15.76a	5.20b	48.51c

Means in different column followed by the different letter are significantly different by DMRT at P ≤ 0.05; Where, T0 = Open field referred as control, T1= 0.0 feet to 2.5 feet distance from the tree, T2 = 2.5 feet to 5.0 feet distance from the tree, T3 = 5.0 feet to 7.5 feet distance form the tree.

Yield: Different distance from tree base had significant influence on the both fresh and dry yield of Okra and yield gradually increased with increasing the distance from the Lemon tree base (Fig. 3). At every harvesting period the highest both fresh and dry yield were found in open field condition which were statistically alike to second highest were found in 5.0-7.5 feet distance from the Lemon tree base (Fig. 3). The lowest both fresh and dry yield is found in 0.0-2.5 feet distance from the Lemon tree base at every harvesting period time (Fig. 3). Total fresh yield of Okra in different distance category i.e. in 0.0-2.5 feet, 2.5-5.0 feet and 5.0-7.5 feet from tree base were 43.70%, 26.60% and 6.81% reduced compare to it open field condition. Total dry yield of Okra in different distance category i.e. in 0.0-2.5 feet, 2.5-5.0 feet and 5.0-7.5 feet from tree base were 54.36%, 30.87% and 10.07% reduced compare to it open field condition (Fig. 3). Considering this result it is clear that two years old Lemon tree negatively affect the yield of associated crops/ vegetables up to 5 feet distance from the Lemon tree base. Similar result also observed by Tanni *et al.* (2010) and Habib *et al.* (2012) in different winter and summer vegetable grown in association with Lohakat (*Zylia dolabiformis*) tree.

Yield of Okra along with both Guava and Lemon was gradually increased with increasing distance from tree base (Fig. 4 and 5). Highest fresh and dry yield was obtained from open field condition which was 23.50 and 1.49 t/ ha, respectively. Fresh yield produced from 5-7.5ft distant area from tree base was almost similar with control condition which is only 2.5 and 6.85% reduced along with Guava and Lemon, respectively. Among different distance groups in association with both Guava and Lemon, similar types of yield was observed which were ranking as $T_3 > T_2 > T_1$ i.e. 7.5-5ft > 2.5-5 > 0-2.5 ft distances from tree base. Total fresh yield of okra along with Guava in T_3, T_2, T_1 treatment were 22.97, 18.27 and 14.88 t/ha, respectively. In case of Lemon, these yield were 21.9, 17.25 and 13.23 t/ha, respectively.

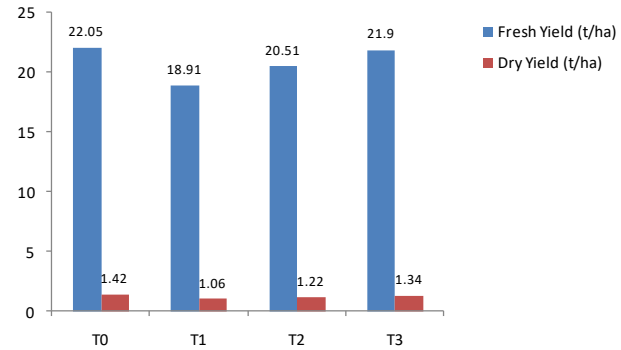

Fig.3. Total fresh and dry yield of okra association with Lemon

Comparing the yield of Okra produced along with Guava and Okra was not same. 5-7% yield reduced in different treatment along with Lemon compare to Guava (Fig. 4 and 5). This may be due to the different root expansion habit of Lemon and Guava root systems. Root expansion of Lemon relatively more parallel expanded compare to Guava root system. Similar result was also observed by Brown and Woods (1968), root extension of trees in surface soils of the North Carolina Piedmont.

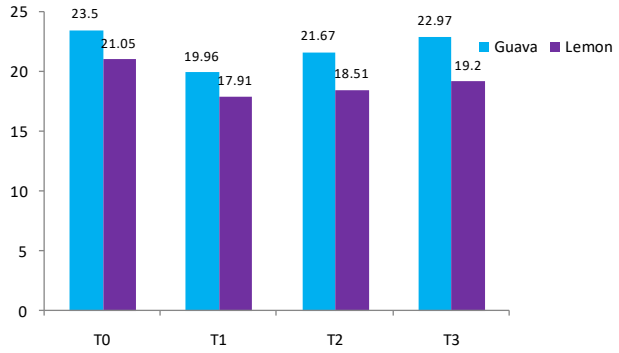

Fig.4. Comparative dry yield of Okra association with Guava and Lemon

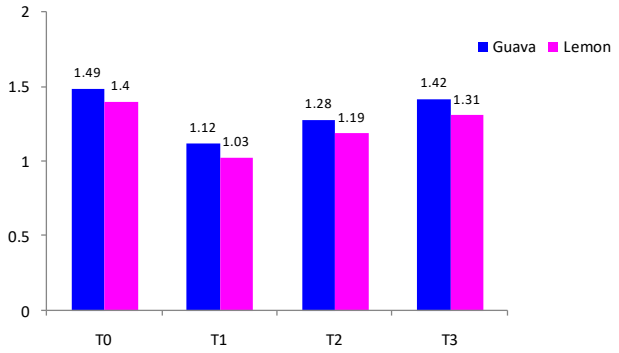

Fig.5. Comparative fresh yield of Okra association with Guava and Lemon

Table 3. Growth of Lemon and Guava in association with okra and control condition

Tree species	Condition	Height (cm)			Stem girth(cm)			No. of branches		
		Before	After	Distance	Before	After	Distance	Before	After	Distance
Guav	With okra	116	123	7	8.93	11.7	2.77	14.67	16	1.33
	Without Okra	126.67	137	10.33	10.5	14.23	3.73	15.67	18.89	3.22
Lemon	With Okra	151	168	17	11.7	14.53	2.83	7.33	10	2.67
	Without Okra	156	178.1	22.1	12.73	16.89	4.16	14.35	18.33	3.98

For this reason, may be surface layer of soil was more dried and less fertile under lemon compare to Guava tree.

Growth of Guava and Lemon in Association with Okra and Control Condition: The growth characteristics of Guava *(Psidium guajava)* and Lemon *(Citrus limon)* such as, plant height, stem girth and number of branches per plant was significantly influenced by Okra during the cropping season (Table 3). Growth of all parameter of both Guava and Lemon tree was lower in association with Okra plant compare to open field condition (Table 3). Plant height, stem girth and number of branches per plant of Guava increasing during Okra growing period were 7cm, 2.77cm and 1.33, respectively. However in open field condition these values were 10.33cm, 3.73cm and 3.22, respectively. In case of lemon, plant height, stem girth and number of branches per plant of Lemon increasing during Okra growing period and the values were 17cm, 2.83cm and 2.67, respectively. However in open field condition these values were 22.10cm, 4.16cm and 3.98, respectively. This result indicates growth of both tree components was lower along with Okra, this may due to competition for different growth parameter like, light, water and nutrients. Similar result also observed by Tanni *et al.* (2010) in *Xylia dolabiformis* in association with winter vegetables.

Acknowledgements: This work is supported by the SPGR sub-project 'Coordinated project on improvement of Agroforestry practices for better livelihood and environment: BAU component' under NATP phase-1.

References

BBS. 1997. Year Book of Agricultural Statistics of Bangladesh. Bangladesh Bureau of Statistics (BBS). Statistics Division. Ministry of Planning. Govt. of the People's Republic of Bangladesh. pp. 80-88.

Bose, T.K. and Mitra, S.K. 1990. Guava. In: Fruits Tropical and Subtropical. Ed. Bose, T.K. Nayaprakash, India. pp. 280-303.

Brown, J.H.Jr. and Woods, F.W. 1968. Root extension of trees in surface soils of the Caroling Piedment. Botanical Gazettle. 129(2):126-132.

FAO. 1988. Tropical forestry resources assessment project (GEMD): Tropical Africa, Tropical Asia, Tropical America (4 Vol.), FAOIUNDP, Rome.

Gomez, A. K. and Gomez, A. A. 1984. Statistical Procedures for Agricultural Research John Willy and Sons. New York, pp.130-215.

Habib, M.A., Mondol, M.A., Alam, Z., Hasan, M.R. and Wadud, M.A. 2012. Interaction effect of four years old *Xylia dolabriformis* tree on the growth and yield of summer vegetables. J. Agroforestry and Environment 6(1): 19-22.

Hodgson, R.W. 1967. Horticultural varieties of Citrus. In: (Reuther. W., Webber, H.J. and Batechtor, L.D.) (Ed). The citrus Industry. Univ. of Calif. Div. Agril. Of Science, U.S.A. pp. 431-576.

Khatun, M.A., Wadud, M.A., Yasmin, R., Sayed, M.K.I. and Rahman, G.M.M. 2009. Agroforestry practices with three winter vegetables during early establishment period of civit (*Swintonia floribunda*) plantation. J. Agrofor. and Environ. 3(1): 1-4.

Millar, C.D. and Bazore, K. 1945. Guava. Hawaii Agr. Exp. Sta. Bull. p. 96.

Nair, P.K.R. 1990. An introduction to agroforestry. Kluwer Academic publishers, ICRAF.

Phandis, N.A. 1970. Physico-chemical composition of guava fruits. Indian J. Hort. 27: 417- 433.

Purseglove, J.W.(ed).1968. Tropical crops: Dicotyledons, vol. 2. 1st Edition, John Wiley and Sons, Inc., New York. p.370.

Rashid, M.M. 1999. Sabji Biggan. Rashid Publishing. House. 94, Old DOHS. Dhaka-1206. p. 476.

Tanni, A.D., Wadud, M.A., Sriful, M.O., Mandol, M. A. and Islam, M. T. 2010. Influence of Lohakt (X*ylia dolabriformis*) tree an growth and yield of four winter crops. J. Agrofor. and Environ. 4(2):63-67.

Thompson, H.C. and E. Kelly. 1959. Vegetable Crops. McGraw-Hill Book Co. Inc., New York. p.562.