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Performance of Kangkong under two years old Akashmoni tree

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Abstract: A field experiment was conducted to evaluate the effect of Akashmoni *(Acacia auriculiformis)* on the growth and yield of Kangkong grown as understory vegetable crops. The experimental site was located at SPGR sub-project experiment field, Char Kalibari, Mymensingh, during June 2012 to November 2012, under the dipartment of Agroforestry, Bangladesh Agricultural University, Mymensingh. This experiment was degined with a Randomized Complete Block Design (RCBD) with three replication. Different distance from tree base was treated as different treatment. Three different distance category 0-2.5ft, 2.5-5ft, 5-7.5ft from tree base were the three different treatment of the study. There was a control treatment i.e. Kangkong 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), T_3 (7.5 ft distance from the tree base). Growth of Akashmoni tree also observed during the Kangkong cultivation period. The results showed that Kangkong was gradually increased with increasing distance from Akashmoni tree base. However yield of Kangkong was highest in open field condition. On the contrary, yield of Kangkong in association with Akashmoni reduced 2.71, 17.16 and 31.99% in 5-7.5ft, 2.5-5ft and 0-2.5ft distance from the tree base, respectively. Kangkong successfully cultivate along with 2 years old Akashmoni tree without significant yield loss; However the vegetable yield had reduced remarkably at 5ft distance from tree base.
Key words: Akashmoni, yield, Kangkong, Agroforestry.

Introduction

Agroforestry combines agriculture and forestry technologies to create more integrated, diverse, productive, profitable, healthy and sustainable land-use systems. Small scale agriculture plays an important role in Bangladesh economy. It provides nearly 50% of cash flow to the rural poor (Leuscher and Khaleque, 1987). Forestry plays an important role in maintaining environmental equilibrium and socio-economic aspects of the people. A country needs 25% of forest land of its total area for ecological stability and sustainability. Unfortunately, Bangladesh is endowed with only 17% (BFD, 2011) of unevenly distributed forests. However, actual tree cover is less than 10% of unevenly distributed forests (Akter *et al*, 1989). Bangladesh has only 2.52 mha (million hectares) (17%) of land designated as forests (BFD, 2011), although FAO (2011) estimates 1.442 mha (11%) as effective forest cover. The per capita forest area in Bangladesh is very low (0.009 ha) compared to average values in Asia (0.145 ha) and the world (0.597 ha). The central region where the population density is the highest, has the least forest resources. Substantial depletion of forest resources has occurred in the last few decades, and now it is reduced to less than 0.02 ha per person, which is one of the lowest ratio in the world (BBS, 2001). Under these alarming situations, agricultural production as well as forest resources must be increased by using modern or new techniques.

Though agroforestry is an age-old practice in Bangladesh, further improvement may be brought for harvesting maximum benefit through adopting appropriate tree- crop combination. Akashmoni (*Acacia auriculiformis*) is an important timber tree species that is grown all over the country for its wide range of adaptability. During this establishment period of this tree farmers can grow annual crops (vegetables) as intercropping at the tree base and surrounding area. Cultivation of vegetables can ensure maximizing use of land resources and ultimately increases total yield.

In Bangladesh, different crops are cultivated in summer season. Among the different summer vegetables, Indian spinach, Amaranth, Okra, Jute and Kangkong are the important summer vegetables in Bangladesh. These are well known and very popular vegetables grown successfully during summer season in our country.

Kangkong (*Ipomoea reptans*) is very important cultivated crop in all South East Asian countries, where it has superior, bushy varieties that are grown with much care either as upland or a lowland crop (Edie and Ho, 1969). Kangkong is rich in carotene, vitamins and minerals that is excellent for human health. Kangkong is usually used as an ingredient in sinigang (sour stew). 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 present experiment has carried out to grow various crops within different spacing from the tree base.

Materials and Methods

Experimental site: The experiment was carried out at Kalir char which is situated by the side of Brahmaputra river adjacent to the Bangladesh Agricultural University, Mymensingh during the period from 15 June 2012 to 15 November 2012. The place is geographically located at about 24°75'' North latitude and 90°50' East longitude (Khan, 1997).

Planting materials: In this study the tree species is Akashmoni *(Acacia auriculiformis)* in combination with this tree Kangkong (*Ipomoea reptans*) was cultivated surrounding the tree base in different distance.

Experimental design : The Experimental design was laid out in a Randomized Complete Block Design (RCBD) with three replications. Four tree-crop distance treatments were used. These are: T_0= Open field referred to as control, T_1= 0-2.5 ft distance from the tree base, T_2=2.5- 5 ft distance from the tree base, T_3= 5-7.5 ft distance from the tree base.

Vegetable cultivation: Kangkong seeds are shown on 15 June 2012. The seeds were shown maintaining the spacing of 30cm from one line to another. One day after sowing of seeds, light irrigation was given to facilitate the germination process. The individual plot size for Kangkong was 2.5 m x 2.4 m. After germination all necessary management practices like fertilizer application, weeding and irrigation, pest and disease control etc were done properly.

Data collection: Data were collected from randomly selected individual plants of all vegetables when the crop reached at edible size. The parameters were studied such as plant height (cm), no. of leaves per plant , no. of branches per plant, length of per branch, leaves of branchper plant, leafs size (length and breadth), stem garth, leaf weight/plant (g), stem weight/plant (g), leaf stem ratio. Sample plants were weighted for fresh yield (expressed in gm) which was converted to t/ha. For determining the weight of leaves and weight of stem per plant the leaves were separated from stem and then weighted separately. The leaf stem ratio was determined by dividing the leaf weight by stem weight. Dry yield was calculated using the following formula:

Statistical Analysis: The Data on various growth and yield contributing characters of two vegetables were statistically analyzed to examine the significant variation of the results. The analysis of variance for each of the character under study was done by F (variance ratio) test for Randomized Complete Block Design (RCBD). The treatments means were compared by the Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984) at 5% level of significance.

Results and Discussion

Kangkong was harvest four times at 15 days intervals. First harvest was done at 35 days after planting (DAP) 2nd, 3rd and 4th harvest was done 50, 65 and 80 days at 15 Days interval after planting. Morphological parameters and yield of Kangkong was significantly influenced by Akashmoni tree at different distances from the tree base.

Plant height: The result shows that height of Kangkong gradually decreases with increasing the distance from tree base at each harvesting time i.e. first, second, third and fourth time harvest (Table 1). These were probably due to higher apical dominance under shade condition (Hillman, 1984). Among the four distance levels, the tallest plants (34.25 cm, 32.75 cm, 31.5 cm and 29.25 cm) were produced within T_1 (0-2.5 feet distance from the tree). Plant height of Kangkong grown with in T_0 and T_3 was statistically similar.

Table 1: Morphological characteristics of Kangkong under two years old Akash moni tree after different harvesting time

Harvesting period	Treatment	Morphological characteristics of Kangkong								
		Plant Height (cm)	Number of leaves/plant	Numberof branch/plant	Leaf length(cm)	Leaf breadth(cm)	Stem girth(cm)	Weight of leaves/plant(g)	Weight of stem/plant(g)	Leaf stem ratio
First at 35 DAS	T_0	29.25c	12a	1.5a	11.9a	3.75a	2.8a	8.5a	4.25a	2a
	T_1	34.25a	10b	1c	9.4d	2.25c	2bc	5.5bc	3.15b	1.74b
	T_2	31.25b	10.5b	1.25b	10.4c	2.75b	2.35b	6.5b	3.25b	2b
	T_3	29.5c	11.5a	1.45a	11.65b	3.35ab	2.6a	8.3a	4.2a	1.97a
Second at 50 DAS	T_0	28.5b	58a	7.5a	11.3a	3.56a	2.94a	42.5a	20.25a	2.09a
	T_1	32.75a	51bc	5.25c	8.93c	2.13cd	1.9cd	30c	17b	1.76b
	T_2	30.25ab	53b	6.5b	9.88b	2.61c	2.23c	37.5b	16.25b	1.86ab
	T_3	28b	57.5a	7.25a	11.06a	3.18b	2.73b	41.5a	21a	1.97a
Third at 65 DAS	T_0	27.25bc	75a	9.75a	11.15a	3.49a	3.12a	55.25a	27.62a	2a
	T_1	31.5a	62.5d	6.5c	8.78c	2.01bc	2.1c	41c	14.5b	2.82b
	T_2	28.25b	65.62c	8.12b	9.72c	2.57b	2.57b	43.87b	21.12b	2.07b
	T_3	26.5c	71.87b	9.42a	10.89b	3.12a	3.12a	53.95a	27.3a	1.93a
Fourth at 80 DAS	T_0	25.75c	66a	8.25a	11.24a	3.54a	2.95a	46.75a	22.5a	2.05a
	T_1	29.25a	55d	5.5a	8.88b	2.12c	2.11b	30c	16.5b	1.81b
	T_2	27b	57.75c	6.87c	9.82b	2.59bc	2.48ab	37.25b	17.87b	2.08b
	T_3	24.75c	63.25b	7.97b	11a	3.16b	2.74a	45.65a	23.1a	1.97a

Means in different column followed by the different letter are significantly different by DMRT at $P \leq 0.05$; Where, T_0 = Open field referred as control, T_1= 0.0 feet to 2.5 feet distance from the tree, T_2 = 2.5 feet to 5.0 feet distance from the tree, T_3 = 5.0 feet to 7.5 feet distance from the tree.

Number of leaves per plant: Number of leaves per plant of kangkong was also significantly influenced by different reduced distance from the tree base (Table 1). The number of leaves increased gradually with increasing of distance from tree base. The highest number leaves per plant (12, 58, 75 and 66) at first, second, third and fourth time harvest, respectively. The lower number of leaves per plant at every harvesting time under T_1 (0.0-2.5 feet distance from tree base) level for reduced light conditions may be due to lower production of photosynthates under low light conditions for a longer period and tree crop competition for food, space, light and water etc.

Number of branch per plant: It was noted that no. of branch of Kangkong was meaningfully enlarged with the rise of distance from tree. It was perceived that no. of branch of Kangkong was affected by tree (Table 1). The maximum no. of branch per plant (1.5, 7.5, 9.75 and 8.25) was noted from T_0 at first, second, third and fourth time harvest, respectively and 5.0-7.5 feet (1.45, 7.25, 9.42 and 7.97) distance from the tree base.

Leaf size (length x breadth): Both length and breadth of Kangkong leaves were significantly influenced by different levels of distance from tree base and the pattern of variation in both cases was almost identical (Table 1). Leaf size decreased progressively with decreasing distance

from tree base. Similar observation was reported earlier by Yoshida and Parao (1976) who observed that vegetables grown under shade resulted in smaller leaves. Among the four distance levels, the (11.9cm x 3.75 cm, 11.3cm x 3.56 cm, 11.15cm x 3.49 cm and 11.24 cm x 3.54 cm) was obtained in open place and smallest leaf (9.4 cm x 2.25 cm, 8.93 cm x 2.13 cm, 8.78 cm x 2.01 cm and 8.88 cm x 2.12 cm) was obtained in 0.0-2.5 feet distance from the tree base. This may be due to the stimulation of cellular expansion and cell division under shaded conditions (Schoch, 1972).

Stem girth: Stem girth of Kangkong grown under full sunlight (2.8 cm, 2.9 cm, 3.12 cm, and 2.95 cm) at first, second, third and fourth time harvest, respectively and 5.0-7.5 feet distance (2.6 cm, 2.73 cm, 3.12 cm and 2.74 cm) at first, second, third and fourth time harvest, were statistically identical but reduced drastically when grown under 2.5-5.0 feet distance (2.35 cm, 2.23 cm, 2.57 cm and 2.48 cm) at first, second, third and fourth harvest time and 0.0-2.5 feet distance (2.3 cm, 1.9 cm, 2.1 cm and 2.11 cm) at first, second, third and fourth time harvest, respectively.

Leaf weight: Weight of leaf per plant of Kangkong was also influenced by the different distance (Table 1). Highest leaf weight (8.5 g, 42.5 g, 55.25 g and 46.75g) of Kangkong was found from T_0 (Open field referred as control) and second maximum weight was (8.3 g, 41.5 g, 53.25 g and 45.65 g)obtained from T_3 (7.5 ft distance from the tree). The lowest weight was (6.75g, 30g, 41g and 30g found from T_1 (2.5 ft distance from the tree).

Stem weight: The highest weight of stem per plant (4.25 g, 20.25 g, g, 27.62 g and 22.5 g at first, second, third and fourth time harvest, respectively) were produced under full sunlight condition which was statistically similar to that of 5.0-7.5 feet distance form the tree base (4.2 g, 21 g, 27.3 g and 23.1 g at first, second, third and fourth time harvest, respectively). But significant reduction of stem weight per plant (3.25, 16.25, 21.12 and 17.87 g at first, second, third, and fourth time harvest, respectively) were observed within 2.5-5.0 feet distance and the lowest stem weight per plant (3.15 g, 17 g, 14.5 g, and 16.5 g at first, second, third, and fourth time harvest, respectively) were produced within 0.0-2.5 feet distance from tree base.

Leaf stem ratio: The leaf stern ratio of Kangkong gradually decreased with decreasing distance from Akashmoni tree base at different harvesting time (Table 1). At first harvest time highest leaf stem ratio was 2 under open field condition and lowest was 1.74 under 0.0-2.5 feet distance from tree base. At second and third harvesting time the highest leaf stem ratio were 2.09 and 2.82, respectively, under control and 0.0-2.5 feet distance from the tree base and lowest were 1.76 and 1.93, respectively 0.0-2.5 feet and 5.0-7.5 distance from tree base.

Yield:

Fresh yield: There was significant variation in fresh yield of kangkong grown in different area from tree base (Table 5a). In all harvests similar type of variation was found among the different distant area from Akashmoni tree base. But highest fresh yield was obtained in all harvests under open field condition and these was 7.51, 14.51, 16.28 and 15.15 t/ha, respectively. Fresh yield gradually increased up to third harvest, after third harvest fresh yield decreased remarkably. Among the different distant area (i.e, 0-2.5 ft, 2.5-5 ft and 5-7.5 ft area from tree base). Highest fresh yield was found in 5-7.5 ft distant area from tree base and which is only 2-3% lower compare to open field condition. In 0-2.5 ft and 2.5-5.0 ft distant area fresh yield of kangkong remarkably decreased and these were 30-32% and 16-17% lower compare to open field condition. This yield reduction may be due to negative interaction for water and nutrients between the kangkong and Akashmoni root system in these areas. After 5 ft distance from tree base this negative effect may be severe because root expansion of Akashmoni with in 2 year not spreaded in these areas. As a results yield of kangkong beyond 5 ft distance from tree base was similar with open field condition. Similar type of fresh was found by Sayed *et al.* (2009) and Khatun *et al.* (2009) in Telsur(*Hopea odorata*) and Civit (*Swinfonia floribunda*) along with different winter vegetables.

Table 2(a). Fresh yield of Kangkong along with Akashmoni tree in different distances from tree base

Treatment	Fresh yield (t/ha)			
	1st harvest	2nd harvest	3rd harvest	4th harvest
T_0	7.51a	14.51a	16.28a	15.15a
T_1	5.11c	9.86c	11.07c	10.31c
T_2	6.22b	12.03b	13.51b	12.57b
T_3	7.38a	14.06a	15.79a	14.77a

Means in coloumn followed by the different letter are significantly different by DMRT at $P \leq 0.05$

Dry yield: Like fresh yield, dry yield of kangkong also significantly influenced in different distant area from Akashmoni tree base (Table 5b). Dry yield gradually increased up to third harvest, after third harvest dry yield decreased remarkably. Among the different distant area (i.e., 0-2.5 ft, 2.5-5 ft and 5-7.5 ft area from tree base). Highest dry yield was found in 5-7.5 ft distant area from tree base and which is only 1.5-3.5% lower compare to open field condition. In 0-2.5 ft and 2.5-5.0 ft distant area dry yield of kangkong remarkably decreased and these were 28-35% and 15-20% lower compare to open field condition. Due to completion for growth resources this

yield reduction may be occurred. Similar opinion also copied by Tanni *et al*. (2010) in Lohakat (*Zylia dolabiformis*) tree in association with winter vegetables.

Table 2(b). Dry yield of Kangkong along with Akashmoni tree in different distances from tree base

Treatment	Dry yield (t/ha)			
	1st harvest	2nd harvest	3rd harvest	4th harvest
T_0	0.95a	1.61a	1.48a	1.35a
T_1	0.64c	1.08c	1.01c	0.91c
T_2	0.79b	1.27b	1.22b	1.12b
T_3	0.92a	1.56a	1.43a	1.31a

Means in coloumn followed by the different letter are significantly different by DMRT at P≤ 0.05

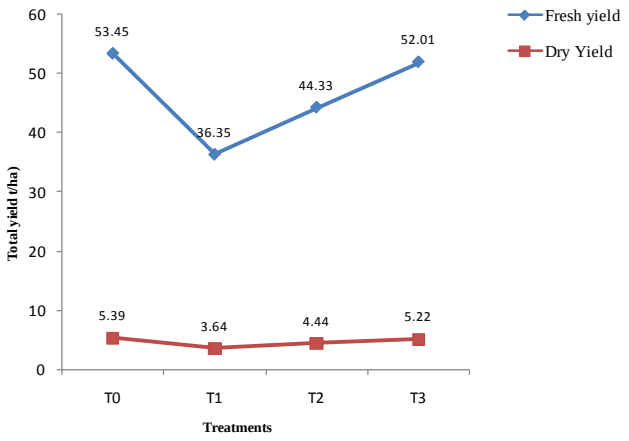

Fig. 1. Total yield of Kangkong with Akashmoni tree

Total yield: Total fresh and dry yield (total of four harvests) of kangkong was also significantly influenced in different distant area from Akashmoni tree base (Fig. 3). Like each harvest total fresh and dry yield also highest in open field condition and these was 53.45 and 5.39 t/ha, respectively (Fig. 1). Among the different distant group highest total fresh and dry yield was in 5-7.5 ft area from tree base and in 0-2.5 ft and 2.5-5 ft area these yield was 36.35 t/ha and 3.64 t/ha and 44.33 t/ha and 4.44 t/ha respectively. These results stated that total fresh and dry yield of kangkong was lower in the near area from tree base and this might be due to completion for growth resources (water, light and nutrient) between tree crop root system. Habib *et al.* (2012) also stated that near the Lohakat (Zylia *dolabiformis)* tree yield of winter vegetables decreased remarkably.

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