J. Agrofor. Environ. 7 (2): 19-22, 2013 ISSN 1995-6983

Effect of five years old lohakat tree (X*ylia dolabriformis*) on the growth and yield of carrot

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Abstract: A field experiment was conducted at the Agroforestry Farm of Bangladesh Agricultural University, Mymensingh, during the period from September 2012 to March 2013 with the aim of evaluating effect of five years old Lohakat tree (*Xylia dolabriformis*) on the growth and yield of Carrot (*Daucus carota*). The experiment was designed with a Randomized Complete Block Design (RCBD) with three replications. Different distances from tree base viz. 1.0-1.5m, 0.5-1.0m and 0-0.5m were treatments of this study. There was a control treatment i.e., without tree condition or open field. The individual plot size was 6m x 2m and each plot contains two Lohakat trees maintaining 3m distance from one to another. In this study growth and yield of Carrot was observed as root production purpose. Growth and yield of Carrot in association with Lohakat tree was remarkably decreased with decreasing distance towards the tree base and the variation was very wide near the Lohakat tree base compare to open field condition. The result showed that plant characteristics viz. plant height (cm), no. of leaves plant^{-1}, leaf size (cm^2), leaf weight plant^{-1}(g), root length (cm), root girth (cm), root weight plant^{-1} (g) of Carrot was less vigorous near the Lohakat tree base. Individual root weight was highest (47.18 tha^{-1}) in open field condition which almost identical with the yield produced in the 1.0-1.5m distance area (46.65 tha^{-1}) from Lohakat tree base. It was found that yield of Carrot remarkably reduced with reducing distance from Lohakat tree base where 21.05 tha^{-1} and 13.21 tha^{-1} yield obtained from 0.5-1.0m and 0-0.5m distance area from Lohakat tree base respectively which were 55.38 and 72.00 % lower compare to open field condition. Thus it appears that yield performance of Carrot was better beyond 1m distance from Lohakat tree base without significant yield loss.

Keywords: Carrot, Lohakat, *Xylia dolabriformis*, Agroforestry.

Introduction

Agroforestry makes use of the complimentarily relationship between trees and crops, so that the available resources can be effectively utilized. Agroforestry allows for the diversification of farm activities and makes better use of environmental resources. Bangladesh is a densely populated country, occupies a unique geographical location, spanning a relatively short stretch of land between the Himalayan chain and the Indian Ocean. The majority (64.2%) of land is under agricultural use and only 10.2% of the total land is under forest cover (FAO 2005). Now-a-days Bangladesh contains about 6.7% forest area (FAO, 2010), but for sustainable ecology a country needs 25% forest coverage of its total area. Agriculture is the mainstay of the economy. At the moment, roughly one-fifth (19.95%) of Bangladesh's GDP originates from agricultural sector (BBS, 2011) and the sector absorbs about half of the total labour force of the country. Agricultural land is being reduced to meet the rapidly growing demand for non-agricultural needs. There is an immediate need for innovative land use practices for maximizing output and income from the limited land resource. Agroforestry is considered to be a very significant tool for optimizing land use, maximizing output and integrating the production of crops, woody perennial, fodder and livestock into farming system.

Carrot (*Daucus carota* L.) is a winter crop and is one of the important root vegetable crops cultivated throughout the world. It is among the top ten most economically important vegetables crops in the world, in terms of both area of production and market value. Its fleshy edible roots are used as human food and animal feed. Carrot is one of most popular root vegetables, rich in health benefiting compounds such as beta-carotenes, vitamins A, minerals, antioxidants, and dietary fibres and is an excellent source of iron, calcium, phosphorus, and folic acid and vitamin B. It is also rich in sugar content (Yawalker, 1992) and some important medicinal values (Sadhu, 1993). It is used as salad and as cooked vegetable in soups, stews, curries, etc. and is also used for the preparation of pickles, jam, and sweet dishes (Kabir *et al.*, 2000). In Bangladesh, carrot is cultivated on about 846 ha and production is 6350 ton with an average yield of 7.51 tha^{-1}(BBS, 2007).

Xylia dolabriformis, one of the ironwoods is found in Indian subcontinent. It attains a height of about 65 to 80 feet without branching. *Xylia dolabriformis* is an excellent construction wood for house posts, bridges, piles, poles, flooring, and planking and is used for railway ties because of its natural durability. It is also used for tent pegs, cart wheels, tool handles and boat building.

As Lohakat is an important timber yielding tree species and at the same time Carrot is a very important vegetable in Bangladesh it will be a good combination if both of these plant species are possible to cultivate combindly as agroforestry system. Therefore present study investigates the effect of Lohakat tree on growth and yield performance of Carrot.

Materials and Methods

Study site: The experiment was carried out at the experimental field, Department of Agroforestry, Bangladesh Agricultural University, Mymensingh during the period from September 2012 to March 2013.The place is geographically located between 24^{0}75´ North latitude and 90^{0}50´ East Longitude.

Plant materials: Lohakat (*Xylia dolabriformis*) tree and Carrot (*Daucus carota*) as crop were plant materials of this study. Lohakat trees were planted in the study plots in the year of 2008 i.e., five years ago. Carrot seeds were collected from BADC (Bangladesh Agricultural Development Corporation).

Experimental design and treatment combination: The experiment was laid out following a Randomized Complete Block Design (RCBD) with three replications. The layout of the study is shown in Fig. 1. In each replication two Lohakat trees were included in a 6m × 2m size plot (Fig. 1). In this plot Carrots were planted in 17 rows surrounding the both Lohakat trees and the position of Carrot rows also shown in the Fig. 1. Four tree crop distances were used as treatments of the study such as T_0

(Open field referred to as control), T_1 (1.0 to 1.5 meter distance from the tree base), T_2 (0.5 to 1.0 meter distance from the tree base) and T_3 (up to 0.5 meter distance from the tree base).

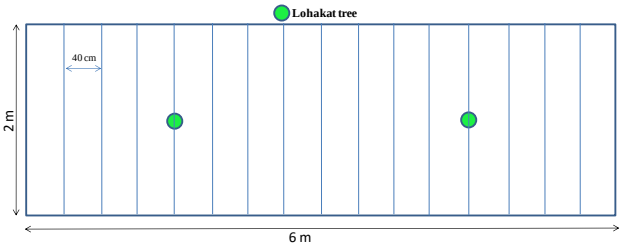

Fig.1. Layout of experiment showing one research plot

Tree establishment and management: During the study period average height and girth of Lohakat trees were 6.59 m and 0.25 m, respectively. Lohakat trees were well established to compete significantly with Carrot for nutrient, moisture and other growth requirements. Before final land preparation the trees were pruned.

Vegetable cultivation: Carrot seeds were directly sown in the experimental plots on November 2013. The seeds were sown maintaining 40 cm spacing from one line to another. After emergence, finally Carrot plants were thinned out maintaining 8 to 10 cm distance from plant to plant. All necessary management practices like fertilizer application, weeding, irrigation, pest and diseases control etc were done properly.

Data collection: Data were collected randomly from all rows of respective plots at vegetative stage and when Carrot reached at proper harvesting stage. Eight representative sample plants were uprooted to collect data during vegetative stage .The parameters were studied such as plant height (cm), no. of leaves plant^{-1}, leaf size (length in cm and breadth in cm), leaf weight plant^{-1}(g), root length plant^{-1}(cm), root girth plant^{-1}(cm), root weight plant^{-1}(g). At harvesting stage sample plants roots were weighted for fresh yield (expressed in gm) which were converted to tha^{-1}.

Statistical analysis: The recorded data were compiled and analyzed 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) (Gomez and Gomez, 1984).

Results and Discussion

Effects of Lohakat tree (*Xylia dolabriformis*) on Carrot (*Daucus carota*) of this study are presented as morphological features and yield of Carrot as influenced by Lohakat tree.

Morphological features:

In this study morphological parameters of Carrot were observed during the vegetative and harvesting stages. During vegetative stage observed parameters were plant height (cm), no. of leaves plant^{-1}, leaf size (length in cm and breadth in cm), root length plant^{-1} (cm). Data on plant height (cm), no. of leaves plant^{-1}, leaf weight plant^{-1}(g), root length plant^{-1} (cm), root girth plant^{-1} (cm), root weight plant^{-1} (g) were recorded during harvesting stage. Morphological features of Carrot were remarkably influenced by Lohakat tree in different distances from Lohakat tree base both in vegetative (Table 1 and Fig. 2) and harvesting stages (Table 2 and Fig. 3) and effects on morphological characters of Carrot were as:

Table 1. Morphological Characteristics of Carrot at vegetative stage

Treatment	Plant height (cm)	No. of leaf /plant	Leaf size		Root length (cm)
			Length (cm)	Breadth (cm)	
T_0	34.23a	9.48a	25.67a	15.39a	8.56a
T_1	33.42a	9.81a	25.43a	14.94b	7.99a
T_2	27.54b	6.83b	20.93b	12.14bc	6.61b
T_3	23.37c	5.92c	18.58b	10.43c	4.79c

Means in column followed by the different letter are significantly different by DMRT at $P \leq 0.05$, T_0 = Control, T_1 = 1.0-1.5m from tree base , T_2 = 0.5-1.0m from tree base, T_3 = upto 0.5m from tree base.

Fig. 2. Carrot cultivation along with lohakat tree

Plant Height: Plant height of Carrot was significantly affected by Lohakat tree by different distances from tree base during both in vegetative (Table 1 and Fig. 2) and harvesting stages (Table 2 and Fig. 3). In both cases it grew more vigorously in the open field than those grew close distance to the tree. At vegetative stage, the tallest average plant height was found in control condition i.e., without tree condition and the value was 34.23 cm. Among the different distances from Lohakat tree base taller average plant height was recorded in treatment T_1 (1.0 to1.5 m distance from the tree), the value was 33.42 cm followed by 0.5 to 1.0 m distance from the tree and up to 0.5 m distance from the tree and the plant height in these areas were 27.54 and 23.37 cm, respectively (Table 1). Plant height recorded in T_1, T_2 and T_3 treatments was

2.37, 19.54 and 31.73 % lower compare to control condition i.e., without tree combination. At harvesting stage, the tallest plants (62.25 cm) were produced within T_0 (open field referred to as control) and shortest plant (42.25 cm) near the tree base. Plant height recorded in T_1, T_2 and T_3 treatments was 4.42, 18.07 and 32.14 % lower compare to control condition i.e., without tree combination. In both cases, plant height of Carrot grown within T_0 and T_1 level were statistically similar and higher as compared to T_2 and T_3 level.

From this study it was found that plant height of Carrot gradually increased with increasing distance from Lohakat tree base, it may be due to higher competition for moisture and nutrients very near the Lohakat tree base. Similar type of height growth was observed by Mallick *et al.,* (2013) in Strawberry plants along with *Xylia dolabriformis* tree.

No. of Leaves plant^{-1}: Different distances from base of *Xylia dolabriformis* tree had significant effect on number of leaves plant^{-1} of Carrot both in vegetative and harvesting stages. During vegetative stage the result revealed that the highest no. of leaves plant^{-1} (9.81) was produced by T_1 (1 to 1.5m distance from the tree base). The second highest no. of leaves plant^{-1} (9.48) was produced under T_0 (open field referred to as control) and the lowest result (5.92) was observed at T_3 (up to 0.5 m distance from the tree) and second lowest result was (6.83) at T_2 (0.5 to 1m distance from the tree) level (Table 1 and Fig. 2). At harvesting stage number of leaves plant^{-1} increased gradually with the increasing distances from tree base. The highest no. of leaves plant^{-1} (12.25) was produced by T_1 (1 to 1.5m distance from the tree base). The second highest no. of leaves plant^{-1} (12.00) was produced under T_0 (open field referred as control) and the lowest result (7.80) was observed at T_3 (up to 0.5 m distance from the tree) level (Table 2). Lowest no. of leaves plant^{-1} at every observed time was under T_3 (up to 0.5 m distance from the tree) level at reduced light conditions. This might be occurred due to tree crop competitions for food, space, light, water and other growth requirements and might be also for lower photosynthates production under low light condition for a longer period. Similar type of assumption was also opined by Tanni *et al.,* (2010) for Radish and Lettuce along with 4 years old *Xylia dolabriformis* tree.

Table 2. Morphological Characteristics of Carrot during harvest

Treatment	Plant height (cm)	No. of leaf/plant	Leaf wt./plant (g)	Root length (cm)	Root girth (cm)	Root wt./plant (g)
T_0	62.25a	12.00a	48.50a	15.88a	11.38a	84.87a
T_1	59.5a	12.25a	51.25a	15.38a	10.95a	84.25a
T_2	51.00b	8.65b	28.75b	10.25b	6.70b	35.00b
T_3	42.25c	7.80c	13.75c	7.42c	5.80c	22.00c

Means in column followed by the different letter are significantly different by DMRT at $P \leq 0.05$, T_0 = Control, T_1 = 1.0-1.5m from tree base , T_2 = 0.5-1.0m from tree base, T_3 = upto 0.5m from tree base.

Leaf size: Leaf size (length × width) of Carrot was notably influenced by different levels of distance from tree base (Table 1 and Fig. 2). Among the four distance levels, the biggest extended leaf area (395.06 cm^2) was obtained in open field and the smallest leaf area (193.79 cm^2) was obtained in 0-0.5 m distance from tree base (Table 1 and Fig. 2). Competition for growth resources (light, water and nutrients) might be the reason for reducing leaf size of Carrot under Lohakat tree. Due to this type of competition leaf area of Coriander decreased near the base of Civit (*Swintonia floribunda*) tree which was reported by Khatun *et al.,* (2009).

Leaf weight plant^{-1}: With the decreasing of distance from tree base leaf weight plant^{-1} of Carrot decreased substantially. Among the four distance levels, the higher leaf weight plant^{-1} of Carrot were obtained under full sunlight i.e., control condition and T_1 (1 to 1.5m distance from the tree base) level which were 48.50 g and 51.25g respectively (Table 2). Again, the lowest leaf weight plant^{-1} of Carrot was obtained under T_3 (up to 0.5 m distance from the tree) level where growth resources are generally limited due to tree crop competition.

Root length plant^{-1}: Root length plant^{-1} of Carrot was remarkably increased with the increasing distances from tree base. At vegetative stage, best average root length plant^{-1} was found in control condition i.e., without tree condition due to absence of tree crop competition and the value was 8.56 cm. The second highest root length plant^{-1} of Carrot (7.99 cm) at T_1 (1.0 to 1.5 m distance from the tree base), lowest root length plant^{-1} of Carrot (4.79 cm) at T_3 (0 to 0.5 m distance from the tree base) level (Table 1 and Fig. 2). Root length plant^{-1} recorded in T_1, T_2 and T_3 treatments was 6.66, 22.78 and 44.04 % lower compare to control condition i.e., without tree combination. At harvesting stage, root length plant^{-1} of Carrot was also pointedly amplified with the rising of distances from tree base. The superior root length plant^{-1} (15.88 cm) was obtained from T_0 (open field referred to as control) and shortest (7.42 cm) near the tree base (Table 2 and Fig. 3). About 3.15, 35.45 and 53.27 % reduction of root length plant^{-1} was occurred at T_1, T_2 and T_3 treatments. This might be due to shortage of growth necessities near the tree bases.

Root girth plant^{-1}: Like root length plant^{-1} of Carrot, root girth plant^{-1} also influenced by Lohakat tree in its different distances from base. Root girth plant^{-1} in control condition i.e., open field, 1.0-1.5m, 0.5-1.0m and 0-0.5m distances from tree base were 11.38, 10.95, 6.70, and 5.80 cm respectively (Table 2 and Fig. 3). Root girth plant^{-1} of Carrot in different distance category i.e. in 1.0-1.5m, 0.5-

1.0m and 0-0.5m from tree base were 3.78%, 41.12% and 49.03% reduced compare to it open field condition. Considering this result it is clear that Lohakat tree negatively affects the root girth of Carrot up to 1.0m distance from the tree base.

Root weight plant-1: Root weight of Carrot directly related with root size (length × girth), so similar type of variation like root size was recorded in this study. Root weight was recorded as per plant in gram which was significantly influenced by Lohakat tree in different distances from tree base. Individual root weight was highest under open filed condition (84.87 g) and it was statistically similar with the root produced in 1.0-1.5m distance (84.25 g) from Lohakat tree base (Table 2). Root weight plant^{-1} in the 0-0.5m and 0.5-1.0m distance from Lohakat tree base were 22.00 g and 35.00 g which were 74.07 and 58.76% lower compare to open field condition. Same reason also responsible for varying root weight in different distance from Lohakat tree base like competition for solar radiation, nutrients and moisture.

Fig. 3. Carrot in different treatments of this study

Yield: Yield of Carrot was recorded as ton per hectare which was significantly influenced by Lohakat tree in different distance from tree base (Fig. 3 and 4). Highest yield (47.18 tha^{-1}) was recorded under open condition which almost identical with the yield produced in the 1.0-1.5m distance area (46.65 tha^{-1}) from Lohakat tree base. It was found that yield of Carrot remarkably reduced with reducing distance from Lohakat tree base where 21.05 tha^{-1} and 13.21 tha^{-1} yield obtained from 0.5-1.0m and 0-0.5m distance area from Lohakat tree base, respectively which were 55.38 and 72.00 % lower compare to open field condition (Fig. 4).

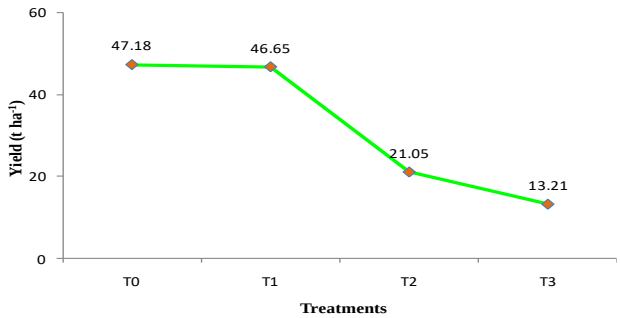

Fig. 4. Yield of Carrot in different treatments

Yield of Carrot in association with Lohakat tree remarkably reduced with reducing distance from tree base. Root size as well as individual root weight was reduced with reducing distance from Lohakat tree base which ultimately results the lower yield in the same area. These results indicate very near the tree base (within 1m) Carrot yield reduced by different negative effects of tree like competition for nutrients and moisture in the below ground and reducing phosynthetically active radiation by tree shade in above ground. Sometimes allelopathic effect also influences the growth and yield of associated crops with trees. From this study it may be concluded that beyond the 1.0m distance from five years old Lohakat tree Carrot can be cultivated without significant yield loss.

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