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Influence of Lohakat (*Xylia dolabriformis*) tree on the growth and yield of four winter crops

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Abstract: A field experiment was conducted at the Agroforestry Farm of Bangladesh Agricultural University, Mymensingh during the period from 15 November 2009 to 13 March 2010 to find out the performance (growth and yield) of tomato, radish, soybean and lettuce under different distance from the *Xylia dolabriformis* tree and also under pruned and unpruned condition of the tree. Different treatments of the experiment were T_0 (open field), T_1 (3 feet distance from tree), T_2 (6 feet distance from tree) and T_3 (9 feet distance from tree) under pruned and unpruned conditions of the tree *Xylia dolabriformis*. The experiment was laid out in RCBD for all four crops with 3 replications. The result of the experiment revealed that the yield of the crops increased gradually with the increase of planting distance from the tree and crops under pruned condition of the tree provide better yield performance compared to unpruned condition. In radish, the highest value of yield (20.97 t ha^{-1}) was found under open field which was statistically similar to treatment T_3 under pruned condition. In tomato, it was also found that open field produced highest yield (52.08 t ha^{-1}). In soybean, the highest grain yield (4.2t ha^{-1}) was recorded in open field which was also statistically similar to treatment T3 under pruned condition. In lettuce, it was observed that open field produced highest yield (18.5 t ha^{-1}). In case of all crops, lowest yield was found in 3 feet distance from the tree under unpruned condition of *Xylia dolabriformis*. The growth characters such as height, number of leaves and stem girth of *Xylia dolabriformis* tree are not satisfactory in association with tomato but growth characters of *Xylia dolabriformis* tree are found higher in association with soybean so we may recommended that growing of soybean at 9 feet distance from *Xylia dolabriformis* under pruned condition of tree is the best tree-crop combination in Agroforestry system.
Key words: *Xylia dolabriformis*, Radish, Tomato, Soybean, Lettuce, Agroforestry, Interactions.

Introduction

Agroforestry, the integration of tree and crop or vegetable on the same area of land is a promising production system for maximizing yield and maintaining friendly environment (Nair, 1990). Growing annual crops in association with trees is becoming popular day by day for their higher productivity. But farmers used to face the problems of growing crops after 4-5 years of tree plantation and even sometimes failed to grow understroyed crops under and around trees. In agroforestry systems, different types and nature of species are grown in association, therefore, there is an inevitable competition for growth resources such as light, water and nutrients which may reduce the productivity of understroyed crops in particular. Among different resource limitations light availability is the most important one for the performance of the under storey crops or vegetable, particularly, where an upper storey perennial forms a continuous overstorey Canopy (Miah *et al.* 1995).

Vegetables are grown in Bangladesh throughout the year but the production is not sufficient. The demand for vegetable is increasing but the area under vegetable production is decreasing. Unfortunately these limited areas are decreasing due to increasing the area of Boro rice and wheat in winter season. On the other hand, a country needs 25% of forest land of its total area for ecological stability. So, the effective area of forest (5.4) in Bangladesh is neither in a position to fulfill the requirements of the people's fuel and timber nor to stabilize the climatic condition. Under these circumstances it is necessary to find out a suitable alternative to overcome this situation. Since there is no scope for expanding forest area and sole grain crops area. The country has to develop a sustainable combined production system by the integration of trees and crops in the same unit of land which is now being called agroforestry In Bangladesh, a large number of vegetable are grown of which most of them are grown in winter season. Among the different winter vegetable, tomato and radish are the important winter vegetable in Bangladesh. Radish is important for its quick crowing nature and high yield potential. It is easily cultivated as a companion crop or intercrop between the rows of other vegetable. Tomato is a well known and a very popular vegetable grown successfully throughout Bangladesh. Tomato is popular for its diversified use and nutritional value. Soybean is the most important leguminous grain crop used as vegetable and edible oil consumption purposes. Soybean contains higher amount of both oil and protein than any other legume corps. Soybean contains about 43.2% protein, 19.5% fat, 20.9% carbohydrate and a good amount of calcium, phosphorus, iron and vitamins (Gopalan *et al.* 1971). Lettuce is the most popular of the shoot crops being in nearly all home gardens and by large number of commercial growers. Lettuce is especially valuable for its vitamin content, as well as for supplying bulk.

For identifying the compatible tree-crop combination, particularly under storey species i.e. different crops should be screened out in terms of their adaptability and yield in association with the early stage of tree. For this purpose, the best way of experimentation is to grow different crops at different spacing from the tree. So, if we know the suitability of different crops in terms of growth and yield, it would be very useful information for selecting the best tree-crop combination. Therefore, the study was conducted to determine the yield and yield attributes of tomato, radish, soybean and lettuce grown in association with *Xylia dolabriformis* sapling for selecting suitable winter crops for sustainable agroforestry practice and to judge the combination effect of tomato, radish, soybean and lettuce with *Xylia dolabriformis*.

Materials and Methods

The experiment was carried out at the experimental farm, Department of Agroforestry, Bangladesh Agricultural University, Mymensingh, during the period from 15 November 2009 to 13 March 2010. The place is geographically located at about 24°75" North latitude and 90°50' East longitudes (FAO, 1988). In this study four winter crops, such as: Radish, Tomato, Soybean and

Lettuce were grown in association with 2 years old Lohakat (*Xylia dolabriformis*) saplings. Each crop was laid using the Randomized Complete Block Design (RCBD) with three replications as separate experiment. Pruning condition of the tree was also taken into consideration. Individual plot size was 9ft x 2ft. In each experiment crops were grown at different distances from tree base which were treated as treatments. For every experiment treatments were as; T_0 = Open field referred to as control; T_1 = 3 feet distance from the tree base; T_2 = 6feet distance from the tree base and T_3 = 9 feet distance from the tree base. *Xylia dolabriformis* Saplings was also grown without crops referred to as control.

Radish seeds were directly sown in the experimental plot on 15 November 2009. The seeds were sown continuously 30 cm apart lines. After emergence finally radish plants were thinned out maintaining 10 and 15 cm distance from plant to plant. Tomato seedlings (30 days old) were transplanted on 15 November 2009 in the experimental plot maintaining the spacing of 45 cm x 30 cm. Seedling planted in all plots were watered immediately after transplanting. Soybean seeds were sown in the experimental plot on 15 November 2009 by hand dibbling method at a depth of 4-5 cm maintaining the spacing of 15 x 15 cm from plant to plant. Lettuce seeds were broadcasted in the experimental plot on 15 November 2009. After emergence, lettuce plants were thinned out. Necessary cultural operations were done for all crops.

Plant samples of radish, soybean, tomato and lettuce were collected randomly from all rows of the respective plots. Ten representative sample plants were selected from each plot for data collection. In case of radish, plant height, number of leaves plant^{-1}, radish (root) length, diameter of root plant-1, fresh weight plant^{-1} and yield (t ha^{-1}); in case of tomato, number of fruit plant^{-1}, weight of fruit plant^{-1}, fruit diameter and yield (t ha^{-1}); in case of soybean, the parameter such as plant height, number of pods plant^{-1}, number of seeds pod^{-1}, number of seeds plant^{-1} and yield (t ha^{-1}) and in case of lettuce, plant height, number of leaves plant^{-1}, fresh weight plant^{-1} and yield (t ha^{-1}) were recorded at the final harvesting period.

The collected data were analyzed statistically by using PC M-STAT software package to find out the statistical significance of the experimental results. The means for all the treatments and analysis of variance of all the characters were calculated by Duncan's Multiple Range Test (DMRT).

Results and discussion

Effect of *Xylia dolabriformis* saplings on the growth and yield of radish, tomato, soybean and lettuce

Growth parameters: Different growth parameters of radish, tomato, soybean and lettuce were significantly influenced by *Xylia dolabriformis* saplings these were as:

Radish

Plant height: Radish plant cultivated under different distance from the tree grew more vigorously in the open field than those grew close distance to the tree. The shortest plant was (40.00 cm) found in treatment T_1 under unpruned condition and the tallest plant (61.00 cm) was recorded under treatment T_0 due to no interaction with the tree. Souza *et al.* (1999) studied the effect of 3 levels of shading (0, 30, and 50%) on the development and tuberous root yield of radish (*Raphanus sativus*) under field conditions and reported that 50% level of shading increased the plant height, life cycle, foliar area and reduce leaf chlorophyll content and the tuberous root yield.

Table1. Morphological characters of radish, tomato, soybean and lettuce in association with *Xylia dolabriformis*

Treatments	Radish				Tomato			Soybean				lettuce		
	Plant height (cm)	Number of leaves / Plant	Root length (cm)	Diameter of root/ plant (cm)	Number of fruits / Plant	Weight of fruit / plant (g)	Fruit diameter (cm)	Plant height (cm)	Number of pods / plant	Number of seeds / pod	Number of seeds / plant	No of Leaves / Plant	Plant height (cm)	Fresh weight / plant (g)
T_0 (Control)	61.00a	17.00a	32.00a	31.00a	23.00a	651.00a	15.00a	86.00a	126.00a	3.33a	200.00a	27.67a	28.00a	264.33a
T_1 Unpruned	40.00c	9.33e	19.00d	17.67d	13.00d	350.00c	9.33d	47.67e	41.67d	1.67d	88.67d	16.67e	17.67e	153.33c
T_1 Pruned	45.67bc	11.67d	25.33cd	22.67d	18.00c	486.67b	11.33c	53.67de	46.67cd	2.00c	101.67d	22.33d	19.67d	193.33b
T_2 Unpruned	46.67b	12.67cd	28.33bc	25.33c	19.33bc	501.67b	11.67bc	60.67cd	55.00cd	2.33 bc	144.67c	23.67c	21.67cd	212.33b
T_2 Pruned	47.67b	14.00bc	29.00ab	25.33c	19.67bc	510.00b	11.67bc	64.00c	64.33c	2.67b	154.33c	23.33bc	22.67bc	214.33b
T_3 Unpruned	56.00a	15.67ab	30.33ab	28.00b	21.00ab	633.33a	13.33ab	73.33b	103.67b	2.67ab	170.67b	25.33ab	24.33b	245.00a
T_3 Pruned	57.33a	16.33a	30.33ab	29.67a	22.67a	636.67a	14.00a	81.67a	112.00a	3.00a	186.67a	26.00a	26.67a	248.67a
CV (%)	6.65	7.74	6.53	4.80	8.27	6.70	7.73	7.33	12.31	19.05	5.12	6.78	7.63	13.32
Level of sig.	**	**	**	**	**	**	**	**	**	**	**	**	**	**

Mean followed by a common letter(s) are not significantly different at the 5% level by DMRT, ** significant at 1% level of probability

Number of leaves plant^{-1}: 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 time being highest at 60 DAS. The highest number of leaves was 17 when plants were grown under treatment T_0 (control) which was statistically similar to treatment T_3 under pruned and unpruned condition. The lowest number of leaves (9.33) was found under treatment T_1 and unpruned condition (Table 1). Number of leaves per plant showed significant variation due to different distance of radish plant from the tree.

Root length: Distance of radish plant from the tree had significant effect on root length at final harvest. The maximum root length (32.00cm) was found under treatment T_0, which was statistically similar to treatment T_3 under pruned and unpruned condition and T_2 under pruned condition. The minimum root length (19.00 cm) was recorded from treatment T_1 under unpruned condition which was statistically different from other treatments due to high competition with tree.

Diameter of root plant^{-1}: Different treatments had significant effect on root diameter at final harvest. The maximum root diameter (31.00 cm) was recorded from the plant grown under treatment T0 which was statistically similar to treatment T_3 under pruned condition (Table 1). The minimum diameter of root (17.67 cm) was obtained from treatment T_1 under unpruned condition (Table 1). However, the diameter of radish root was decreased with the decreased light source by the application of tree shade.

Miah *et al.* (1999) stated that bulb diameter was highest under full sunlight.

It was found that plant height, number of leaves per plant, root length and root diameter within the 3 feet from tree base under unpruned condition of tree were relatively lower as compared with control condition and other treatments i.e., more than 3 feet distance from tree base. This may be due to the competition for moisture and nutrients between the roots of *Xylia dolabriformis* saplings and radish, because saplings age was two years, within this time, tree root can spread only 2-3 feet distance. Similar type results were also observed by Dhukia *et al.* (1988) who found that closer plant from tree base has severely affected by root competition.

Tomato

Number of fruits plant^{-1}: Number of fruits plant is the most important yield contributing character, which was also significantly influenced by different distance of growing tomato plant from the tree. The maximum number of fruits per plant was found in the open field (23), which was statistically similar to that of found from treatment T_3 under pruned (22.67) condition and significantly the lowest number of fruits plant^{-1} (13) was found from treatment T_1 under unpruned condition (Table 1). Basak *et al.* (2009) also showed that the yield contributing characters of the vegetables increased gradually with the increase of planting distance from the tree.

Fruit diameter: Fruit diameter of tomato grown under different planting distance from the tree followed almost a similar pattern of variation like number of fruits per plant. The maximum fruit diameter recorded from treatment T_0 was 15.000 cm which was statistically similar to treatment T_3 under pruned condition (14.00cm). Significantly the lowest fruit diameter (9.33cm) was recorded from treatment T_1 under unpruned condition (Table 1). The lower fruit diameter under the close contact with tree may be associated with the lower mobilization of reserve assimilates to reproductive organ. Similar findings in case of mungbean were also reported by Ali (1998).

Like radish the lower number of fruits plant^{-1}, weight of fruits plant^{-1} and fruit diameter under close contact of the tree condition was probably due to poor photosynthetic capacity and nutrients competition between tree and crops.

Soybean

Plant height (cm): Plant height of soybean was significantly influenced by planting distance of soybean plant from the tree. The highest plant height (86.00cm) was recorded under the treatment T_0 (open fiend) which is statistically similar to the treatment T_3 under pruned condition (81.67cm) and dissimilar to the other treatments. Plant height of soybean increased with the increase of plating distance of soybean plant from the tree. The lowest value of plant height was recorded 47.67cm from the treatment of T_1 under unpruned condition which was close contact of the tree. Taleb *et al.* (2003) showed that plant height of the vegetables increased gradually with the decrease of light levels.

Number of pods plant^{-1}: Number of pods per plant was significantly influenced by planting distance of soybean plant from the tree. The highest number of pods per plant (126) was found under the treatment T_0 (open field) which was statistically similar to the treatment T_3 under pruned condition (112). The lowest number of pods per plant (41.67) was found from the treatment T_1 under unpruned condition (Table 1) which was remain close distance from the tree and it was statistically different from the other treatments. Lal (1989) concluded that shading was responsible for yield reduction of maize and cowpea under tree.

Number of seeds pod^{-1}: Number of seeds per pod of soybean was significantly influenced by planting distance of soybean plant from the tree and it was increased with the increased of planting distance. The highest number of seeds per pod (3.333) was recorded under the treatment of T_0 (control). The lowest number of seeds per pod (1.67) was found from the treatment of T_1 under unpruned condition which was three feet distance from the tree. All the values were statistically dissimilar to other treatments.

Number of seeds plant^{-1}: Planting distance of soybean from the tree had highly significant influence on the number of seeds per plant. The highest number of seeds per plant (200) was found under the treatment T0 (control) and the lowest number of seeds per plant (88.67) was recorded from the treatment T_1 under unpruned condition (Table 1) which was statistically different from other treatments due to root competition between the tree and soybean plants. Khan and Aslam (1974) also showed decrease of yield in wheat under sissoo compared to the open field.

Lettuce

No. of leaves per plant^{-1}: Good foliage indicates higher growth, development and productivity of plant. The highest number of leaves was 27.67 when plants were grown under treatment T_0 (control). The lowest number of leaves (16.67) was found from treatment T_1 under unpruned condition (Table 1). Number of leaves per plant showed significant variation due to different distance of from plant from the tree. Ong *et al.* (1992) showed that total maize yields under improved trees were only 50% of the sole maize yield which increased to 80% due to pruning indicating the benefits of pruning in reducing tree-crop competition.

Plant height: Lettuce plant cultivated under different distance from the tree grew more vigorously in the open field than those grew close distance to the tree. It exhibited significantly longer height respective of treatments with the increased of distance from the tree, plant height increased significantly. The shortest plant was (17.67cm) found in treatment T_1 under unpruned condition and the tallest plant (28.00cm) was recorded under treatment T0 (open field) due to no interaction with the tree and it was statistically similar to treatment T_3 under pruned condition (26.667 cm).

Yield: Yield of radish, tomato, soybean and lettuce were significantly influenced by *Xylia dolabriformis* saplings at closer distance from the base. Again, crops under pruned condition of the tree provide better yield performance compared to unpruned condition might be due to less competition for natural resources. Highest yield of radish, tomato, soybean and lettuce were recorded under open field condition (control) and lowest yield were found at 3

feet distance area from the base of the tree under unpruned condition (Fig. 1a, 1b, 1c and 1d). Yield at 9 feet distance from tree base under pruned condition were statistically similar with control condition. During the sapling stage, competition for growth resources is occur only in closest to the basal areas of sapling. For this reason some yield reduction of all four crops were observed near the basal area (3 feet distance) of *Xylia dolabriformis*. Similar result was also reported by Ali *et al.* (1998) who reported that the yield of red amaranth and okra gradually increased with increasing distance from Drumstick tree base.

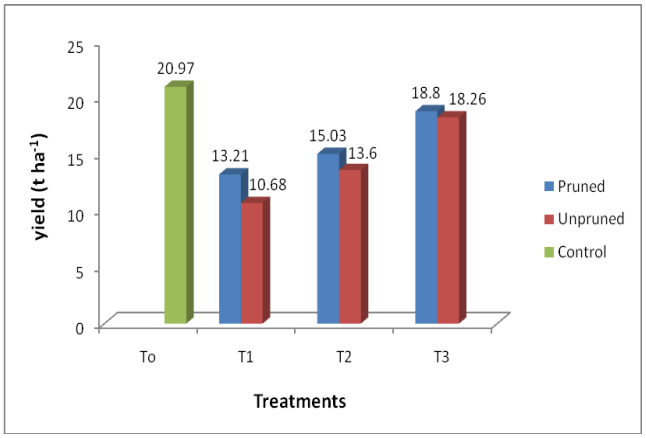

Fig. 1a Yield of radish in association with *Xylia dolabriformis*

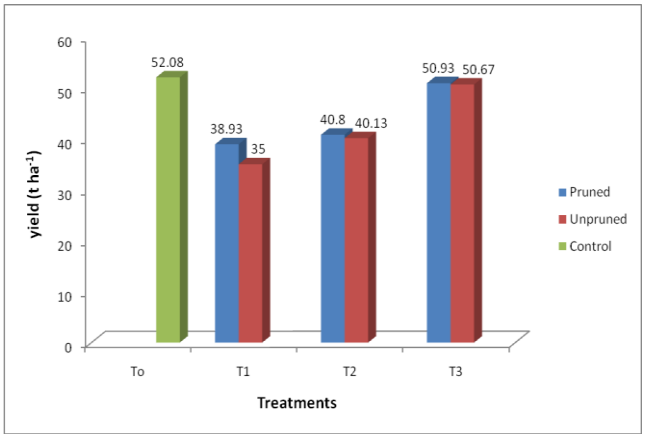

Fig. 1b Yield of tomato in association with *Xylia dolabriformis*

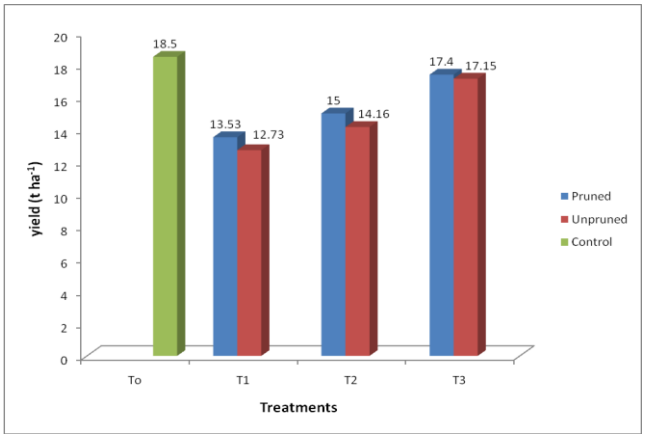

Fig. 1c Yield of soybean in association with *Xylia dolabriformis*

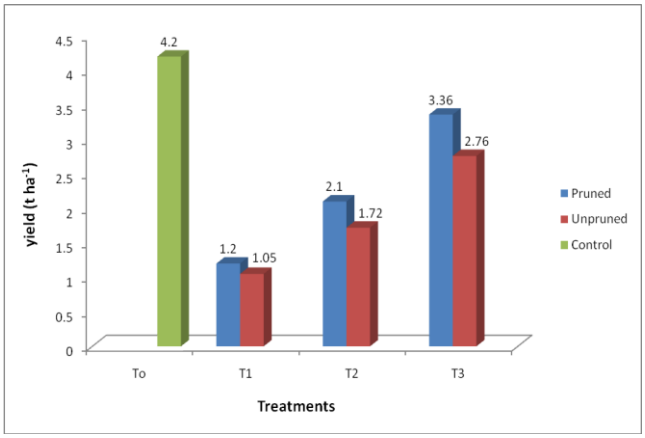

Fig. 1d Yield of lettuce in association with *Xylia dolabriformis*

Effect of radish, tomato, soybean and lettuce on the growth characteristics of *Xylia dolabriformis*

The growth characteristics such as plant height, leaf numbers and stem girth of *Xylia dolabriformis* significantly influenced by the interaction of tomato (Fig. 2). Height, leaf numbers and stem girth of *Xylia dolabriformis* were significantly low when it was in association with tomato (Fig. 2). Among the four crops tomato has fibrous root system and its root volume also large. For this reason competition may be dominant between *Xylia dolabriformis* saplings and tomato roots for growth resources especially for nutrients and moisture as a result *Xylia dolabriformis* was suppressed. On the others hands, soybean is the leguminous crop and lower volumes of both shoot and root system which helps the growth of *Xylia dolabriformis* by supplying nitrogen into the tree sapling. The growth characters (plant height, leaf numbers and stem girth) of *Xylia dolabriformis* tree are quite better in association with lettuce than tomato and radish but not better than soybean.

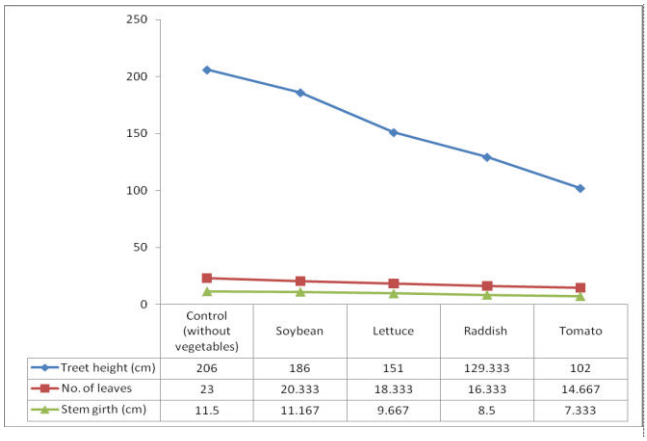

Fig.2. Effect of radish, tomato, soybean and lettuce on the growth characteristics of *Xylia dolabriformis*

The yield components of four winter crops (radish, tomato, soybean and lettuce) and growth characteristics of *Xylia dolabriformis* tree are highly interacted with each other. From the result we found that among the tree-crop interaction, tree-soybean combination gives highest value and tree-tomato combination gives lowest value of tree height, leaf number and girth of the stem. Tree-lettuce and tree-radish combination give moderate value of those parameters. Again, better yield performance of crops was found under pruned condition of the tree compared to unpruned condition. Therefore, it may be concluded that all the tested crops are suitable in Agroforestry practice, but degree of their suitability may be ranked as Soybean > Lettuce > Radish > Tomato. On the basis of pruning condition of tree and planting distance from the base of tree, 9 ft distance from the crop under pruned condition of tree with soybean is the best among all the tree-crop interaction in this experiment.

References

Ali, M.A. 1998. Growth and yield of mungbean genotype under sun and shade condition. M.S. Thesis, BSMRAU, Gazipur, Bangladesh.

Basak, S., Hasan, M.K., Islam, M.S. and Wadud M.A. 2009. Performance of radish, tomato and soybean during the first year of Lohakat (Zylia *dolabriform*) plantation. J. Environ. Sci. Nat. Resour., 2(1): 185-189.

Dhukia, R.S., Lodhi, G.P., Jatasra, D.S. and Ram, S. 1988. Productivity of forage and food crops in agroforstry system under shisharn and sit-is tress. Indian J. Range Management, 9:53-57.

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

Gopalan, C., Sastri Rum, B.V. and Balas Ubramanion, S. C. 1971. Nutritive value of Indian Foods. 1. C. H. R., Hyderabad, India, referred by R. G. Smith, Home Economist, M. C. C. p. 23-29.

Jiang, J.P., Zhu, J.J., Liu, T.Z., He, S.N., Zhou, Z.M. and SU, F.J. 1994. Related changes of wheat yield and photosynthetically active radiation in paulownia tree and wheat intercropping system. Acta Agric. Boreati Sinica, 9:133-137.

Khan, G.S. and Aslam, R.M. 1974. Extend of damage of wheat by Sissoo. Proceedings of the Pakistan Forestry Conference held in Nov. 4-8, 1974. Pakistan Forest Ins., Peshawar, p. 37-40.

Lal 1989. Agroforestry systems and soil surface management of a tropical altisol:I. Soil moisture and crop yields. Agroforest. Syst., 8:7-29.

Miah, M.G., Rahman, M.A. and Haque, M.M. 1999. Performance of onion under different reduced light levels for agroforestry and intercropping system. Bull. Trop, Agric., 22 Nair, P.K.R. 1990. An introduction to agroforestry. Kluwer Academic publishers, ICRAF.

Ong, C.K., Rao, M.R. and Mathuva, M. 1992. Trees and Crops. Composition for resources above and below ground. Agroforest. Today, 4(2): 4-5.

Roy, U.K. 2004. Performance of two winter vegetables under different tree canopies of various shade levels as agroforestry practice. M.S. Thesis, BAU, Mymensingh, Bangladesh.

Souza, J.R.P., Mehl, H.O., Rodrigues, J.D, and Pedras, J.F. 1999. Shading and the development and yield of radish *(Raphanus sativus L)* Scientia Agricola, 56(4): 987-992. [Cited from Cab. Abst., 1998-2000].

Taleb, M.A. 2003. Screening of some winter vegetables as lower layer crops under three layered agroforestry system. M.S. Thesis, BAU, Mymensingh, Bangladesh.