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Performance of Indian spinach in litchi based Agroforestry system

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Abstract: A field experiment was conducted at the Litchi-Pineapple based Agroforestry Farm, Hajee Mohammad Danesh Science and Technology University during April 2007 to June 2007 to examine the growth performance of Indian spinach grown in association with pineapple at different orientations of litchi tree. There were five treatments consisted of 4 different orientations (north, south, east and west) of litchi tree for production of Indian spinach and one control plot. The aim of the study was to detect the orientation effect of Litchi -Pineapple based agroforestry system on the yield performance of Indian spinach. The longest plant of Indian spinach was recorded in east orientation. The values of all other parameters were found highest in open field (full sun light). Significantly the highest yield (7.12 tha^{-1}) of Indian spinach was recorded in open field followed by south orientation (6.60 tha^{-1}) while the lowest yield (5.80 tha^{-1}) was found in the east orientation. Moreover, the results indicate that, the Litchi -Pineapple based agroforestry system have the potentiality for producing Indian spinach as agroforestry production concept.
Key words: Indian spinach, Litchi -Pineapple based agroforestry.

Introduction

Bangladesh has the lowest per capita arable land due to its high population density. This limited land resource is engaged in producing minimum food requirements for the people. Therefore, much emphasis was not given on vegetable and fruit production, which are important sources of nutrition. The minimum dietary requirement of fruits per day per capita is 85 g, whereas the availability is only 30-35 g (Siddique, 1995). Vegetable crops excluding potato occupy only 1.97% of the total cropped area with a gross production of 1.89 million tons (BBS, 2007). The per capita consumption of vegetable in Bangladesh is only 53 g, which is pretty below the recommended daily requirement of 200 g/head/day. The low consumption of vegetables creates a tremendous pressure over cereals and also causes malnutrition leading to several kinds of health hazards. To provide balance diet there would be no alternative to produce vegetable, as this would also provide vitamins and minerals. On the other hand, there is little scope to increase cultivation area. Hence we need to find out other alternatives. The demand and supply of fuel wood are 310 and 125 million cft., respectively, and those for timber are 115 and 44 million cft., respectively (Hossain, 1999). Thus, the shortages of timber and fuelwood are 61.91% and 59.67%, respectively. This large demand of wood has created a tremendous pressure on the reserved forests. For instance, reserve forests depleted by 61% between the year 1963 to 1983 (Chowdhury and Hossain, 1989). It is said that country needs at least 25% forest cover to maintain its ecological balance. But we have only 17% forest land and actual vegetation (tree) cover is only 6-7% (Hossain, 1990).There are many food orchard in the country which are used as sole fruit production. These food orchards are easily converted to multistoried agroforestry production system. Now-a-days Jackfruit-Pineapple based agroforestry system is found in Madhupur region and Litchi-Pineapple based agroforestry is going to be introduced in Northern part of Bangladesh. These agroforestry systems can be converted into multistoried agroforestry system introducing a lower storey vegetable crop. Considering the above fact Indian Spinach (Pui shak) is introduced into the gap between two rows of pineapple for measuring its growth and yield production as well as to fulfill the multistoried agroforestry system.

Materials and Methods

The experiment was conducted in the Litchi-Pineapple based Agroforestry Farm, Hajee Mohammed Danesh Science and Technology University, Dinajpur. This site was located between 25°13' latitude and 88°23' longitude and about 37.5 m above sea level. The experimental site is situated in a medium high land belonging to the Old Himalayan Piedmont Plain area (AEZ 01). The experiment was carried out in concentric row design (satisfying RCBD) with three replications for each treatment. There are five treatments i.e. four different orientation T_1 = North orientation (37.12% shade), T_2 = South orientation (22.03% shade), T_3 = East orientation (48.61% shade), T_4 = West orientation (40.16% shade) of litchi tree for production on Indian Spinach and one control plot T_5 = Open field (Full sunlight). The 30 years old litchi tree was used for the study situated at the eastern side of Agroforestry farm. The structural description of tree was tree height-15 m, Base girth-2.03 m and Canopy diameter-10.5 m. The land was opened in the early February 2007 and then prepared thoroughly by tractor and spading also. Harrowing was done for several times to obtain a good tilth. The weeds and stubbles were removed from the field and the bigger clods were broken into smaller pieces. Each orientation occupied 19.63 m^2 of land. Indian spinach was cultivated under litchi tree in each orientation maintained 15 cm plant to plant distance. The planting date of Indian spinach was 10 April 2007. Weeding was done periodically whenever necessary. Indian spinach was collected at 35 (DAS) days after sowing for consumption and sell as the when vine height was elongated enough. Then the Indian spinach was allowed to regenerate at 70 DAS, second harvesting was done. The following parameters were recorded Vine length (cm), Number of leaves per plant, Leaf size (cm^2), Base girth of vine (cm), Stem fresh weight $plant^{-1}$, Leaf fresh $weightplant^{-1}$ (g), Leaf dry weight $plant^{-1}$ (g) and Stem dry weight $plant^{-1}$ (g). Light intensity was measured by the light spectrophotometer (LUX meter). Light measuring was done at three different times in a day (at 9.30 am, 12.30 pm and 3.30 pm) for two days per week during April to June 2007 are fixed for light measurement and average value was calculated for each time of the day. (Fig. 1). The data on various growth and yield contributing characters were statistically analyzed to determine the significant

variation of the result due to different orientations effect of litchi-pineapple based agroforestry system. Data were analyzed statistically following ANOVA technique and means separations were adjusted by DMRT test at 5% level of significance.

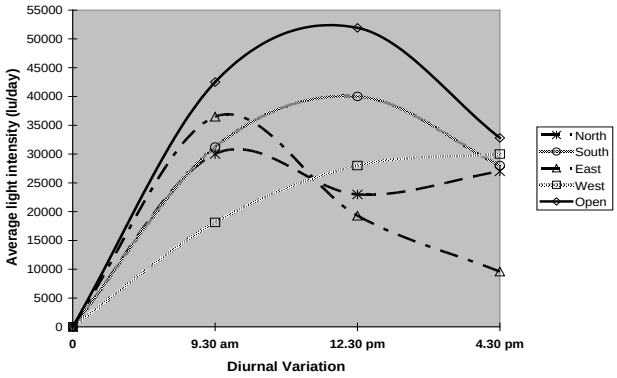

Fig. 1. Light interception at different orientations of litchi tree due to diurnal variation during April to June 2007

Results and Discussion

Orientation effect of Litchi-Pineapple based Agroforestry system on different parameters of Indian spinach are described bellow-

Vine length: Vine length of Indian spinach grown under litchi tree was significantly affected by different orientations (Table 1 and Table 2). Indian spinach grew vigorously under Litchi tree than that of open field. Significantly the largest vine length (69.33 and 59.67cm at the first and second harvesting dates, respectively) was found in east orientation followed by west orientation (61.33 and 50.33 cm, respectively). Significantly the shortest vine length was recorded in open field (41.00 and 27.67 cm in both sampling dates). The longest vine length of Indian spinach in east orientation might be due to heaviest shade created by Litchi tree (48.61% shade) as compared to other orientations. Similar result was found by Miah *et al.* (2007) in case of egg plant under heaviest shade of Eucalyptus-cane association. Higher plant height under reduced light level was also reported by Islam (1995) in mungbean and Murshed (1996) in chick pea. This may attributed due to the stimulation of the cellular expansion and cell division under shaded condition.

Table 1. Orientation effect of litchi tree on the performance of Indian spinach at 35 days after sowing (DAS)

Treatment	Vine length (cm)	No. of leaf plant^{-1}	Base girth of vine (cm)	Leaf area (cm^2)	Leaf fresh weight plant^{-1} (g)	Stem fresh weight plant^{-1} (g)	Leaf dry weight plant^{-1} (g)	Stem dry weight plant^{-1} (g)
North	50.00 b	17.00 a	4.10 a	141.0 bc	58.20 ab	29.80 c	5.83 ab	3.533b
South	49.67 b	17.00 a	4.40 a	174.7 ab	58.63 ab	35.80 c	6.067 ab	5.06a
East	69.33 a	15.00 b	4.033 a	107.3 c	32.60 c	46.83 a	5.33 b	3.33 b
West	61.33 ab	16.33 a	4.067 a	132.6 bc	39.07 c	40.23 a	5.75 ab	3.43 b
Open	41.00 c	17.33 a	4.43 a	185.2 a	72.00 a	29.97 c	6.467 a	5.33 a
C V%	9.10	8.66	9.40	12.47	11.54	8.66	10.27	12.40

In a column, figures having similar letter(s) do not differ significantly where as figure (s) bearing dissimilar letter(s) differ significantly by DMRT.

Table 2. Orientation effect of litchi tree on the performance of Indian spinach at 70 days after sowing (DAS)

Treatment	Vine height (cm)	No. of Leaf Plant^{-1}	Base girth of vine (cm)	Leaf area (cm^2)	Leaf fresh weight plant^{-1}(g)	Stem fresh weight plant^{-1} (g)	Leaf dry weight Plant^{-1}(g)	Stem dry weight plant^{-1}(g)
North	39.67 bc	26.00 b	4.50 ab	58.50 b	31.70 b	35.30 ab	6.000 b	5.50 ab
South	31.00 c	28.00 ab	4.66 ab	58.42 b	37.30 ab	33.40 ab	6.167 b	4.40 b
East	59.67a	23.67 b	4.267 b	55.75 b	20.87 b	44.87 a	5.067 c	4.37 b
West	50.33 b	25.67 b	4.67 ab	57.25 b	29.53 b	37.97 ab	5.267 c	5.17 ab
Open	27.67c	30.00 a	4.933 a	109.6 a	45.17 a	30.97 b	7.200 a	6.17 a
C V%	11.40	13.51	9.75	10.23	12.24	14.14	9.88	5.50

In a column, figures having similar letter(s) do not differ significantly where as figure (s) bearing dissimilar letter(s) differ significantly by DMRT.

Leaf number: Number of leaf per plant of Indian spinach was significantly affected by different orientations (Table 1 and Table 2). The highest number of leaves was recorded in the open field at both harvesting dates (17.3 and 30.0 at 35 DAS and 70 DAS, respectively). At 35 DAS, number of leaf per plant recorded in north, south and west orientations were 17.00, 17.00 and 16.33, respectively which were statistically similar. But incase of second harvesting date (70DAS) number of leaves (28.0) under south orientation was statistically similar to that of

open field (Table 2). The lowest number of leaves (23.6) was recorded in the east orientation which was statistically similar to that of north (26) and east orientation (23.6). Similar observation was also reported by Miah *et al.* (2007) in egg plant open field condition compared to different shade level of Eucalyptus-cane association. Ali (1999) also observed that number of leaf per plant of red amaranth gradually decrease in drumstick tree canopy compared to leaves number per plant obtained in open field.

Leaf Area: Leaf area of Indian spinach was significantly influenced by different orientations of litchi tree (Table 1 and Table 2). At first harvesting date (35 DAS), significantly the highest leaf area was recorded in the open field (185.2 cm^2), which was statistically similar to that of south orientation (174.7 cm^2). Significantly the lowest leaf area was found in the east orientation (107.3 cm^2) which was statistically similar to that of north (141.0 cm^2) and west orientation (132.6 cm^2). At second harvesting date, significantly the highest leaf area was also found in open field (109.6 cm^2) (Table 2) followed by south orientation (58.4 cm^2). But the leaf area values produced at south (58.42 cm^2), north (58.5 cm^2), east (55.7 cm^2) and west (57.2 cm^2) orientations were statistically similar. Similar observation was also reported by Ali (1999) who observed smaller size of leaf of red amaranth at different orientations under guava and drumstick trees compared to open field.

Vine Base Girth: Base girth of Indian spinach grown under litchi tree at different orientation was significantly lower compared to open field at final harvesting time. At first harvesting date (35 DAS) there was no significant variation among the orientations, although numerically the highest base girth was found in open field (4.43 cm). At second harvesting date, significantly the highest vine base girth of Indian spinach was recorded in the open field (4.93 cm), which was statistically similar to that of north (4.50cm), south (4.66 cm) and west orientation (4.6 cm) (Table 2). Significantly the lowest vine base girth was found in east orientation (4.27 cm). Similar observation was also reported by Hossain *et al.* (2005) in the performance of Indian spinach grown in association with eucalyptus tree.

Leaf Fresh Weight: Leaf fresh weight per plant of Indian spinach was significantly influenced by different orientations of litchi tree (Table 1 and Table 2). At first harvesting date (35 DAS), significantly the highest leaf fresh weight was recorded in open field (72.0 g), which was statistically similar to that of north (58.2 g) and south (58.6 g) orientations. Significantly the lowest leaf fresh weight per plant was found in the east orientation (32.6 g), which was statistically similar to that of west orientation (39.07 g). At second harvesting date (70 DAS), significantly the highest leaf fresh weight was also found in the open field (45.17 g), which was statistically similar to that of south orientation (37.30 g). Significantly the lowest leaf fresh weight was recorded in the east orientation (20.87g), which was statistically similar to that of north (31.70 g) and west (29.53 g) orientations. Simillar observation was found in open field reported by Miah *et al*. (2005) in turmeric and zinger under different light levels.

Stem Fresh Weight: Stem fresh weight per plant was significantly affected by different orientations of litchi tree (Table 1 and Table 2). At first harvesting date (35 DAS), significantly the highest stem fresh weight per plant was recorded in east orientation (46.83 g), which was significantly identical to that of west orientation (40.23 g) of litchi tree. Significantly the lowest stem fresh weight per plant was found in the north orientation (29.80 g), which was statistically similar to that of south orientation (35.809 g) and open field (29.97 gm). At second harvesting date (70 DAS), significantly highest stem fresh weight per plant was found in the east orientation (44.87 g), which was statistically similar to that of north (35.30 g), south (37.30 g) and west (37.97 g) orientations of litchi tree. Significantly the lowest stem fresh weight per plant was recorded in the open field (30.97 g). Similar observation was found by Hossain *et al*. (2005) for Indian spinach in association of eucalyptus trees.

Leaf Dry Weight: Leaf dry weight (per 100 g) was significantly influenced by different orientation of Litchi-Pineapple based Agroforestry system (Table 1 and Table 2). At first harvesting date, significantly the highest leaf dry weight (per 100 g) was recorded in the open field (6.467 g), which was statistically similar to that of north (5.83 g), south (6.06 g) and west (5.75 g) orientations of litchi tree. Significantly the lowest leaf dry weight was found in the east orientation (5.33 g). At second harvesting date, significantly the highest leaf dry weight (per 100 g) was found in the open field (7.20 g) followed by south orientation (6.17 g), which was statistically similar to that of north orientation (6.0 g). Significantly the lowest leaf dry weight was recorded in east orientation (5.06 gm), which was statistically similar to that of west orientation (5.27 g). This variation of dry matter production might be different due to variation of light intensity as photosynthesis is directly related to light intensity or light duration per day and dry matter production is directly proportional to the rate of photosynthesis. Similar observation was found by Hossain *et al*. (2005) that leaf dry weight (per 100 g) increase in open field with increase of light level in Indian spinach cultivation under eucalyptus tree.

Stem Dry Weight: Stem dry weight (per 100g m) was significantly affected by different orientation of Litchi-Pineapple based Agroforestry system (Table 1 and Table 2). Significantly the highest stem dry weight (per 100 g) was recorded in the open field (5.33 g) which was statistically identical to that of south orientation (5.06 g) at the first harvesting date (35 DAS). Significantly the lowest stem dry weight (per 100 g) was found in the east orientation (3.33 g), which was statistically similar to that of north (3.53 g) and west (3.43 g) orientation of litchi tree. At the second harvesting date, significantly the highest stem dry weight per plant was also found in the open field (6.17 g) which was statistically similar to that of north (5.5 g) and west (5.17 g) orientation of litchi tree. Again, significantly the lowest stem dry (per 100 g) was recorded in the east orientation (4.37 g) which was statistically similar to that of south orientation (4.40 g). Similar observation was found by Hossain *et al.* (2005) in Eucalyptus-Indian spinach association.

Table 3. Orientation effect on yield of Indian spinach grown in between two concentric rows of pineapple

Treatment	Yield		Total yield/ plant (gm)	Yield/ Orientation (Kg)
	1st Harvest (gm/plant)	2nd Harvest (gm/plant)		
North	88.0	67.0	155	12.17
South	94.43	70.7	165.13	12.96
East	79.43	65.74	145.17	11.39
West	79.30	67.5	146.8	11.52
Open Field	101.97	76.14	178.11	13.98

Yield of Indian Spinach: The yield of Indian spinach produced was greatly affected by the orientation of litchi-pineapple association (Table 3). The highest yield was found in the open field (13.98 kg) and the lowest yield was observed in the east orientation (11.39 kg). Different orientations i.e. north, south and west orientation produced 12.17 kg, 12.96 kg, and 11.52 kg, respectively. Significantly the highest yield (7.12 tha^{-1}) of Indian spinach was recorded in open field followed by south orientation (6.60 tha^{-1}) while the lowest yield (5.80 tha^{-1}) was found in the east orientation (Fig. 2.).

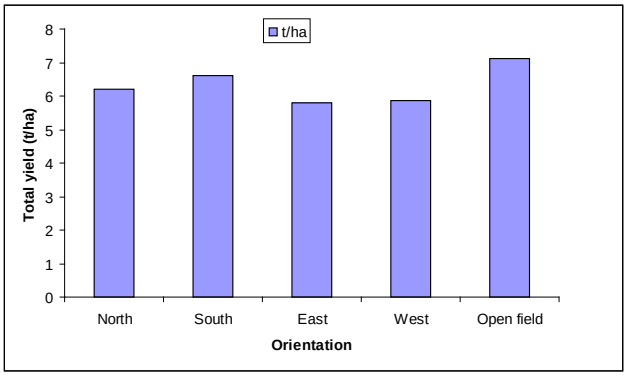

Fig. 2. Total yield (ton ha^{-1}) of Indian spinach grown with pineapple at different orientations of litchi tree

References

Ali, M.A. 1999. Performance of red amaranth and Lady's finger growth at different orientations and distance under Guava and Drumstic trees. MS thesis, Dept. of Agroforestry and Environment, BSMRAU, Bangladesh.

BBS (Bangladesh Bureau of Statistics). 2007. Statistical Year Pocket Book of Bangladesh. Stat. Divin. Minist. Plann. Govt. Peaples Repub. Bangladesh.

Chowdhury, R. A. and Hossain, M. Z. 1989. Forest management practices in Bangladdesh. Traditionala Practice and Alternative Approches. Paper presented in a seminar in Forest Resource Management in Bangladesh, Chittagong.

Hossain, K. L., Wadud, M. A., Hossain, K. S. and Abdullah, M. R. 2005. Preformance of Indian spinach in association with Eucalyptus for Agroforestry system. J. Bangladesh Agril. Univ. 3(1): 29-35.

Hossain, M. K. 1999. Shade effect on the yield and quality of pineapple in a jackfruit-pineapple agroforestry system. M. S. Thesis, Department of agroforestry and Environment, Bangladesh Sheik Mujibur Rahman Agricultural University, Gazipur. p.57.

Islam, S. M. 1995. Effect of shading on gas exchange characteristics and productivity of mungbean and blackgram. MS Thesis, Dept. of agroforestry and Environment, BSMRAU, Bangladesh.

Miah, M. M. U., Rahman, M. S., Hakim, M. A., Amin, M. H. A. and Rahman, M. Z. 2007. Organic production of egg plant in multi storied agroforestry systems. J. Agrofor. Environ. 1(2):79-82.

Miah,M.G., Miah, M.M.U., Rahman, M.A. and Ahmed, T. 2005. Performance of turmeric and zinger under different light levels for agroforestry systems. J.Sci. and Tec. (3): 18-25

Murshed, A. N. M. M. 1996. Influence of management condition on growth, flowering and pod set, seed development and yield of chickpea, MS Thesis, Dept. of Agroforestry and Environment, BSMRAU, Bangladesh.

Siddique, A. B. 1995. Importance of vegetables and spices production. Horticulture Research and Development Project, Dhaka.