Strawberry cultivation along with Lohakat (*Xylia dolabriformis*) tree as agroforestry system

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Abstract: A field experiment was conducted at the Agroforestry Farm of Bangladesh Agricultural University, Mymensingh, during the period from July 2012 to April 2013 with the aim of evaluating the growth performance of strawberry (*Fragaria anaanassa*) grown as intercrop with five years old Lohakat (*Xylia dolabriformis*) trees. The experimental design was 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 is 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 tree maintain 3m distance from one to another. In this study growth and yield of strawberry was observed as fruit production purpose. Growth and yield of strawberry 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 morphological characteristics viz. plant height, no. of leaves per plant, leaf size, leaf area (cm^2), number of flower per plant, number of fruit per plant, fruit length (cm), fruit girth (cm), fruit weight (g) of strawberry was less vigorous near the Lohakat tree base. Highest number of flower per plant (52.87), fruit per plant (31.13) and percent fruit setting (58.885) was in open field condition which were almost identical in 1.0-1.5m distance area (51.83, 30.45 and 58.75%) and lowest value was recorded in 0-0.5m distance area (26.08, 12.03 and 46.13%) from tree base. Maturity period of strawberry fruit decreased with decreasing distance from tree base and average maturity period was 18.0 days and it ranges from 13-25 days. Strawberry fruit harvest starts from the month of December but it was optimum in January and after that it continued upto March with reducing rate. Individual fruit weight was highest in open field condition (17.81g) followed by 1.0-1.5m (17.53g), 0.5-1.0m (11.8g) and 0-0.5m (7.45g) distance area from Lohakat tree base. Yield of fruit was highest in open field condition 33.00t/ha which was 3.73, 56.35 and 83.84% lower in 1.0-1.5m, 0.5-1.0m and 0-0.5m distance area from Lohakat tree base, respectively.
Key words: Strawberry, Lohakt-*Xylia dolabriformis*, Intercropping, Agroforestry system.

Introduction

Bangladesh has a long tradition of agroforestry practices. But management has always been extremely poor. Selection of plants, planting techniques, and also their utilization in most cases is poorly done, although the country is mostly dependent on the plants grown in and around human habitats. Because of the growing population, quick urbanization, and other forms of development efforts, the agroforestry practices are declining. It is reported that about 10% of homestead trees are being removed annually without replacement (Abedin and Quddus, 1991). Recently plantation of more tree species along the agricultural lands is being emphasized.

For ecological sustainability, a country needs 25% forest coverage of its total area. But now-a-days, Bangladesh contains about 6.7% forest area. The total land area of Bangladesh is about 14.845 million hectare and the forest land is about 2.999 million hectare (BBS, 2011) where the population is above 15 crores. So the forest land cannot fulfill the demand of fuel, fodder, timber for people. Bangladesh is predominantly an agricultural country. 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). So, conflict for land use between agriculture and forestry are a frequent incident in Bangladesh. To overcome this situation it is necessary to find out a suitable alternative. So in Bangladesh context, intercropping can be best source of getting maximum benefits.

In Bangladesh, project experiences and research, have shown that Agroforestry presents one of the very few options that can protect and sustainably manage the degrading forest resources. Agroforestry is considered as one of the major strategies for sustainable forest management as well as poverty reduction in Bangladesh where there is obvious priority of food crop production. Fruit consumption has declined in rural areas more than doubling in the 1970s (FAO, 1981). Strawberry is an exotic fruit in Bangladesh. But it is very popular and also very nutritious and delicious fruit. Strawberry is rich in Vitamin C and iron. In addition to being consumed fresh, strawberries can be frozen, made into preserves, as well as dried and used in prepared foods, such as cereal bars. Strawberries are a popular addition to dairy products, as in strawberry-flavored milk, ice cream, milkshakes, smoothies, and yogurts (Hossain, 2012). Now it is grown in many areas of Bangladesh. Strawberry is a popular variety of fruit across the country and it is also a cash crop. One kilogram of strawberry is sold at Taka 850. For this reason, the Golden Seed Farm, a farm of Jessore has started production of the strawberry at Omar Khan Union under sadar upazila of Panchagarh district (Ittfaq, 2009). An acacia-like tree, *Xylia dolabriformis*, one of the ironwoods is found in considerable quantities in India, Burma, and Bangladesh. It rises 70 or 80 feet without branches, and furnishes a reddish-brown timber in large sizes and of remarkable quality. It resists decay even better than teak, and its heart-wood is proof against white ants. This tree is considered a medicinal plant in India. In Thailand its leaves are used to treat wounds in elephant.

As Lohakat is an important timber yielding tree species allowing sunlight to the forest floor, there is a good scope to cultivate strawberry as intercrop between the rows of Lohakat trees. It will be a good combination if both of these plant species are possible to cultivate combindly as agroforestry system. Therefore, the present study investigates the effect of Lohakat tree on growth and yield performance of strawberry.

Materials and Methods

Study site: The experiment was carried out at the experimental farm in the project field under department of Agroforestry in Bangladesh Agricultural University,

Mymensingh during the period from July 2012 to April 2013. The place is geographically located between $24^0$75´ North latitude and $90^0$50´ East Longitude.

Plant materials: Plant materials of this study were Lohakat (*Xylia dolabriformis*) tree and strawberry (*Fragaria anaanassa*) as herbaceous crops. Lohakat tree was planted in the study plots five years ago i.e., in the year of 2008. Strawberry seedlings were raised at the department of agroforestry, Bangladesh Agricultural University, Mymensingh on polybags.

Tree establishment and management: During the study period lohakat tree were well established and average height and girth of Lohakat trees were 6.59 m and 0.25 m, respectively. The trees were pruned before final land preparation. So the strawberry plants get the sunlight directly. It enhances the growth of strawberry plants.

Seedling establishment:

The seedlings of strawberry were raised in the poly bag from vegetative parts of plant i.e. runner during July to October, 2012. 10×6 inch size poly bags were used raising seedling as supported materials. Total 200 seedlings were raised for this study. Strawberry is commercially propagated by runner plants. For large scale propagation of virus free plants, tissue culture is widely used.

Experimental design and treatment combination: The study was laid out following the 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 total 63 {(5 × 13) – 2 = 63} strawberry plants included surrounding the both lohakat trees and the position of strawberry also shown in the Fig. 1. Different treatments of the study were the different distances from lohakat tree base (Fig 2) and the treatments of this were as: T_0 = Open field referred to as control, T_1 = 0.5 meter distance from the tree, T_2 = 1.5 to 1.0 meter distance from the tree, and T_3 = 1.0 to 1.5 meter distance from the tree.

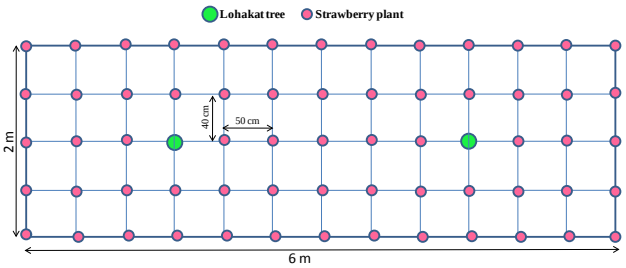

Fig. 1. Layout of experiment showing one research plot

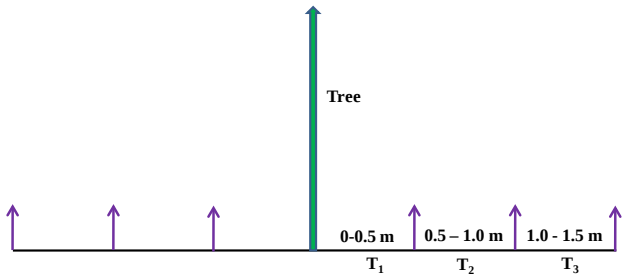

Fig. 2. Layout for different treatments in different distances from tree base.

Seedling Transplantation: The seedlings of strawberry were transplanted into the main field during the month of late September, 2012. Healthy and vigorous seedlings were planted inside the center of the pit. Total 180 (3 replications × 60 seedlings per replication) seedlings of strawberry plants were planted in three different plots as three replications. All seedling of strawberry were transplanted maintaining the spacing of 50cm × 40cm. Seedling planted in the plots were watered immediately after transplanting. Information regarding seedling physical condition is shown in the Table 1.

Table 1. Strawberry seedling status during plantation

Plant height (cm)	No. of leaves/seedling	Av. leaf area (cm^2)	Leaf area /plant (cm^2)
7.1	8	28.4	226.8

Intercultural operation: Different intercultural operations viz. irrigation, weeding, fertilization, pest control, removal of runner, net setting and mulching were done for better growth of strawberry plants. Irrigation, weeding, fertilization and pest control were done it was required. Runners are removed from the plants as they appear, in order to encourage the plants to put most of their energy into fruit development. It also helps in vigorous growth of plants. Strawberry is a colorful fruit which is very much attract by different birds. To protect this fruit from birds it is essential to cover the whole plot by net. For this purpose all experimental plots were surrounded as well as over the plots by nets. Mulch need be applied over strawberries to protect the plants from extreme winter cold and from damage to the roots caused by rapid freezing and thawing of the soil. Three to five inch layer of straw mulch were applied into the plot in the early December but after every 20-25 days it was renewed for irrigation purpose

Fruit Harvesting: In this study harvest was started 70 days after planting i. e., mid December, 2012 and it was continued upto March 2013. Harvesting is done regularly three to four weeks after flowering. All fruits were harvested by entirely hand picking. When the entire fruits appeared as red/pink color then the fruits were harvest. After harvest size and weight of the each fruit was measured.

Data Collection: Data were recorded for growth parameters, flower and fruit information, yield and yield attributes from every plant of every plot. For growth purpose plant height (cm), number of leaves per plant, leaf area (cm^2) was measured. Regarding flower information first flowering date, Fruit maturity period (days), number of flower per plant was recorded. Regarding fruit information number of fruit per plant, fruit length (cm), fruit girth (cm), fruit weight (g) was determined. Based on number of flower and fruit per plant, percent fruit setting also measured. Yield was determined as per plant (g), per plot (kg) and it was also converted as t/ha.

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) and also by Least Significant Difference (LSD) test.

Results and Discussion

Effect of Lohakat tree (*Xylia dolabriformis*) on strawberry plants of this study are presented as morphological features, flower information, fruit setting information and yield of strawberry as influenced by Lohakat tree.

Morphological features:

Morphological parameters of strawberry in this study were observed during the flowering season for plant height (cm), no. of leaves per plant, individual leaf area (cm^2) and leaf area per plant (cm^2). Morphological features of strawberry was remarkably influenced by Lohakat tree in different distances from Lohakat tree base (Table 2) and effect on each morphological characters of strawberry was as:

Plant Height: During optimum fruit setting period plant height of strawberry plant was significantly affected at different distance from the base of Lohakat tree (Table 2). Plant height decreased gradually with the increasing of distance from tree base. Among the four distance levels, the shortest plant 20.2 cm was produced within T_1 (0-0.5 m distance from the tree) and tallest plant 36.2 cm within T_0 (open field referred as control). Plant height of Strawberry grown within T_0 (36.2 cm) and T_3 (35.8 cm) level were statistically similar and intermediate as compared to T_1 (20.2 cm) and T_2 (29.5 cm) level. Near the tree base taller plant was produce probably due to higher apical dominance under shade condition (Hillman, 1984). This may be attributed due to the stimulation of cellular expansion and cell division under shaded condition (Schoch, 1972). Significantly shorter plant of Okra and Indian spinach was produced near the tree base of *Xylia* tree which was recorded by Habib *et al.,* (2012).

Table 2. Morphological features of strawberry during the flowering period

Treatments	Plant height (cm)	Average no. of leaves/plant	Average area /leaf (cm^2)	Average leaf area /plant (cm^2)
T_o	36.2	31.8	190.5	6057.9
T_1	20.2	13.7	95.7	1311.1
T_2	29.5	23.6	143.5	3386.6
T_3	35.8	32.1	188.5	6050.9

Means in column followed by the different letter are significantly different by DMRT at $P \leq 0.05$, T0 = Control, T1 = upto 0.5m from tree base, T2 = 0.5-1.0 m from tree base, T3 = 1.0 -1.5m from tree base.

No. of Leaves Plant^{-1}: Different distances from base of *Xylia* tree had significant effect on number of leaves plant^{-1} of Strawberry (Table 2). The result revealed that the highest no. of leaves per plant (32.1) was produced by T_3 (1.5m distance from the tree). The second no. of leaves per plant (31.8) was produced under T_0 (0.5m distance from the tree) and the lowest result (13.7) was observed at T_1(0.5 m distance from the tree) and second lowest result was (23.6) at T_2 (1m distance from the tree) Table 4. Number of leaves per plant was reduced near the near base may be due to competition for moisture and nutrients between the roots of strawberry and Lohakat tree. Similar type of assumption was also opined by Tanni *et al.,* (2010) for Radish and lettuce along with 4 years old *Xylia dolabriformis* tree.

Leaf size: Leaf size **(**length × width) of strawberry s was significantly influenced by different levels of distance from tree base (Table 2). Individual leaf area as well as total leaf area per plant decreased progressively with decreasing distance from tree base. Among the four distance levels, the biggest leaf area (190.5cm^2) was obtained in open field and the smallest leaf area (95.7cm^2) was obtained in 0-0.5 m distance from tree base. Completion for growth resources (Light, water and nutrients) may be the reason for reducing leaf size of strawberry under Lohakat tree (Ong *et al.,* 1991). 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).

Flower information of strawberry

Flower information of strawberry along with Lohakat significantly influenced by different distance level from the tree base (Table 3). First flowering date, number of flower per plant and fruit maturity period of strawberry was recorded in different distance from Lohakat tree base and recorded data are presented as:

First flowering date: The result shows that flower initiation time of strawberry was significantly influenced by different distance level. It was found that flower initiation period gradually increased with decreasing distance from tree base (Table 3). Among the four different treatments first flower initiate in open field condition (16th December) followed by treatment T_3 i.e., 1-1.5m distance (18th December), T_2 i.e., 0.5-1.0m distance (22nd December) and T_1 i.e., 0-0.5m distance (25th December). Late flower initiation in the near of tree base may be the combined effect of partial shade and competition for nutrients as well as for moisture between the roots of strawberry and Lohakat tree. Partial shade condition sometimes delays the flower forming hormone in the plant (Hilman, 1984). Delayed flower formation also observed by Wadud and Miah (2001) under artificially created shade condition in okra.

Fruit maturity period (days): Fruit maturity is the most important yield contributing character, which was also significantly influenced when grown in association with Lohakat tree (Table 3). In this study it was found that average maturity period of strawberry was 18.0 days and it ranges 13-25 days (Table 3). But in different treatments of this study it was recorded that average long period (19.7 days) required in the open field condition and in association with Lohakat trees it takes little bit short period compare to open field condition (Table 3). Maturity period decreases with decreasing distance from tree base i.e., near the tree base. Average shortest period (15.4 days) recorded in the 0-0.5m distance and it ranges from 13 to 20 days. In the 0.5-1.0m and 1.0-1.5m distance level average period for fruit maturity was 17.5 and 19.5 days,

respectively (Table 3). Average fruit maturity period in open field and 1.0-1.5m distance from Lohakat tree base was statistically similar which indicate interaction between five years old Lohakat tree and strawberry plants was minimum beyond 1 m distance from tree base. Tanni *et al.*, (2010) also observed short maturity period for tomato near the 3 years old *xylia* tree.

Table 3. Flower information of strawberry during total cultivation period

Treatments	1st flowering date	Fruit maturity period (days)		Average number of flower/plant					
		Range	Average	November	December	January	February	March	Total
T_o	16.12.12	17-25	19.7a	4.23a	10.50a	15.23a	13.27a	9.64a	52.87a
T_1	25.12.12	13-20	15.4c	2.47b	4.95c	7.23c	6.34c	5.09c	26.08c
T_2	22.12.12	16-23	17.5b	3.88a	7.72b	11.36b	10.55b	7.27b	40.77b
T_3	18.12.12	16-24	19.5a	4.09a	10.00a	15.14a	13.05a	9.55a	51.83a
Total average			18.0				Total average		42.89

Means in column followed by the different letter are significantly different by DMRT at P ≤ 0.05, T0 = Control, T1 = upto 0.5m from tree base, T2 = 0.5-1.0 m from tree base, T3 = 1.0 -1.5m from tree base.

Number of flower per plant: Significant effect of Lohakat tree was notice on number of strawberry flower per plant when these two plants are grown combindly (Table 3). In all treatments of this study average number of strawberry flower were 42.89 whereas highest number of flower recorded in the open field condition (52.87) which was statistically similar with 1.0-1.5m distance level (51.83). Number of strawberry flower per plant in 0-0.5m and 0.5-1.0m distance from Lohakat tree base was 40.77 and 26.08, respectively. Almost 50% flower less in very near (0-0.5m) Lohakat tree base. Due to lack of nutrients and moisture by competition and short of solar radiation by creating shade very near tree base may be the growth of strawberry plant was less vigorous which results less number flower in this area. Habib *et al.*, (2012) also found less number of flowers in okra very near *Xylia dolabriformis* tree.

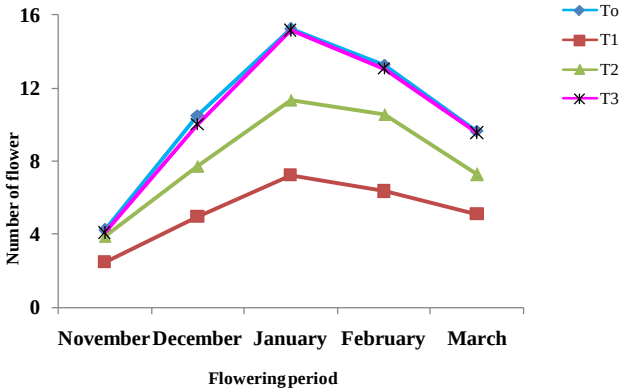

Fig. 3. Number of flowers per plant throughout the cultivation period.

There is a seasonal variation also observed in strawberry plants for producing number of flower per plant (Table 3 and Fig. 3). Though flower formation starts from the month of November but it was optimum in January and after that it reduced upto March. Similar trend of variation was observed in the open field condition as well as in association with Lohakat tree. Such type of variation also notices by Barney *et al.*, (1992) in strawberry and Alam *et al.*, (2012) in bittergourd and sweetgourd.

Fruit information of strawberry

Information regarding fruit setting of strawberry in association with Lohakat was significantly influenced by different distance level from the tree base (Table 4 and Fig. 4). Number of fruit per plant, fruit size (length and girth), fruit weight, seasonal variation of fruit setting and percent fruit setting was recorded in different distance from Lohakat tree base and recorded data are presented as:

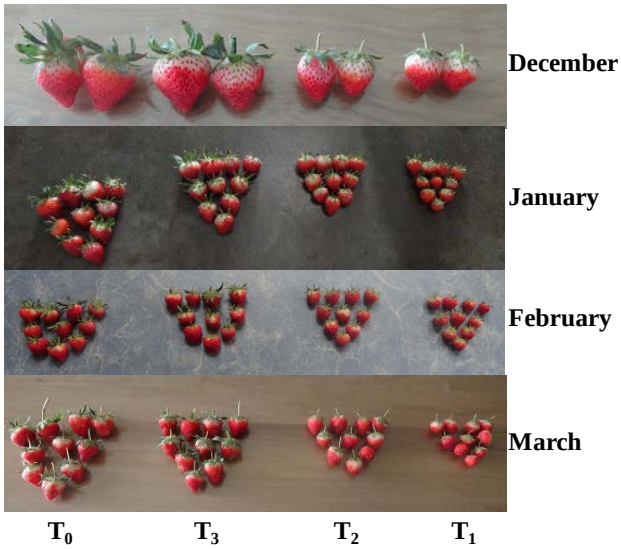

Fig. 4. Fruit size variation different treatments and months

Number of fruits per plant: Like number of flowers per plant, number of fruits per plant also significantly influenced when it was grown in association with Lohakat tree (Table 4). Highest number of fruits per plant was recorded under open filed condition (31.13) and it was statistically similar with the fruit produced in 1.0-1.5m distance (30.45) from Lohakat tree base. Number of fruits per plant in the 0.5-1.0m and 0-0.5m distance from Lohakat tree base were 20.51 and 12.03 which was 34.1 and 62.4% lower compare to open field condition. Fruit formation greatly influenced by the total assimilate which is produced by photosynthesis, near the tree base due to less interception of solar radiation (resulted by tree shade very near tree base) total assimilate production reduced. Tanni *et al.*, (2010) also found less number of fruits in soybean very near *Xylia dolabriformis* tree. Seasonal variation also observed in strawberry plants for producing number of fruit per plant (Table 4 and Fig. 4). Though fruit harvest starts from the month of December but it was optimum in January and after that it reduced upto March. Similar trend of variation was observed in the open field

condition as well as in association with Lohakat tree. Such type of variation was also reported by Barney *et al.*, (1992) in strawberry and Alam *et al.*, (2012) in okra.

Fruit size: Fruit size (Length and girth) of strawberry was largely affected by different treatments in this study (Table 4 and Fig. 4). Both length and girth of strawberry fruit was highest in open field condition (7.1 and 12.8cm) which was almost similar with the fruit produced in 1.0-15m distance (7.0 and 12.4cm) from Lohakat tree base (Table 4). Fruit size in the 0-0.5m and 0.5-1.0m distance from Lohakat tree base were 2.9 & 6.9 cm and 4.1 & 9.0cm, respectively. Near the Lohakat tree base fruit size 30-60% reduced compare to open field condition may be due to severe completion for nutrients and moisture between the strawberry and Lohakat tree roots. It may also affected by shade influence in the understorey layer of Lohakat tree. Similar type of observation was also recorded by habib *et al.*, (2012) 2009) in okra along with Garjan tree. Fruit size also varied with seasonal variation, it was recorded in all treatments of this study in a similar pattern where optimum size fruit was found in the month of February (Table 4).

Table 6. Fruit information of strawberry during total cultivation period

Treatments	Harvesting period	Av. no. of fruit per plant	Av. length per fruit (cm)	Av. girth per fruit (cm)	Av. weight per fruit (g)
T_o	December	5.22	7.2	12.6	17.91
	January	9.95	7.5	13.3	21.56
	February	9.64	6.9	12.8	16.2
	March	6.32	6.7	12.3	15.57
	Total/average	31.13a	7.1a	12.8a	17.81a
T_1	December	1.82	2.8	6.7	7.13
	January	4.14	3.1	7.3	8.51
	February	3.81	3.0	7.2	7.75
	March	2.26	2.5	6.3	6.42
	Total/average	12.03c	2.9c	6.9c	7.45c
T_2	December	2.73	4.4	9.3	12.56
	January	7.19	4.7	10.0	13.75
	February	6.73	3.7	8.7	10.55
	March	3.86	3.5	7.9	10.33
	Total/average	20.51b	4.1b	9.0b	11.8b
T_3	December	5.09	7.1	12.1	17.83
	January	9.77	7.3	12.7	20.95
	February	9.45	6.8	12.7	15.9
	March	6.14	6.6	11.9	15.42
	Total/average	30.45a	7.0a	12.4a	17.53a

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

Fruit weight: Fruit weight directly related with fruit size, so similar type of variation like fruit size was recorded in this study in case of individual fruit weight (Table 4). Individual fruit weight was highest under open filed condition (17.81g) and it was statistically similar with the fruit produced in 1.0-1.5m distance (17.53g) from Lohakat tree base. Number of fruits per plant in the 0-0.5m and 0.5-1.0m distance from Lohakat tree base were 7.45g and 11.8g which was 58.2 and 33.7% lower compare to open field condition. As fruit size varied with seasonal variation, individual fruit weight was also varied with seasonal variation where heavy fruit was found in the month of January and then reduced upto March (Fig 4). Same reason also responsible for varying fruit weight in different distance from Lohakat tree base like completion for solar radiation, nutrients and moisture. Tanni *et. al.*, (2010) opined similar reason for reducing fruit weight in tomato near the base of *xylia* and *Dipterocarpus turbinatus* tree.

Percent fruit setting: Percent fruit setting means the number fruit produced from 100 flowers or rate fruit setting from flower. Fruit setting of strawberry was also significantly influenced by different reduced distance levels (Table 5), where the maximum fruit setting (58.88%) was observed under full sunlight condition T_0 (open field as control) which almost identical with that of 1-1.5 m distance from the tree base (58.75%). But significant reduction of fruit setting (50.3%) based on number of flower was observed in 0.5-1 m distance area and the lowest fruit setting (46.13%) under 0-0.5 m distance area from tree base. Like different morphological parameters fruit setting also reduced near the tree base might be due to the nutrients or moisture deficit which results competition between the roots of strawberry and Lohakat tree. Fruit setting also reduced in tomato and okra along with two and four years old *Xylia dolabriformis* tree at much closed distance from tree base which was observed by Habib *et al.*, (2012) and Tanni *et al.*, (2010).

Table 7. Percent fruit setting of strawberry based on number of flower

Treatments	Average No. of flower per plant	Average No. of fruit per plant	% fruit setting
T_o	52.87a	31.13a	58.88a
T_1	26.08c	12.03c	46.13c
T_2	40.77b	20.51b	50.3b
T_3	51.83a	30.45a	58.75a

Means in column followed by the different letter are significantly different by DMRT at $P \leq 0.05$, T0 = Control, T1 = upto 0.5m from tree base, T2 = 0.5-1.0 m from tree base, T3 = 1.0 -1.5m from tree base.

Yield of strawberry:

Yield of strawberry was recorded as per plant, per plot as well per hectare which was significantly influenced by Lohakat tree in different distance from tree base (Fig. 5 and 6). Highest yield per plant (554.43g) was recorded under open condition which almost identical with yield per plant produced in the 1.0-1.5m distance area (533.79g) from Lohakat tree base. It was found that yield of strawberry remarkably reduced with reducing distance

from Lohakat tree base where 242.02g and 89.62g yield obtained from 05.1.0m and 0-0.5m distance area from Lohakat tree base, respectively which were 56.35 and 83.84% lower compare to open field condition (Fig. 5). Similar trend of variation also found when the yield converted as ton per hectare (Fig. 6) where highest value (33.00 tha^{-1}) recorded in the open field condition followed by 1.0-1.5m distance area (31.77 tha^{-1}), 0.5-1.0m distance area (14.41 tha^{-1}) and 0-0.5m distance area (5.34 tha^{-1}) from Lohakat tree base, respectively (Fig. 6).

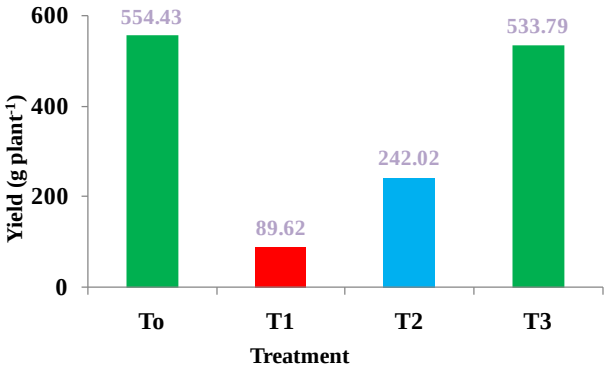

Fig. 5. Yield of strawberry per plant along with Lohakat tree

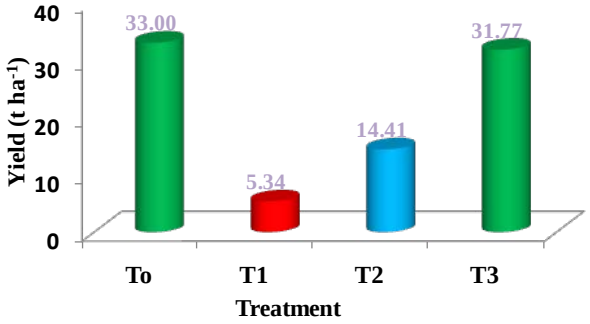

Fig. 6. Yield of strawberry per hectare along with Lohakat tree

In the open field condition yield of strawberry varied based on edaphic and ecological variations and the range of variation is 30-40 tha^{-1}(Strik, 1989; Barney *et al.*, 1992; Bolda *et al.*, 2006). Yield in association with Lohakat tree remarkably reduced with reducing distance from tree base. Number of flower per plant, percent fruit setting, number of fruit per plant, fruit size as well as individual fruit 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) strawberry yield reduced by different negative effects by tree like competition for nutrients and moisture in the belowground 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. But beyond the 1.0m distance yield of strawberry was statistically similar with open field condition which indicate negative effects of Lohakat tree both above and below ground was minimum in this area. So, along with five years old Lohakat tree strawberry can cultivate beyond 1m distance without significant yield loss.

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