Performance of seven winter vegetables along with four years old Akashmoni tree in charland based agroforestry system

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Abstract: The experiment was carried out in Char Kalibari of Old Brahmaputra River under the Department of Agroforestry, Bangladesh Agricultural University, Mymensingh during the period from October 2013 to March 2014 to observe the performance of seven different winter vegetables in association with four years old Akashmoni tree for 'Char' based farming system. Winter vegetables were planted in association with Akashmoni tree following two factorial Randomized Complete Block Design (RCBD) with 4 (four) replications. Factor A: tree species were Akashmoni (*Acacia auriculiformis*). Factor B: seven winter vegetables and these were sweet potato (*Ipomoea batatus*), potato *(Solanum tuberosum*), radish (*Raphanus sativus*), chilli (*Capsicum annuum*), carrot (*Daucus carota*), sweet gourd (*Cucurbita moschata*), and coriander (*Coriandrum sativum*). Yield and yield attributes of all tested winter vegetables was better in open field condition. Except plant height, all other morphological parameters of sweet potato, potato, radish, chilli, carrot, sweet gourd, and coriander was slightly increased in open field condition as compared to combined condition. Almost all tested vegetable species were slightly taller (4-8%) in association with Akashmoni trees but in sweet gourd tallest plant was observed without tree condition. Number of tuber/fruits/leaves per plant, tuber/fruit/root length and individual tuber/fruit/root weight was partially increased (10-20%) without Akashmoni tree association or open field condition. Height and girth increment of Akashmoni tree was little bit higher under combination of with vegetables condition (with potato, coriander and sweet gourd) and the lowest was found under the combination of chilli, sweet potato, carrot, radish. The morphological performance of akashmoni significantly influenced by the interaction of seven winter vegetables such as sweet potato (*Ipomoea batatus*), potato (*Solanum tuberosum*), radish (*Raphanus sativus*), chilli (*Capsicum annuum*), carrot (*Daucus carota*), sweet gourd (*Cucurbita moschata*), and coriander (*Coriandrum sativum*). Yield of sweet potato, potato, radish, chilli, carrot, sweet gourd, and coriander were 11.3, 16.2, 15.4, 17.8, 17.1, 52.1 and 18.0% lower along with Akashmoni combination as compared to open field condition.

Key words: Akashmoni tree (*Acacia auriculiformis*), winter vegetables, yield, agroforestry, charland.

Introduction

Agroforestry, the integration of the tree, crop and vegetable on the same area of land is a promising production system for maximizing yield and maintaining friendly environment (Nair, 1990). Growing of crops and vegetables in association with trees is becoming popular day by day for their higher productivity, multipurpose use and environmental consciousness among the people. In Bangladesh scope of Agroforestry is vast. The major venues of agroforestry are homestead, roadside, railway side, embankment side, charland, coastal area, deforested area, institutional premises, riverside etc. Among them charland is the most important venue for practicing agroforestry systems. 'Char' a tract of land surrounded by the waters of an ocean, sea, lake, or stream; it usually means any accretion in a river course or estuary (Chowdhury, 1988). The total area covered by chars in Bangladesh was 1,722 sq km (Banglapedia). A large number of populations are living in these char areas and maintaining their livelihood through char based farming systems. Therefore, for increasing production, maintaining ecological balance and improving socio-economic condition of the charland people, integrated approach with crops/vegetables and trees are necessary. Akashmoni *(Acacia auriculiformis)* is a fast-growing, nitrogen-fixing tree which has shown adaptability to a wide range of environmental conditions and also has multiple uses (Pinyopusarerk, 1990). It can also tolerate highly alkaline and saline soils. Acacia is a good source of firewood and good quality charcoal (does not smoke), as well as timber for furniture and pulp for making paper. To meet up the demand of vegetable as well as timber and fuel wood, farmers will be cultivate these plant species combindly as agroforestry system. Population of Bangladesh is increasing rapidly, therefore, demand for vegetable is increasing simultaneously whereas the areas under vegetable production including tuber crops are 912005 ha that produce 11.38 million metric tons of vegetable yearly (BBS, 2011). Vegetables may play a vital role in this aspect. Generally vegetables are rich sources of minerals, vitamins and essential amino acids. A large number of vegetables are grown in the field in our country. Most of them are grown in the winter season of which chilli, Radish, potato, sweet potato, coriander, carrot and sweet gourds are very common, popular and quick growing vegetables having high nutritional value and can grow easily. Chilli (*Capsicum sp.*) is most widely used and universal spice belongs to the Solanaceae family and rich in vitamins, especially in vitamin A and C (Raju and Luckose, 1991). Radish is easily cultivated as a companion crop or intercrop between the rows of other vegetables (Roy, 2004). Coriander is an increasingly popular green herb for its diversified use and nutritional value and also medicinal values (Sadhu, 1993). Sweet potato and Potato are widely grown as winter vegetable crop in Bangladesh. The tuber has remarkable for both its adaptability and its nutritional value. As well as providing starch, an essential component of the diet, potatoes are rich in vitamin C, high in potassium and an excellent source of fiber. Sweet potato leaves could be used as vegetables which are rich in various nutrients. Among the different winter vegetables, carrot is the important winter vegetables in Bangladesh which contains most important beta-carotenes, vitamins A, minerals and rich root crops. It also rich in sugar content (Yawalker, 1992) and some important medicinal values (Sadhu, 1993) and also used for the preperation of prickles, jam and sweet dishes (Kabir *et al.,* 2000). Radish is a member of the Brassicaceae family, cool season, fast maturing, easy to grow annual leafy and rooty vegetable and rich in ascorbic acid, folic acid and potassium (USDA Nutrient Database, 1999). Sweet gourd is a tender tendril bearing and vine

like plant rich in various nutrients mainly both alpha and beta carotene which generates vitamin A (Tecson, 2001). Present study was undertaken to examine the competitive effect of seven winter vegetables (chilli, radish, potato, sweet potato, coriander, carrot and sweet gourd) grown in association with akashmoni tree at the Char Kalibari in the bank of Old Brahmaputra River.

Materials and Methods

Experimental site: The experiment was carried out in Char Kalibari of Old Brahmaputra River during the period from October, 2013 to March, 2014. The geographical position of char kalibai located between 24˚45' - 24˚45'40" North and 90˚24'4" - 90˚24'44" East Latitude. The physiographic unit of the soil of this char is old Brahmaputra flood plain. Every year after the monsoon huge area along the bank of the river old Brahmaputra developed as char which is rich due to silt deposition. The climatic condition of this char is sub-tropical and scanty rainfall associated with moderately low temperature during the Rabi season (October to March). Char Kalibari is an attached charland which have three distinct elevations. The upper elevation is relatively stable char, while the middle and lower elevation remained inundated during the rainy season from June to September each year. During summer season only stable portion of this char is suitable for vegetables cultivation.

Planting material: In this study the four years old previously established akashmoni (*Acacia auriculiformis*) trees were used as tree components and seven winter vegetables like sweet potato (*Ipomoea batatus*), potato (*Solanum tuberosum*), radish (*Raphanus sativus*), chilli (*Capsicum annuum*), carrot (*Daucus carota*), sweet gourd (*Cucurbita moschata*), and coriander (*Coriandrum sativum*) were used as plant materials. The seeds of Coriander variety viz. local were purchased from seed center, seeds of Carrot variety viz., laltir were collected from International Seed Fair in BAU campus Mymensingh, the seeds of Radish variety BARI Mula-2, Chilli variety BARI-2, Sweet potato variety Bari-2, Potato variety Bari-3 and Sweet gourd variety BARI Misti Kumra-1 were collected from International Seed Fair in Bangladesh Agricultural University campus, Mymensingh.

Crop Establishment: Seeds of seven vegetables of sweet potato, potato, radish, chilli, carrot, sweetgourd, and coriander were directly sown in the experimental plot. Sweet gourd were sown with spacing, Sweet potato and potato were line sowing. Carrot, chilli, radish and coriander were sown after land preparation in a broadcast method during 20th October 2013. All necessary cultural operations were done when it was required. After germination all necessary cultural operations like thinning, gap filling, weeding, fertilizing, irrigation, pest control etc. were done properly. Individual plot size for all vegetable was same and it was 12′ × 24′.

Experimental design, layout and tree sapling transplantation: Winter vegetables were planted in association with akashmoni trees following two factorial Randomized Complete Block Design (RCBD) with 4 (four) replications. Factor A: Akashmoni tree species and Factor B: Seven different winter vegetable species. Tree species were planted maintaining a strip method with 12′ × 12′ spacing during April 2011 in the study site. Necessary silvicultural management activities like watering, cleaning, weeding, fertilizing, branch cutting, bamboo stick setting were done in time for proper growth and development of all tree saplings.

Growth measurement of tree species: Growth of all planted tree sapling were recorded as height and girth during before and after winter season i.e. first time in the month of October 2013 and second time in the month of March 2014. Girth was measured using the formula: $G = 2 \Pi r$, where, r = radius. Difference between the recorded data during before and after the winter season treated as increment during winter season for both height and girth. Girth of all trees was measured 8 inch above the ground level.

Sampling and Data collection: Data were collected randomly from all treatments of seven vegetables. In case of chilli, plant height (cm), no. of leaves plant^{-1}, leaf length (cm), leaf breadth (cm), weight of per fruit plant^{-1} and yield of chilli (t/ha) was recorded. Sweet potato and potato plant height (cm), no. of leaves plant^{-1}, tuber length (cm), fresh per tuber weight plant^{-1} (g) and yield (t/ha) were recorded at harvesting stage. For radish and carrot plant length (cm), no. of leaves plant^{-1}, root length (cm), weight of root plant^{-1} and yield of radish and carrot (t/ha) was recorded at harvesting stage. In sweet gourd plant height (cm), no. of leaves plant^{-1}, fruit length (cm), weight of per fruit plant^{-1} and yield of sweet gourd (t/ha) was recorded. For yield measurement, data were recorded from individual plots and it was converted as tha^{-1}. In case of Coriander plant height (cm), no. of leaves plant^{-1}, leaf length (cm), fresh weight of plant^{-1} and yield of coriander (t/ha) was recorded.

Statistical analysis: The recorded data were compiled and analysed by RCBD design to find out the statistical significance of the experimental results. The means for all recorded data were calculated and the analyses of variance for all the characters were performed. The mean differences were evaluated by Duncan's New Multiple Range Test (DMRT) at 5% level of significance (Gomez and Gomez, 1984) and also by Least Significant Difference (LSD) test.

Results and Discussion

Morphological characteristics:

Sweet potato: Morphological behaviors of sweet potato significantly influenced by akashmoni tree (Table 1 and Fig.1). Plant height (cm), no of leaves, tuber length,weight of tuber plant^{1}, were influenced by akashmoni tree in a similar pattern where highest values of all above parameters was in open field condition which was statistically similar with tree association (Table 1). Highest value of plant height, no of leaves, tuber length, weight of tuber plant^{-1} 72 cm, 13.7, 15.2 cm, 325.0 g respectively. Near the tree base growth of all morphological parameters was less vigorous comparing without tree. This might be due to negative interaction between tree-vegetable root systems for growth resources like water and nutrients. Basak *et al.* (2009) observed similar type of influence in

Radish, Tomato and Soybean along with two years old Lohakat tree.

Potatot: performance of potato was observed along with akashmoni tree in this study (Fig.1). Highest value of plant height, no of leaves, tuber length, weight of tuber plant^{-1} were recorded 47.3cm, 9.8, 10.5 cm, 471.5 g respectively which are presented in the (Table 1) and it was found that all growth parameters was not good condition in the very near the akashmoni tree. Islam *et al.* (2009) observed similar type interaction in winter vegetables in association *Hopea odorata* tree.

Table 1. Morphological characteristics of winter vegetables in association with *Acacia auriculiformis* tree

Vegetables	Morphological Characteristics							
	Plant height (cm)		No. of tuber/fruits/leaves plant^{-1}		Tuber/fruit/root length (cm)		Weight per tuber/fruit /root plant^{-1} (g)	
	with trees	without trees	with trees	without trees	with trees	without trees	with trees	without trees
1. Sweet Potato	72.0	70.5	12.0	13.7	13.5	15.2	310.5	325.0
2. Potato	45.5	47.3	9.2	9.8	9.8	10.5	450.5	471.5
3. Radish	48.5	46.0	10.0	11.5	22.5	25.7	151.5	170.5
4. Chilli	71.5	69.5	83.5	89.5	6.0	6.5	3.0	3.5
5. Carrot	44.3	43.0	10.0	12.0	17.0	18.5	121.5	137.0
6. Sweet gourd	255.2	284.5	12.0	14.0	15.5	17.5	1850.5	1995.0
7. Coriander	19.5	20.5	11.5	12.5	..	..	1.2	1.5

Radish: Highest Plant height (48.5cm) was found in open field condition whereas lowest height was observed in the absence of tree combination. No of leaves (11.5), root length (25.7 cm), weight of root plant^{1} (170.5 g) were found highest in open field condition which was statistically similar with tree association (Table 1 and Fig.1). In this study, the morphological characteristics of radish was increased consistently without akashmoni tree association. Khatun *et al.* (2010) reported competitive interaction between medicinal plants and winter vegetables near the base area of medicinal plants.

Fig. 1. Winter vegetables in association with Akashmoni tree (A) Sweet potato, (B) Potato, (C) Radish, (D) Chilli, (E) Carrot, (D) Sweetgourd and (G) Coriander.

Chilli: Except plant height (cm), no of leaves, fruit length, weight of fruit^{-1} plant^{1}, were influenced by akashmoni tree in a similar pattern where highest values of all above parameters was in open field condition which was statistically similar with tree combination (Table 1 and Fig.1). Highest value of plant height, no of leaves, fruit length, weight of fruit^{-1} plant^{-1} 71.5 cm, 89.5, 6.5 cm, 3.5 g respectively. These results are in agreement with the results of Rahman *et al.* (2013) in different winter vegetables under alley cropping system.

Carrot: Similarly in case of carrot, no of leaves, root length, weight of root plant^{1}, were influenced by akashmoni tree (Fig.1). But highest value of plant height 44.3 cm was found in the tree association. This might be because of leaf biomass plant was relatively strong and stout comparing without trees (Table 1).

Sweet gourd: Maximum plant height (284.5cm), no of leaves (14), fruit length (17.5cm), weight of fruit^{-1} plant^{1} (1995.0g) were found in absence of akashmoni tree combination which was statistically similar with tree combination (Table 1 and Fig.1). It was probably due to poor photosynthetic capacity and nutrient competition between tree and crop.

Coriander: Morphological behaviors of coriander such as plant height (cm), no of leaves, weight plant^{1}, were influenced by akashmoni tree (Table 1 and Fig.1). Highest value of plant height, no of leaves, weight plant^{-1} 20.5 cm, 12.5, 1.5 g were found in without tree condition respectively which was statistically similar with tree condition. It might be due to shading effect and nutrient competition between tree and crop.

Yield: Total yield of all tested winter vegetables were significantly influenced by *Acacia auriculiformis* tree. Yield of sweet potato, potato, radish, chilli, carrot, sweet gourd, and coriander under open field and with tree combination were 15.5, 26.6, 39.6, 3.95, 35.6, 25.5 & 3.05 t/ha and 13.75, 22.3, 33.5, 3.25, 29.5, 11.2 & 2.5, respectively. Yield of all seven winter vegetables were significantly lower in association with Akashmoni tree which was 15.4-18% reduced compare to open field condition except sweet potato where yield was similar with open field condition and sweet gourd where yield was reduce with open field condition (Fig. 2). The yield reduce remarkably with tree combination may be due to completion for growth resources like water and nutrients. It was found from this study competition for growth resources was minimum where tree was absent which indicates root of four years old Akashmoni spread after far

from tree base beyond the crop root system as a result after distance from tree base competition between the tree-crop was absent or minimum in this area. Similar observation was reported by Islam *et al.* (2009) and Tanni *et al.* (2010) in different winter vegetables along with Telsur (*Hopea odorata*) and Lohakat (two years old) tree.

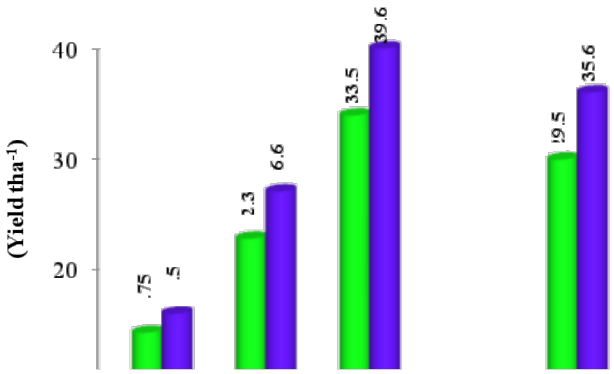

Fig. 2. Yield of different winter vegetables with Akashmoni trees

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