J. Agrofor. Environ. 2(1): 1-6, 2008 ISSN 1995-6983

Performance of winter vegetables in guava-coconut based multistrata Agroforestry system

F. Islam, K.K. Islam[1] and M.A. Rahim[2]
Department of Agroforestry and Environment, Sher-e-Bangla Agricultural University, Dhaka,
[1]Department of Agroforestry, [2]Department of Horticulture, Bangladesh Agricultural University, Mymensingh-2202

Abstract: An experiment was conducted to evaluate the performance of winter vegetables viz. tomato, chilli, carrot, onion, garlic, turnip and french bean under guava-coconut based multistrata system allowing 50% Photosynthetically Active Radiation (PAR) at Fruit Tree Improvement Project (FTIP), Horticulture Department of Bangladesh Agricultural University along with control (100% PAR). Results revealed that significantly vigorous plant growth as well as tallest plants were found (except french bean) under the treatment T_1 (reduced light level), whereas maximum yield per plot and yield per hectare were recorded under full sunlight (T_0) condition. Economic analysis showed that multistrata system gave higher economic return than control (monocrop condition) and chilli was the winter vegetable which gave the maximum economic income (107095 Tk/ha) compared to the others. From this study we can conclude that multistarata production system is economically more feasible than other production systems.
Keywords: Multilayered system, winter vegetables, growth parameters, economic aspect.

Introduction

Bangladesh has been carrying 134.8 million populations in its 147570 sq. km of land with and alarming geometrical growth rate 1.54% (BBS, 2004). As a result per capita land area had decreased at a warning rate from 0.19 hectare in 1961 to 0.10 hectare in 1996 (Haque, 1996). Multistoried production system of Agroforestry is one of the techniques which have already been advocated to overcome the future challenges. Moreover, this system provides one kind of insurance of farmers against the risk of total crop failure as in case of monocropping system. There are about 15.4 million homesteads in the country which comprises about 0.3 million hectares of lands and most of the vegetables produced and consumed in the country are coming from these homesteads (Abedin and Quddus, 1990). Unlike water and nutrient, light can not captured and stored for later use. So, if we know the pruning level of trees and the shade tolerance limits of different vegetables in terms of growth and yield it would be very useful information for selecting the best tree vegetable combination. As winter vegetables, tomato is very popular vegetables, used as salad which is rich in vitamin C 35 mg/100 g); while carrot is rich in carotene (10.52 mg/100 g) and vitamin C (15 mg/100 g). On the other hand, chilli and onion were used as spices and it is very rich in vitamin C (125 mg/100 g). Turnip and french bean though not widely used as winter vegetables all over the country but very rich in mineral (Anon., 1980). However, none of them was systematically tested in Agroforestry system to see their production ability under multistoried condition. Thus the resent study was undertaken to evaluate the performance of winter vegetables and their economic return under the Guava-Coconut based shaded system in Bangladesh conditions.

Materials and Methods

The experiment was carried out on the existing Guava + Coconut based multistoried garden at the Germplasm Centre of Fruit Tree Improvement Project (FTIP), Department of Horticulture, Bangladesh Agricultural University, Mymensingh during the period from November 2005 to April 2006. Geographically it is located at 24°75´North latitude and 90°50´East longitude. Two treatments namely T0 (under full sunlight/open condition) and T1 (Guava + Coconut based Agroforestry system, severe shade condition) were used to evaluate the performance of seven winter vegetables. Treatment T1 was a three layered canopy configuration consisted of coconut, Guava and winter vegetables. The winter vegetables were in ground layer, the second layer had Guava plants which were seven years old and were in fruiting condition and coconut occupied the third layer. The spacing between Guava and rows of coconut were 6m × 8 m which permitted 30-50% of light intensity and the spacing between coconuts plants were 8 m × 8 m. The tested vegetables were carrot (Daucus carota L.), turnip (Brassica rapa), tomato (Lycopersicon esculentum), onion (Allium cepa), garlic (Allium sativum), chilli (Capsicum fruitescens) and french bean (Phaseolus vulgaris) which were laid out following the Randomized Complete Block Design with three replications, while the number of vegetables were same in control and other treatment plots . In total 42 plots were set up and individual plot size for vegetables were 4 m × 2.5 m. Adjacent plots and neighboring blocks were separated by 0.5 m and 2 m respectively. Control plots were situated out side the multilayered system. Irrigation, fertilizers and spacing were maintained following at the recommended way of the vegetables production in Bangladesh conditions. Light intensity was measured with the help of “Quantum Sensor”. Three readings were taken from each plot as well as in control plot and the average values showed 35 to 50% PAR penetrated to the multilayered system. Vegetables were harvested in several times; turnip was harvested at 60 days; Onion at 90 days; Carrot at 80 days of planting and continued up to 105 days. Tomato was harvested in several picking when the fruits appeared at yellow to orange color. Garlic was harvested at 120 days after transplanting while chilli harvesting started at 80 days after planting and continued up to 120 days. Finally total yield was converted into the hectare (10,000m2)

and calculate the total cost of production of individual vegetables under multistrata system.

Results and Discussion

Tomato: The parameters related to growth and yields of tomato were found significant when grown under reduced light level. The tallest plant (104.25 cm) and maximum number of leaves per plant (33.32), number of branches per plant (7.55), number of clusters per plant (6.35) were recorded when tomato plants grown under shade condition i.e. under Guava + Coconut based multistoried system (Table 1). Whereas, other selected parameters performed better under full sunlight condition, which were number of fruits per plant (30.50), diameter of fruit (6.10 cm), fresh weight of fruits per plant (0.75 g), yield per plot (3.32 kg) and yield per hectare (32.68 t) (Table 1). Durieux (1997) reported that under the full sunlight condition yield of tomato was the highest while Gracie (2004) said that incase of edible vegetables flower buds formation was highest under full sunlight situation.

Table 1. Growth and yield contributing characters of tomato under different light conditions

Treatment combination	Plant ht. (cm)	No. of leave/ plant	No. of br./plant	No. of clusters/ plant	No. of fruits/ plant	Diameter of fruit (cm)	Fresh wt. of fruits/plant (kg)	Yield/ plot (kg)	Yield (t/ha)
T_0	97.50	26.75	6.30	4.95	30.50	6.10	0.75	3.32	32.68
T_1	104.25	33.32	7.55	6.35	27.00	5.70	0.53	2.98	29.33
Lsd (0.05)	4.968	4.968	1.242	0.9937	2.484	0.2484	0.2222	0.2484	2.484

T_0 =full (100%) sun light and T_1 =50% reduced light condition.

Chilli: Significant difference on yield and yield contributing characters were also recorded in chilli (Table 2). Maximum plant height (62.00 cm), numbers of leaves per plant (18.20), number of branches per plant (5.73) were observed under 30-35% reduced PAR level. On the other hand, maximum number of fruits per plant (19.30), length of fruit (5.40 cm) and highest fresh weight of fruits per plant (150.00 g), yield per plot (0.83 kg), yield per hectare (8.17 t) were measured under 100% PAR level, i.e. under full sunlight condition. Brainard *et al.* (2005) reported that morphological parameters of vegetables were varied significantly under shade level.

Carrot: Performance of carrot was found to be significant under different sunlight conditions (Table 3). Morphological characters such as plant height (61.17 cm), number of leaves per plant (6.80), and length of leaves (45.80 cm) were gradually increased with the increase of shade level (Table 3). Under reduced sunlight condition in carrot Miah (2000) was observed that plant height was increased. But length of root (12.00 cm), diameter of root (3.13 cm), fresh weight of root (148.01 g) yield per plot (2.51 kg), and yield per hectare (24.70 t) were found progressively increased under open field condition.

Onion: All the morphological parameters *viz.* plant height, number of leaves per plant and fresh weight of leaves were significantly increased with decreased of light levels. However, highest plant height (45.04 cm), number of leaves per plant (6.65) and fresh weight of leaves (150.30 g) were observed under treatment T_1 (Table 4). While lowest values of the same parameters were recorded under full sunlight. Moreover, maximum diameter of bulb (2.95 cm), fresh weight of

Table 2. Growth and yield contributing characters of chilli under different light conditions

Treatment combination	Plant height (cm)	No. of leaves/ plant	No. of branches/ plant	No. of fruits/ plant	Length of fruit (cm)	Fresh wt. of fruits/plant (g)	Yield/plot (kg)	Yield (t/ha)
T_0	57.40	13.00	5.00	19.30	5.40	150.00	0.83	8.17
T_1	62.00	18.20	5.73	13.60	4.73	120.00	0.67	6.70
Lsd (0.05)	2.484	4.968	0.7616	-	0.2939	29.810	0.1111	0.7452

Table 3. Growth and yield contributing characters of carrot under different light conditions

Treatment combination	Plant height (cm)	No. of leaves/ plant	Length of leaves (cm)	Length of root (cm)	Diameter of root (cm)	Fresh wt. of root (g)	Yield/ plot (kg)	Yield (t/ha)
T_0	52.70	5.60	37.60	12.00	3.13	148.01	2.51	24.70
T_1	61.17	6.80	45.80	11.00	2.45	123.50	1.77	17.42
Lsd (0.05)	6.252	0.9937	4.968	0.4968	0.3848	22.41	-	4.968

bulb (37.64 g), yield per plot (0.79 kg), and yield per hectare (7.78 t) were found under the treatment T_0 (open field condition). Wang and Zhang (1998) reported that there is a significant difference between the productions of Ginger in different shade level.

Garlic: The growth and yield characteristics of garlic were influenced significantly (except number of leaves per plant) by the different PAR levels. The tallest plant height (36.00 cm) and maximum fresh weight of leaves (143.25 g) were recorded under reduced PAR level (T_1) (Table 5). Whereas, maximum number of cloves (9.87), diameter of bulb (3.25 cm), fresh weight of bulb (29.80 g), yield per plot (0.60 kg) and yield per hectare (5.90 t/ha) were observed under full PAR level (T_0). Shahadat (2006) conducted an experiment on a leafy medicinal herb and found that under the shade level there was a significant variation in respect of their yield.

Table 4. Growth and yield contributing characters of onion under different light conditions

Treatment combination	Plant height (cm)	No. of leaves/plant	Fresh wt. of leaves (g)	Diameter of bulb (cm)	Fresh wt. of bulb (g)	Yield/ plot (kg)	Yield (t/ha)
T_0	42.00	4.87	142.46	2.95	37.64	0.79	7.78
T_1	45.04	6.65	150.30	2.44	33.62	0.67	6.60
Lsd (0.05)	2.484	1.655	7.452	0.4968	3.478	0.1111	0.9937

Table 5. Growth and yield contributing characters of garlic under different light conditions

Treatment combination	Plant height (cm)	No. of leaves/plant	Fresh wt. of leaves (g)	No. of cloves	Diameter of bulb (cm)	Fresh wt. of bulb (g)	Yield/plot (kg)	Yield (t/ha)
T_0	27.40	6.35	135.72	9.87	3.25	29.80	0.60	5.90
T_1	36.00	5.33	143.25	9.10	2.34	22.50	0.48	4.72
Lsd (0.05)	4.968	NS	7.452	0.4968	-	-	0.1111	1.144

Turnip: Turnip plant cultivated under different light levels was found significant in respect of yield and yield contributing characters. All the morphological parameters such as number of leaves per plant, length of leaves, breadth of leaves and fresh weight of leaves were maximum under shade condition (T_1) and were minimum under full sunlight condition (T_0) (Table 6). Further more, under full light level, diameter of root, fresh weight of root, yield per plot and yield per hectare were recorded highest, which were 9.50 cm, 540.50 g, 4.04 kg and 39.76 t, respectively.

French bean: Plant height, leaf breadth and number of seeds per pod were statistically non significant under different sunlight levels. Highest pods per plant (51.20), length of pod (16.80 cm), pod weight per plant (248.70 g), yield per plot (4.59 kg) and yield per hectare (13.15 t/ha) were counted when french bean grown under full sunlight condition, i.e. under open field condition (Table 7). Wadud (1999) conducted an experiment on four vegetables in Bangladesh with different light level and found that plant height of these vegetable were increased with the increase of shade level while total production was highest under full sunlight conditions.

Table 6. Growth and yield contributing characters of turnip under different light conditions

Treatment combination	No. of leaves/plant	Leaf length (cm)	Leaf breadth (cm)	leaves fresh wt.(g)	Root dia-meter (cm)	Root fresh wt. of (g)	Yield/ plot (kg)	Yield (t/ha)
T_0	7.60	37.67	18.40	180.37	9.50	540.50	4.04	39.76
T_1	8.95	41.84	21.75	195.20	7.34	480.60	3.28	32.28
Lsd (0.05)	0.9937	3.229	2.484	14.90	1.739	57.08	0.4444	7.452

Table 7. Growth and yield contributing characters of french bean under different light conditions

Treatment combination	Plant height (cm)	Leaf breadth (cm)	Pod/ plant	Length of pod (cm)	No. of seeds/ pod	Pod weight (g)	Yield/ plot(kg)	Yield (t/ha)
T_0	50.65	23.14	51.20	16.80	8.00	248.70	4.59	13.15
T_1	52.27	24.19	40.15	12.20	6.00	210.46	3.80	11.35
Lsd (0.05)	NS	NS	4.968	2.484	NS	-	0.7452	4.968

Economic analysis

The input and overhead costs were recorded for all the vegetables and calculated on per hectare basis. The total cost of production ranged between Tk. 16013 to Tk. 35735 per hectare (Table 8) (currently 1 US$ = Taka 70). The total production cost was the highest in case of carrot and the lowest was obtained from the french bean. The gross income from different treatment combinations ranged between Tk. 56750 to Tk. 124000 per hectare. Gross income was the total income through the sale of marketable products. The highest net return (Tk.107095) was obtained from chilli, while lowest net return (Tk. 43687/ha) was obtained from onion when cultivated under Lemon + Coconut based multistoried cropping system.

In case of open condition (100% PAR level) the yield of vegetables was higher than multilayered system but if we considered the total yield of multilayered production system, it was economically profitable. Moreover, multilayered production system can properly utilize the land and nutrient of the production area (Ahmed *et al.*, 2007). Production of vegetables under different layered Agroforestry system says that it is better to cultivate vegetables in early establishment of tree period i.e. initial stages of tree development. In a limited resources country like Bangladesh, multilayered production system can play a significant contribution to the farmers in respect of multiple outputs and economic aspect. From this experiment, chilli under Guava + Coconut based multistoried system was gave the highest economic return among the other vegetables. Therefore, vegetables chilli and carrot under this multistoried system might be encouraged.

Table 8. Cost and return analysis of different vegetables production under Lemon + Coconut based multistrata system

Vegetables	Total yield (t/ha)	Gross income (Tk./ha)	Total cost of production (Tk./ha)	Net return (Tk./ha)
Chilli	6.1	124000	16905	107095
Carrot	19.42	119940	35753	84187
Onion	6.6	66000	22313	43687
Garlic	4.02	108000	18428	89572
Turnip	34.28	97140	20003	77137
French bean	11.35	56750	16013	40737

References

Durieux, A. 1997. Effect of (additional) lighting on the production of vegetables crops. III International symposium on artificial lighting in horticulture. ISHS Acta Horticulturae 418, Netherlands.

Gracie, A., Brown, A.J.P. and Clark, R.J. 2004. Study of some factors affecting the growth and development of myoga (Zingiber misga Roscoe). Scientia Horticulturae. 100(1-4): 267-278.

Abedin, M. Z. and Quddus, M.A. 1990. Homestead fuel situation, home garden and agroforestry practices at six-agroecologically different locations of Bangladesh.In: Abedin et al. (ed). Homestead plantation and agroforestry in Bangladesh. BARI, Winrock International and BARC. pp. 19-53.

Ahmed, F., Rahim, M.A., Alam, M.S., Hamid, M.A. and Haque, K.M.B. 2007. Performance of medicinal plants and species in coconut based agroforestry system. Journal of Agroforestry and Environment. 1(1): 51-53.

Anonymous, 1980. Nutritious value of indigenous food. Institute of Nutrition and Food Sci.. Univ. of Dhaka. pp. 5-15.

BBS. 2004. Monthly Statistical Bulletin, (December, 2004). Bangladesh Bureau of Statistics. Ministry of Planning, Government of the People's Republic of Bangladesh. pp.02-15.

Dan C. Brainard, Robin R. Bellinder and Antonio Di Tommaso. 2005. Effect of canopy shade on the morphology, phenology and seed characteristics of Powell amaranth. Weed Science. 53(2): 175-186.

Haque, M. A. 1996. Agroforestry in Bangladesh. Paper presented at the National Workshop on Homestead Plantation and Agroforestry in Bangladesh, July 17-19 1988, BARI, Gazipur, Bangladesh.

Shahadat, H. 2006. Performance of Thankuni (Centella asiatica) as a medicinal plant under various fertilizer doses and light levels for its suitability in Agroforestry system. MS thesis, Department of Agroforestry, Bangladesh Agricultural University, Mymensingh. P56.

Wadud, M. A. 1999. Performance of four summer vegetables under reduced light conditions for agroforestry systems. An M. S. Thesis submitted to BSMRA University, Salna, Gazipur.

Wang, S, H. and Zhang, Z. X. 1998. Effect of shade on growth and yield of ginger. China Vegetables 5: 5-8.