Performance of kangkong as intercrop grown in association with three years old karanja tree

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Abstract: A field experiment was conducted to evaluate the effect of Karanja (*Pongamia pinnata*) on the growth and yield of Kangkong (*Ipomoea reptans*) as vegetables grown in association with Karanja. The experimental site was located at SPGR sub–project experiment field, Char Kalibari, Mymensingh, during February 2013 to May 2013, under the Department of Agroforesty, Bangladesh Agricultural University, Mymensingh. The experiment was designed following Randomized Complete Block Design (RCBD) with three replications. The distance from tree base was treated as experimental treatment. Three different distances viz. 0-2.5 ft, 2.5-5 ft, and 5-7 ft from tree base were the three different treatments of the study. There was a control treatment i.e. Kangkong and Karanja were cultivated in the open field condition. So the four treatments 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) and T_3 (7.5 ft distance from the tree base). Growth of Karanja tree also observed during the Kangkong cultivation period. The results showed that Kangkong yield was gradually increased with increasing distance from the Karanja tree base. In T_0 T_1, T_2 and T_3 the yield were 58.6 t/ha, 40.71 t/ha, 48.23 t/ha and 57.19 t/ha respectively. The yield produced in open field (T_0) and T_3 (5-7 ft distance from tree base) were statistically similar and there is no significant variation. Therefore, Karanja tree base is suitable for cultivation of Kangkong without significant yield loss compared to that of control.
Keywords: kangkong, Karanja, Char land, Agroforestry**.**

Introduction

Agroforestry is the integration of tree and crop or vegetables on the same area of land is a promising production system for maximizing yield and maintaining friendly environment (Nair, 1990). Agroforestry can provide a sound ecological basis for increased crop and animal productivity, more dependable economic returns, and greater diversity in social benefits on a sustained basis (Rahim, 1997). In agroforestry systems there are both ecological and economic interactions between the different components.

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). The goal of sustainable agriculture should be to maintain production at levels necessary to meet the increasing needs and aspirations of an expanding world population without degrading the environment (TAC, 1989).Bangladesh is one of the most densely populated countries of the world struggling hard to feed her more than 150 million peoples. The economy of the country draws its strength and stability mostly from agriculture. The country has only a land area of 14.39 million hectares, but due to the ever increasing population, per capita land area is decreasing at an average rate of 0.005 ha/cap./year since 1989 (Hossain and Bari, 1996). Due to increasing population, it is important that small scale agriculture be maintained so that sustainable local vegetable production is continued in Bangladesh.

Karanja is an important timber tree species that is grown all over the country for its wide range of adaptability. This timber species is deep rooted, large sized having spread canopy at mature stage and contribute the major share of the timber supply of the country. Besides, the excessive parts of the tree are used as fuel wood, pole and other purposes. On the other hand to meet farmer's timber and fuel wood demand they plant huge number of saplings of timber species in their cropland, homestead, and other fallow lands at block plantations, row plantation, scattered plantations, etc. Initially the saplings are small and it requires wider spacing and it takes sometimes to generate income. Farmers do not get immediate return from the tree monoculture area. During this early period of tree establishment farmers can grow annual crops (vegetables) at the base area and surrounding area of the saplings.

Traditionally, farmers grow shade loving spices and vegetables under different trees in their cropland, homesteads and surrounding areas. But for expanding this concept in wider scales, other important winter vegetables should be tested so that farmers can choose their desired understory crop during sapling stages of timber tree species.

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. For identifying the compatible tree-crop combination, 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, it would be wise to conduct experiments under different tree crop or vegetable combination at different spacing for screening of different crops in terms of their growth and yield performance. Considering the above mentioned facts and potential; the present study has been undertaken with the aim of broad objectives to examine the performance of Kangkong vegetables when grown in association with Karanja tree sapling in a tree- crop agroforestry system.

Materials and Methods

The experiment was carried out at Char Kalibari which is situated by the side of Brahmaputra River adjacent to the Bangladesh Agricultural University, Mymensingh, during the period from February 2013 to May 2013. In this study, the saplings of Karanja tree (*Pongami apinnata*) in combination with Kangkong (*Ipomoea reptans*) were used. The study was done under 3 year's Karanja tree saplings. At first 0.04 feet deep pits were dug at 9 feet distance in the experimental field then the seedlings of the tree were placed. After the tree plantation sufficient irrigation was applied at the base of the tree. The Experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The Kangkong plot size was 2.5 m x 2.4 m. Four tree-crop distance treatments were used.

This were-T_0= Open field referred to as control,T_1= 2.5 feet distance from the tree**,** T_2= 5 feet distance from the tree,T_3= 7.5 feet distance from the tree. Kangkong seeds were sown on 15 March 2013. Kangkong seeds were shown maintaining the spacing of 30 cm and 15 cm. all necessary cultural operations were done for all crops.Kangkong was harvested four times at 15 days interval where the first harvest was done at 25 days after showing.

Plant samples of Kangkong were collected randomly from the respective plots. Ten Kangkong plants were selected from each plot for data collection. Data were collected at 25, 40, 55 and 70 DAP (Day after planting) at 15 days intervals. The studied parameters were as plant height (cm), no. of leaves plant^{-1}, no. of branches plant^{-1}, length of branch^{-1}, stem girth, leaf weight/plant (g), stem weight/plant (g).

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 data on various growth and yield contributing characters of the vegetables was statistically analysed to examine the significant variation of the results due to different parameters. 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 Least Significant Difference (LSD) tested at 5% level of significance.

Results and Discussion

Morphological characteristics of Kangkong under three year's old Karanja tree:

Plant height (cm): Kangkong grew more vigorously in the open field than those grew close distance to the tree. The fourth harvesting was done at 70 days after seed sowing. The highest average plant height was 29.50 cm found in T_1 (2.5 feet distance from the tree) and lowest average plant height was 24.84 cm found in T_3 (7.5 feet distance from the tree). Other than the highest average plant height was 27.09 cm found in T_2 (5 feet distance from the tree) (Table 1 and Fig. 1).

Table 1. Morphological characteristics of Kangkong under three years old Karanja tree

Treatments	Plant height (cm)	No. of leaves /plant	No. of branches /plant	Stem girth (cm)	Weight of leaves/ plant (gm)	Weightof stem/ plant (gm)
T_0	25.83c	66.25a	8.23a	2.95a	46.49a	22.29a
T_1	29.50a	55.25d	5.52d	2.10c	30.58c	16.71c
T_2	27.09b	57.78c	6.89c	2.47bc	37.71b	17.79b
T_3	24.84d	63.53b	7.90b	2.70ab	45.60a	23.10a

Means in different columns 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= 2.5 feet distance from the tree, T_2 =5 feet distance from the tree, T_3 = 7.5 feet distance from the tree.

Number of leaves per plant: The highest number of leaves plant^{-1} was 66.25 when plants were grown under treatment T_0 (Open field referred as control). The lowest number of leaves plant^{-1} was 55.25 found under treatment T_1 (2.5 feet distance from the tree), (Table 1 and Fig. 1). Second highest was obtained 63.53 from T_3 (7.5 feet distance from the tree).

Fig. 1. Kangkong along with karanja tree

Number of branches per plant: The greatest no. of branches 8.23 was noted in control plant treatment (Table 4). No. of branches was noted under 2.5, 5 and 7.5 feet distance from saplings (Table 1 and Fig. 1). The second maximum no. of branches (7.90) was shaped under 7.5 feet distance from saplings and the lowest no. of branch (5.52) was received less than 2.5 feet distance from saplings.

Stem girth (cm): Stem girth of Kangkong was affected significantly by the different distances (Table 1 and Fig. 1). The highest stem girth (2.95 cm) was noted in T_0 (Open field referred as control) and lowest stem girth (2.10 cm) was noted in T_1 (2.5 feet distance from the tree).

Leaf weight (gm)

Weight of leaf (fresh) per plant of Kangkong was also influenced by the different distances (Table 1 and Fig. 1). Highest (46.49 gm) leaf weight of Kangkong was found in T_0 (Open field referred as control) and second highest 45.60 gm was in T_3 (7 feet distance from the tree). The lowest weight was 30.58 gm found in T_1 (2.5 feet distance from the tree).

Stem weight (gm): Weight of stem (fresh) per plant of Kangkong was also influenced by different distances (Table 1 and Fig. 1). Highest (23.10 gm) stem weight of Kangkong was found in T_3 which is 7 feet distance from the tree and second highest (22.29 gm) was in T_0 (Open field referred as control). The lowest 16.71 gm weight was found in T_1 (2.5 feet distance from the tree).

Yield:

Fresh yield (t/ha): There was significant variation in fresh yield of Kangkong grown under different distances. In the first harvest highest yield obtained 7.52 t/ha from T_0 (Open field referred as control) and second highest yield was 7.34 t/ha from T_3 (7 feet distance from the tree). Lowest yield recorded from T_1 (2.5 feet distance from the tree). In

Kangkong, yield was increased in the subsequent harvest. Yield increased gradually in 2nd, 3rd and 4th harvest. The highest fresh yield was obtained from 4th harvest. During the second harvest, the highest 14.54 t/ha fresh yield obtained from T_0 (Open field referred as control) and second highest yield was 14.06 t/ha from T_3 (7 feet distance from the tree). The lowest yield recorded 9.88 t/ha from T_1 (2.5 feet distance from the tree). Similarly, in the third harvest the highest 16.27 t/ha fresh yield obtained from T_0 (Open field referred as control) and second highest yield was 15.85 t/ha from T_3 (7 feet distance from the tree). The lowest yield recorded 11.48 t/ha from T_1 (2.5 feet distance from the tree). Almost similar trend of yield response to the different distances was observed in the fourth harvest (Table 2a).

Table 2a. Fresh yield (t/ha) of Kangkong along with Karanja tree in different distances from tree base

Treatments	1st Harvest	2nd Harvest	3rd Harvest	4th Harvest
T_0	7.52a	14.54a	16.27a	15.09a
T_1	5.11c	9.88c	11.48c	10.32c
T_2	6.20b	12.04b	13.18b	12.52b
T_3	7.34a	14.06a	15.85a	14.73a

Means in different columns 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= 2.5 feet distance from the tree, T_2 =5 feet distance from the tree, T_3 = 7.5 feet distance from the tree.

Dry yield (t/ha): The first harvest highest dry yield obtained 0.95t/ha from T_0 (Open field referred as control) and second highest dry yield was 0.92 t/ha from T_3 (7 feet distance from the tree). The lowest yield was recorded in T_1 (2.5 feet distance from the tree). In Kangkong yield was increase in the subsequent harvest. Yield increase gradually in 2nd, 3rd and 4th harvest. The highest dry yield obtained from 4thharvest. During the second harvest, the highest 1.61 t/ha dry yield obtained in T_0 (Open field referred as control) and second highest (1.552 t/ha) yield was in T_3 (7 feet distance from the tree). The lowest (1.10 t/ha) yield was recorded in T_1 (2.5 feet distance from the tree). Similarly, at third harvest the highest (1.42 t/ha) dry yield obtained from T_3 (7 feet distance from the tree) and second highest (1.32 t/ha) yield was in T_0 (Open field referred as control). The lowest (1.17 t/ha) yield recorded from T_2 (5 feet distance from the tree). Almost similar trend of yield responses to the different distance was observed in the fourth harvest (Table 2b).

Table 2a. Dry yield (t/ha) of Kangkong along with Karanja tree in different distances from tree base

Treatments	1st Harvest	2nd Harvest	3rd Harvest	4th Harvest
T_0	0.95a	1.61a	1.32ab	1.30a
T_1	0.65c	1.10b	1.30ab	0.87b
T_2	0.77b	1.23b	1.17b	1.12a
T_3	0.92a	1.55a	1.42a	1.32a

Means in different columns 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= 2.5 feet distance from the tree, T_2 =5 feet distance from the tree, T_3 = 7.5 feet distance from the tree.

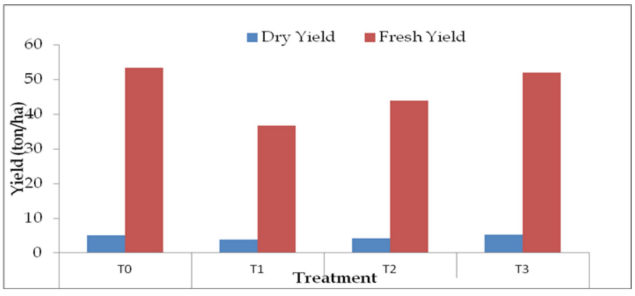

Fig. 2. Total yield of kangkong along with karanja tree

Total yield (t/ha): The highest (53.42 t/ha) total fresh yield was recorded from T_0 (Open field referred as control) and the lowest (36.79 t/ha) total fresh yield recorded from T_1 (2.5 feet distance from the tree) (Fig. 2).

The total dry yield (total of four harvest) of Kangkong gradually increase in different harvest (Fig. 2). The highest (5.21 t/ha) dry yield recorded in T_3 (7.5 feet distance from the tree) and the lowest (3.92 t/ha) dry yield was in T_1 (2.5 feet distance from the tree). Similar type of yield variation was observed by Alam *et al.* (2012) in different summer vegetables along with different trees, Tanni *et al.* (2010) in different winter vegetables along with Lohakat tree, Khatun *et al.* (2009) in different winter crops along with Civit tree and Mallick *et al.* (2013) in strawberry in association with *Xylia dolabriformis* tree.

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