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Mustard cultivation along with five years old Lohakat tree as agroforestry practice

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Abstract: A field experiment was conducted at the field laboratory of the department of Agroforestry of Bangladesh Agricultural University, Mymensingh, during the period from September 2012 to March 2013 with the aim of evaluating the growth and yield performance of Mustard (*Brassica campestris*) grown in combination with five years old Lohakat (*Xylia dolabriformis*) trees. The experimental design was followed by Randomized Complete Block Design (RCBD) with three replications. Different distances from tree base viz. 0-0.5m, 0.5-1.0m and 1.0-1.5m were treatments of this study. There was a control treatments 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. Growth and yield of Mustard in association with Lohakat tree was remarkably increased with increasing distance from the tree base and the variation was very wide near the Lohakat tree base compared to open field condition. Highest plant height (71 cm), no. of primary branch plant^{-1} (12), no. of siliqua per primary branch (15.4), no. of siliqua plant^{-1} (185), length of siliqua (5.1 cm) and no. of seed per siliqua (25.67), thousand seed weight (3.7 g) of Mustard were found in open field condition. Lowest data regarding above parameters were recorded in 0-0.5 m distance from tree base. As evident from results the highest yield of Mustard (1.49 tha^{-1}) was observed in open field condition i.e., without Lohakat tree combination. Yield of Mustard seed produced in 1.0-1.5 m, 0.5-1.0m and 0-0.5m distance from Lohakat tree base was 7.38, 37.58 and 57.72% lower compared to open field condition, respectively.
Key words: Mustard, Lohakat, Agroforestry practice.

Introduction

Agroforestry allows for the diversification of farm activities and makes better use of environmental resources. It involves elements of agriculture and forestry wherein woody perennials are deliberately mixed or retained with crop or animal production units. According to the latest census in 2011, the population of the country was 150 million with the population growth rate of 1.37% and the population density is around 1015/km^2. As a result, there is a tremendous pressure on the natural resources of the country. 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. According to the information of Forest Department (FD) in Bangladesh in 2007 cited by Choudhury and Hossain (2009) total forest land of Bangladesh is 2.52 million hectares of which Forest Department manages 1.52 million hectares. So the forest land cannot fulfill the demand of fuel, fodder, timber for people. Agriculture contributes about 19.95% of the GDP of Bangladesh. Of the total agricultural products about 15.52% come from the various crops and 1.71% from forest products (BBS, 2011). As natural vegetation is cleared for agriculture and other types of development, the benefits that trees provide are best sustained by integrating trees into agriculturally productive landscapes - a practice known as agroforestry.

Mustard (also known as Mustard greens, leaf Mustard) is a quick to mature, easy to grow, cool season vegetable and one of the most nutritious green-leafy vegetables. Have actually more carotenes, Vitamin k and flavonoid anti-oxidants than some commonly consumed vegetables. Musrad is used as raw material in salad, soup, very popular in chinese and pickling. Again, Mustard is very important and well known edible oils. The oil has a low content of saturated fat as compared to other oils. Its oil is healthier and good for the heart and has cholesterol reducing properties.

A fast growing tree such as *Xylia dolabriformis* with a denser wood suitable for structural end uses is therefore highly desired. The species belongs to the family Leguminosae and occurs naturally in India, Indo-China, Myanmar and Thailand. Lohakat tree usually up to about 20- 25 m tall; old trees on moist fertile sites occasionally up to 40 m. Bole often straight and cylindrical. *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, boat building furniture, turnery and household implements. Bark and fruits are used in traditional medicine. It is reported to grow fairly fast and yield a hard and durable wood used for heavy construction in its countries of origin (Anonymous, 1989).

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

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°75´ North latitude and 90°50´ East longitude.

Associated plants: Plant materials of this study were Lohakat (*Xylia dolabriformis*) as tree and Mustard (*Brassica campestris*) as herbaceous crops. Lohakat trees were planted in the study plots in the year of 2008 i.e., five years ago. Mustard seeds were collected from BADC (Bangladesh Agricultural Development Corporation).

Tree establishment and management: Lohakat trees planted at Agroforestry farm during the year 2008 were used as the test plants in the study. 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 Mustard for nutrient, moisture and other growth requirements. The trees were pruned before final land preparation. So, Mustard plants

get the sunlight directly. This enhances the growth of Mustard.

Experimental design, layout and treatment combination: Experimental design, layout and treatment combination was similar as effect of five years old Lohakat *(Xylia dolabriformis)* tree on the growth and yield of Carrot as done by Aysha *et al.* (2013).

Vegetable cultivation: Mustard seeds were directly sown in the experimental plots following broadcasting method on 4th November 2012. All necessary management practices like fertilizer application, weeding, thinning, irrigation, pest and diseases control etc were done properly.

Harvesting: Mustard was harvested as whole plants from the fields when more than 80% of the pods become straw color and 2/3rds of the pods on the terminal raceme turn into chocolate brown color.

Data collection: Data were collected randomly from all treatments (tree-crop distances) of all respective plots at proper harvesting stages. Data on plant height, , no. of primary branch plant^{-1}, no. of siliqua per primary branch, no. of siliqua plant^{-1}, length of siliqua, no. of seed siliqua^{-1} and 1000 seed weight were recorded. Mustard seeds were weighted for yield (expressed in kg plot^{-1}) which was 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, the analyses of variance for all the characters and Least Significant Difference (LSD) test were performed using statistical package programmed MSTAC-C and WASP 2 software. Mean comparisons were done by Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984) and also by Least Significant Difference (LSD) test.

Results and Discussion

Effects of Lohakat tree (*Xylia dolabriformis*) on Mustard (*Brassica campestris*) of this study are presented as morphological features, yield attributes and yield of Mustard as influenced by Lohakat tree.

Morphological features: Morphological parameters of Mustard were highly influenced by Lohakat tree in different distances from Lohakat tree base (Table 1 and Fig. 1). Data on plant height, no. of primary branch plant^{-1}, no. of siliqua per primary branch, no. of siliqua plant^{-1}, length of siliqua and no. of seed per siliqua and 1000 seed weight were recorded. Influence of Lohakat tree on specific morphological characters of Mustard was as:

Plant height (cm): The growth of Mustard was more vigorous in the open field condition. The highest average plant height of Mustard was 71cm found in T_0 (open field condition) and the lowest average plant height of Mustard was 52cm found in T_3 (0-0.5m distance from plant). Another lowest average plant height of Mustard was 60.33cm found in T_2 i.e., 0.5-1.0m distance from the tree. Second highest of plant height was 68 cm which was found in T_1 i.e., 1.0-1.5m distance from tree (Table1). Plant height of Mustard grown in control and in 1-1.5m distance from the tree are statistically similar and intermediate as compared to 52 cm at T_3 and 60.33 cm T_2 treatments. Plant height recorded in T_1, T_2 and T_3 treatments was 4.23, 15.03 and 26.77% lower compared to control condition i.e., without tree combination. This may be due to higher competition for moisture and nutrients very near the Lohakat tree base. Similar type of height growth was observed by Uddin *et al.* (2013) in Carrot in association with Akashmoni tree.

Fig. 1. Growth of Mustard along with Lohakat tree

No. of primary branch plant^{-1}: It was noted that no. of primary branches of Mustard was remarkably enlarged with the rise of distance from tree base. The greatest no. of primary branches (12) was noted in control treatment T_0 and the smallest no. of primary branches (8.33) was observed under treatment T_3. Second highest no. of primary branches (11.67) produced under T_1 and the 2nd lowest no. of primary branches (9.33) produced under T_2 treatments (Table 1). Control produces the best result may be due to the absence of competition. The no. of primary branches plant^{-1} was increased consistently with the increase of distance from tree base that observed by Bali *et al.* (2012) in Okra grown along with Guava and Lemon.

No. of siliqua per primary branch: A significant difference was showed in number of siliqua per primary branch at 1% level of probability (Table 1). The maximum number of siliqua per primary branch (15.4) was recorded at the treatment T_0 and the minimum no. of siliqua (9.42) was produced at T_3. The results revealed that the second and the third highest no. of siliqua were15.05 and 12.35 produced under the treatments T_1 and T_2 respectively. The no. of siliqua per primary branch was decreased about 2.27, 19.81 and 38.83% in T_1, T_2 and T_3 treatments respectively.

No. of siliqua plant^{-1}: Significant effect of Lohakat tree was noticed on number of Mustard siliqua plant^{-1} when these two plants are grown combindly (Table 1). In all treatments of this study average number of siliqua per plant were 138.67 whereas highest number of siliqua per plant recorded in the open field condition (185) which was statistically similar with 1.0-1.5m distance level (175.67). Number of Mustard siliqua per plant in 0-0.5m and 0.5-1.0m distance from lohakat tree base was 78.67 and 115.33 respectively. Almost 60% less siliqua in very near (0-0.5m) to Lohakat tree base. Lack of nutrients and moisture due to competition and short of solar radiation due to shade created at very near tree base may be reason for less vigorous Mustard plant which results less number

siliqua. Rahman *et al.* (2013) also found less number of Sweet gourd fruits very near Akahmoni tree.

Length of siliqua: Length of siliqua of Mustard was largely affected by different treatments in this study (Table 1). Length of siliqua of Mustard was highest in open field condition (5.1 cm) which was almost similar with the siliqua length produced in 1.0-15m distance (4.67cm) from Lohakat tree base (Table 1). Siliqua length in the 0-0.5m and 0.5-1.0m distance from Lohakat tree base were 2.93 cm and 3.6 cm respectively. Near the Lohakat tree base siliqua length 40-50% reduced compared to open field condition. This may be due to severe completion for nutrients and moisture between the Mustard and Lohakat tree roots.

Table 1. Morphological parameters and yield attributes of Mustard

Treatments	Plant height (cm)	No. of primary branch plant^{-1}	No. of siliqua/ primary branch	No. of siliqua plant^{-1}	Length of siliqua(cm)	No. of seed siliqua^{-1}	1000 seed weight(g)
T_o	71.00	12.00	15.40	185.00	5.10	25.67	3.70
T_1	68.00	11.67	15.05	175.67	4.67	24.00	3.65
T_2	60.33	9.33	12.35	115.33	3.60	18.67	2.60
T_3	52.00	8.33	9.42	78.67	2.93	14.33	2.10
CV	4.89	8.69	2.16	11.15	5.10	8.34	2.29
LSD 1%	9.28	2.72	0.85	46.80	0.62	5.21	0.20
Level of sign.	**	**	**	**	**	**	**

T_0 = Control, T_1 = 1.0 -1.5 m from tree base , T_2 = 0.5-1.0 m from tree base and T_3 = up to 0.5 m from tree base

No. of seed siliqua^{-1}: No. of seed per siliqua of Mustard significantly influenced by different distance from the tree base (Table 1). The number of seed was highest in control condition which was 25.67 and the lowest was under treatment T_3 i.e., up to 0.5 m distance from tree base which was 14.33. Second highest no. of seeds per siliqua was 24 produced under 1.0-1.5 m distance from tree base and next highest no. of seeds was18.67 produced by T_2 treatment. From this study it was found that seed per siliqua of Mustard 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. Shah (2013) also found less no. of seeds per siliqua of Mustard near tree base grown along with Akashmoni tree.

Weight of thousand seed: Weight of thousand seed is the most important yield contributing character which was also significantly influenced by different distance of growing Mustard plant from the tree. The maximum weight of seed per plant was 3.7g was observed at T_0 (open field referred as control). The lowest thousand seed weight was 2.1g found under close contact of the tree condition referred as T_3 (0-0.5m distance from the tree and 2nd lowest result (2.6g) was observed at T_2 i.e., 0.5-1.0 m distance from the tree. Second highest weight of seed per plant (3.65g) was produced by T_1 i.e., 1-1.5m distance from the tree. It was probably due shading effect and nutrients competition between Lohakat tree and Mustard (Table 1). Farhana *et al.* (2013) also found less thousand seed weight of Spinach at very close to Lohakat tree.

Yield

At first Mustard was recorded as kg per plot then it was converted to ton per hectare. Highest Mustard yield per plot was 1.79 kg which was found from treatment T_0 i.e., open field referred to as control. 1.65 kg and 1.12 kg Mustard yield was found from 1.0-1.5m distance and 0.5-1.0m distance from the Lohakat tree base. Lowest yield plot^{-1} was recorded under 0-0.5m distance from the Lohakat tree base which was 0.75 kg plot^{-1} (Fig. 2).

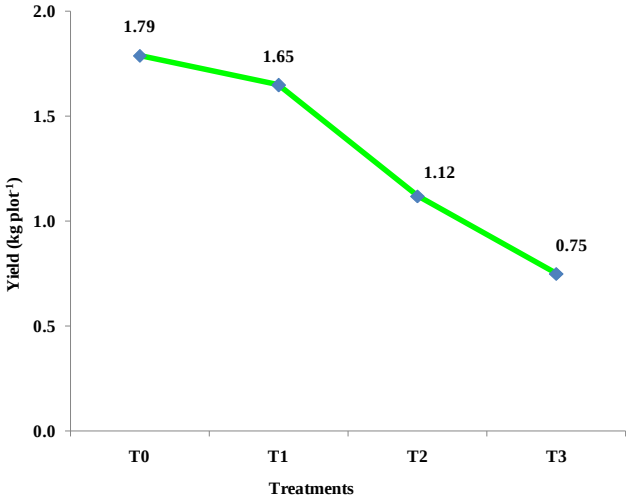

Fig. 2. Yield (kg plot^{-1}) of Mustard in different treatments

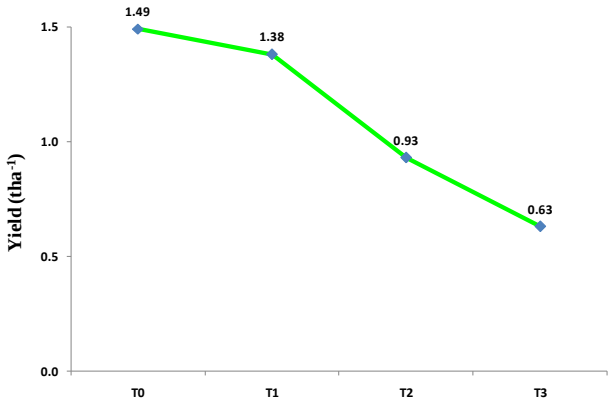

Fig. 3. Yield (tha^{-1}) of Mustard in different treatments

Mustard yield was significantly influenced by Lohakat tree in different distance from tree base (Fig. 2 and 3). As evident from results, the highest yield of Mustard (1.49 tha^{-1}) was observed from open field condition i.e., without Lohakat tree combination which almost identical with the yield obtained from 1.0-1.5m distance area (1.38 tha^{-1}) from tree base. Mustard yield was remarkably reduced with reducing distance from tree base. Mustard yield produced in 0.5-1.0m and 0-0.5m distance area from Lohakat tree base was 0.93 tha^{-1} and 0.63 tha^{-1} respectively (Fig.3) which was 37.58 and 57.72% lower compared to open field condition.

Mustard yield in combination with Lohakat tree as agroforestry system was remarkably decreased with deceasing distance from tree base. These results indicate very close to the tree base (within 1m) yield of Mustard decreased due to competition for nutrients and moisture in the belowground and shade effect in the above ground. But yield of Mustard in the distant area (> 1m) from tree base was almost similar with open field condition which indicates negative interaction by Lohakat tree both above and below ground was minimum in this area. So, in combination with five years old Lohakat tree and Mustard i.e., as agroforestry practices Mustard production can be done without significant yield loss beyond the 1.0m distance from Lohakat tree base.

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