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Performance of root vegetables in association with medicinal trees under charland ecosystem

M.O.R. Sahel, M.A.A. Noman, F. Ahmed, M.A. Wadud and G.M.M. Rahman
Department of Agroforestry, Bangladesh Agricultural University, Mymensingh-2202,
E-mail: sahel.bau@gmail.com

Abstract: The experiment was conducted at the Char Kalibari, at bank of Brahmaputra River flowing through the eastern side of Bangladesh Agricultural University, Mymensingh, during the period from September 2018 to December 2018 to observe the performance of medicinal tree-based agroforestry system under char land ecosystem. In this experiment winter root vegetables (radish, turnip and carrot) were cultivated in association with medicinal trees (horitoki, amloki and bohera). Each root vegetables were cultivated in combination with three medicinal tree species and without tree combination i.e. control condition following a Randomized Complete Block Design (RCBD) with 3 (three) replications. So, the four treatments of this study were T_0 = open field referred to as control, T_1 = root vegetables with amloki tree, T_2 = root vegetables with horitoki tree and T_3 = root vegetables with bohera tree. Growth and yield parameters of all root vegetables were recorded harvesting stage. From results of this study, it was found that different growth parameters *viz*. no. of leaves/plant, root length (cm), root girth (cm), individual root weight (g) were not significantly varied in different treatments of this study. Like morphological parameters, yield of all studied root vegetables were also not varied significantly in different treatments but very near the tree base numerically little bit (2-5%) lower yield was observed. From this study, it may be conclude that root vegetables can be cultivated along with medicinal tree species during its establishment period without significant yield loss as agroforestry system in the chrland ecosystem of Bangladesh.
Key words: Root vegetables, charland ecosystem, agroforestry, medicinal trees.

Introduction

With 1077 people per square kilometer, Bangladesh is one of the most densely populated small country with an area of 147,570 km^2 where 168.9 million people live (BBS, 2017). The effective area of forest (5.4%) in Bangladesh is neither in a position to fulfil the demands of the people's foods, herbal and ayurvedic medicinal requirements nor to stabilize the climatic condition. Significantly prominent phenomena driving country's overall scenario of economic development and environmental imbalance is due to the scarcity of land for ever increasing demand of foods as well as herbal medicines. Under these circumstances it is necessary to find out a suitable alternative to overcome this situation. As a result, this country has to develop a sustainable combined production system by the integration of trees and crops in the same unit of land which is now being called agroforestry.

Medicinal plants are often an important component of an agroforestry system. Millions of people in the Bangladesh, even during this space-age, especially in the rural areas are still dependent on herbal medicines or medicinal plants which are commonly found either in raw form or as processed products manufactured by indigenous ayurvedic and Unani institutions. Most of the Ayurvedic and Unani companies import about 70% medicinal plants in every year and the rest 30% is collected from local production (BFRI, 2016). The Government of Bangladesh places much emphasis on the afforestation and conservation of medicinal plants. So far, more than 300 ha have been planted with medicinal plants (BFD, 2016). Of all the species found in Bangladesh, most commonly used three medicinal plants are horitoki, amloki and bohera. A traditional ayurvedic herbal formulation called triphala is made of from horitoki, amloki and bahera. It is one of the most popular formulas in Ayurveda and has many health benefits. Horitoki *(Terminalia chebula)* is a very important medicinal plant and is regarded as a universal panacea in ayurveda. The triphala (horitoki, amloki and bohera) fruits are considered as useful medicines for diarrhoea, innumerable diseases, jaundice, dyspepsia, coughs, indigestion, anaemia, some cardiac problems, nasal congestion, retention of urine and dysentery (Lichterman, B. L. 2004).

In Bangladesh, a large number of vegetables are grown of which most of them are grown in winter season. Among them radish, turnip and carrot are the most important winter root vegetables in Bangladesh. These are well known and very popular vegetables grown successfully during the winter season all over the country. Though the aforementioned vegetables are very common to all and have good potential in our climate, none of them was systematically tested in agroforestry system or in char land condition to see their production ability in association with medicinal trees.

Materials and Methods

Experimental site and season: The experiment was carried out at Char Kalibari belongs to the Mymensingh sadar upazila during the period from August 2018 to December 2018. The geographical position of Char Kalibari located between 24°45'-24°45'40" North and 90°24'4"- 90°24'44" East Latitude.

Tree and plant materials: In this study, recently established three medicinal trees i.e. horitoki, amloki and bohera were used as test tree components and three winter root vegetables such as radish, turnip and carrot were used as crop materials.

Tree, crop establishment and management: Necessary management activities like watering, cleaning, weeding, fertilizing, branch cutting, bamboo sticks setting were done in time for proper growth and development of all plant's saplings.

Experimental design, layout and treatment combination: In this experiment, winter root vegetables (radish, turnip and carrot) were cultivated in association with medicinal tress (amloki, horitoki and bohera). In this study, winter root vegetables (radish, turnip and carrot) were cultivated in association with medicinal trees (horitoki, amloki and bohera). Each root vegetables were cultivated in combination with three medicinal tree species and without tree combination i.e. control condition following a Randomized Complete Block Design (RCBD) with 3 (three) replications. So, the four treatments of this study were T_0 = open field referred to as control, T_1 = root

vegetables with amloki tree, T_2 = root vegetables with horitoki tree and T_3 = root vegetables with bohera tree. Each medicinal species was transplanted in 3 (three) blocks and each block treated as a replication which contain 9 trees (3 amloki, 3 horitoki and 2 bohera) and planting spacing was 12 ft. × 12 ft.

Sampling and Data collection: Data of different growth and yield parameters were collected at harvesting stage. For data collection plant samples were selected randomly from all the treatments of the plots. The parameters studied were- leaves plant^{-1}, root length (cm), root girth (cm), root weight (g) and yield (t/ha) was recorded at harvest time.

Crop harvesting: Radish and turnip were harvested after 60 days from the date of sowing. Carrot was harvested after 80 days from the date of sowing and yield (t/ha) was recorded at each harvest time.

Statistical analysis: The recorded data were compiled and analyzed by RCBD design to find out the statistical significance of experimental results. The means for all recorded data were calculated and analyzed statistically by using 'WASP 2' software package to find out the statistical significance of the experimental results for all the characters were performed. The mean differences were evaluated by Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984) and also by Least Significance Difference (LSD) test.

Results and Discussion

Growth (Fig. 1) and yield (Fig.2) studied root vegetables viz. radish, turnip, carrot etc. in association with different medicinal trees (amloki, horitoki and bohera) are presented here separately.

Fig. 1. Root vegetables cultivation with medicinal trees during early stage of plantation.

Fig. 2. Root vegetables with medicinal trees at harvesting time.

Table 1. Yield contributing characteristics of radish in association with medicinal trees at harvesting period

Treatments	Growth parameters of radish			
	No. of leaves/plant	Root weight (g)	Root length (cm)	Root girth (cm)
T_0	13.33	580.33	32.63	18.83
T_1	12.66	576.33	31.00	17.90
T_2	12.33	560.00	29.16	16.50
T_3	13.00	574.33	30.13	17.03
CV (%)	13.448	8.221	24.375	5.39
Level of significance	NS	NS	NS	NS

NS = Non-significant; T_0 = Control, T_1 = Radish with amloki, T_2 = Radish with horitoki and T_3 = Radish with amloki bohera.

Radish: Morphological parameters and yield of radish under different treatments are also separately presented as:

Morphological parameters: Different growth parameters of radish viz. leaves plant^{-1}, root length (cm), root girth (cm), root weight (g) and yield (t/ha) were recorded during harvesting time in combination with amloki, horitoki, bohera and without tree combination (Table 1). It was found that all studied parameters of radish were not significantly influenced by different treatments but numerically a few variations were observed among the different treatments. Highest values of all parameters were found in control condition i.e. without tree combination (Table 1). Among the different medicinal tree sapling combinations 2-5% reduction was recorded compare to control condition where maximum reduction was found in association with horitoki tree. During the establishment period of medicinal tree sapling crown and root expansion was not so prominent (Dwivedi, 1992) and at the same time horizontal expansion of lateral root of these species move downward (Krisnawati *et al.*, 2011) as a result there was no significant influenced was found in this study. Among the three different medicinal tree species, growth of horitoki sapling bit better compare to others as a results numerically a few variation was recorded in association with this tree saplings.

Yield: Like morphological parameters, fresh yield of radish as root vegetable was not affected significantly at harvesting stage in association with different medicinal trees (Fig. 3). As evident from results, numerically the highest yield of fresh radish (50.59 t/ha) was recorded from treatment T_0 (open field as control). Yield of radish in association with amloki, horitoki and bohera tree sapling were 49.62, 48.02 and 49.45 t/ha, respectively (Fig, 3).

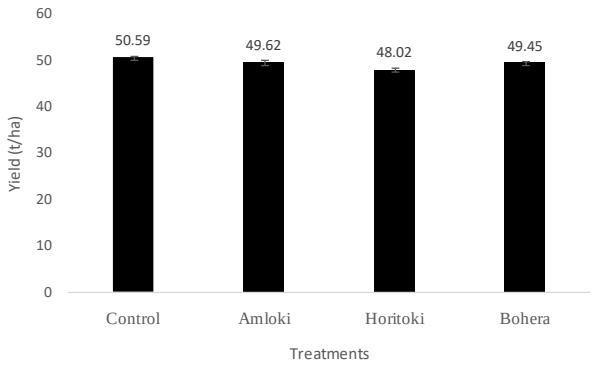

Fig. 3. Yield of radish in different treatments

Yield reduction of radish in combination with amloki, horitoki and bohera tree sapling were 1.91, 5.08, 2.25%, respectively, compared to without medicinal tree combination i.e. open field condition. During the sapling stage of trees competition for different growth resources was minimum as a result yield of associated root vegetables with such type of tree sapling was not affected. Similar type of results also obtained by Alam *et al*. (2012) in summer vegetables when cultivated with mahogany saplings.

Turnip: Morphological characteristics and yield of turnip under different three different medicinal tree saplings and without tree combination are presented here also separately as:

Morphological characteristics: Different morphological parameters of turnip viz. leaves plant^{-1}, root length (cm), root girth (cm), root weight (g) and yield (t/ha) were observed during harvesting period in combination with amloki, horitoki, bohera and without tree combination (Table 2). From the results ot this experiments, it was found that all studied parameters of turnip were not significantly varied by different treatments but numerically minor variations were observed among the different treatments. Maximum values of all studied parameters of turnip were found in control condition i.e. without tree combination (Table 2). Among the three different medicinal tree sapling combinations small reduction (1.5-5.5%) was recorded compare to control condition where maximum reduction was found in association with horitoki tree (5.5%). During the sapling stages of medicinal tree saplings crown and root expansion was not so prominent (Dwivedi, 1992) and at the same time horizontal expansion of lateral root of these species move downward (Krisnawati *et al.*, 2011) as a result there was no significant variation was found in this study. Among the three different medicinal tree species, growth of horitoki sapling bit better compare to others as a results numerically a few variation was recorded in association with horitoki tree saplings. Basak *et al.* (2009) also observed similar type of growth variation in radish, tomato and soybean along with two year old Lohakat tree sapling.

Table 2. Yield contributing characteristics of turnip in association with medicinal trees at harvesting period

Treatments	Growth parameters of radish			
	No. of leaves/plant	Root weight (g)	Root length (cm)	Root girth (cm)
T_0	9.00	344.33	12.10	30.13
T_1	8.66	337.00	11.50	29.00
T_2	7.80	333.66	11.06	27.30
T_3	8.33	338.00	11.26	28.60
CV (%)	12.936	6.564	11.03	9.118
Level of significance	NS	NS	NS	NS

NS = Non-significant; T_0 = Control, T_1 = Radish with amloki, T_2 = Radish with horitoki and T_3 = Radish with amloki bohera.

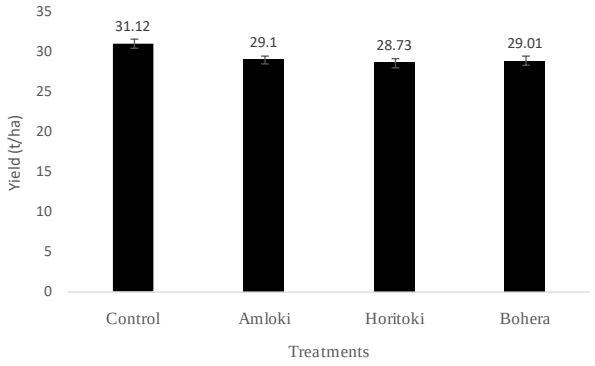

Fig. 4. Yield of turnip in different treatments

Yield: Like morphological characteristics of turnip fresh yield as root vegetable was not affected significantly at harvesting stage in association with the studied three medicinal trees and without tree combination (Fig. 4). As evident from results, numerically the highest yield of fresh turnip (31.12t/ha) was recorded from treatment T_0 (open field as control). Yield of turnip in association with amloki, horitoki and bohera tree sapling were 29.10, 28.73 and 29.01 t/ha, respectively (Fig, 4). Yield reduction of turnip with the studied medicinal trees viz. amloki, horitoki and bohera tree sapling were 7.08, 8.26, 7.37 %, respectively, compared to without medicinal tree combination i.e. open field condition. The reasons of lower performance of turnip with the above medicinal trees may be due to competition for light, water and nutrients between shoot and root system of turnip and medicinal trees. Similar Phenomenon was also found by Najafi *et al.*, (1997) in soybean.

Carrot: Morphological parameters and yield of carrot under different treatments are also separately presented here as:

Morphological parameters: Different growth parameters of carrot viz. leaves plant^{-1}, root length (cm), root girth (cm), root weight (g) and yield (t/ha) were recorded during harvesting time in combination with amloki, horitoki, bohera sapling and without tree combination (Table 3). from the results of this study, it was found that all studied

parameters of carrot were not significantly influenced by different treatments but numerically a few variations were observed among the different treatments. Highest values of all studied parameters of carrot were found in control condition i.e. without medicinal tree combination (Table 3). Among the three different medicinal tree sapling combinations 2.5-5.5% reduction was recorded compare to open field condition where maximum variation was found in association with horitoki tree. During the establishment period of medicinal tree sapling crown and root expansion was not so prominent (Dwivedi, 1992) and at the same time horizontal expansion of lateral root of these species move downward (Krisnawati *et al.,* 2011) as a result there was no significant influenced was found in this study. Among the three different medicinal tree species, growth of horitoki sapling bit better compare to others as a results numerically a few variation was recorded in association with this tree saplings. Similar type of variation was also obtained by Alam *et al*. (2012) in summer vegetables when cultivated with mahogany saplings.

Table 3. Yield contributing characteristics of carrot in association with medicinal trees at harvesting period

Treatments	Growth parameters of radish			
	No. of leaves/plant	Root weight (g)	Root length(cm)	Root girth (cm)
T_0	11.33	144.33	13.66	14.70
T_1	11.00	139.33	13.95	14.76
T_2	10.16	136.33	12.70	13.50
T_3	10.60	138.66	13.06	14.53
CV (%)	13.61	8.43	15.226	5.425
Level of significance	NS	NS	NS	NS

NS = Non-significant; T_0 = Control, T_1 = Radish with amloki, T_2 = Radish with horitoki and T_3 = Radish with amloki bohera.

Yield: Like radish and turnip, fresh yield of carrot was not affected significantly at harvesting stage in association with three different studied medicinal trees (Fig. 5). As evident from results, numerically the highest yield of fresh carrot (25.51 t/ha) was recorded from treatment T_0 (open field as control). Yield of carrot in association with amloki, horitoki and bohera tree sapling were 24.14, 23.62 and 24.02 t/ha, respectively (Fig. 5). Yield reduction of carrot with three different medicinal trees viz. amloki, horitoki and bohera tree sapling were 5.37, 7.40, 5.84%, respectively, compared to without medicinal tree combination i.e. open field condition. During the sapling stage of trees competition for different growth resources was minimum as a result yield of associated root vegetables with such type of tree sapling was not affected. Similar type of variation was also obtained by Tanni *et al*. (2010) in winter vegetables when cultivated with lohakat tree saplings.

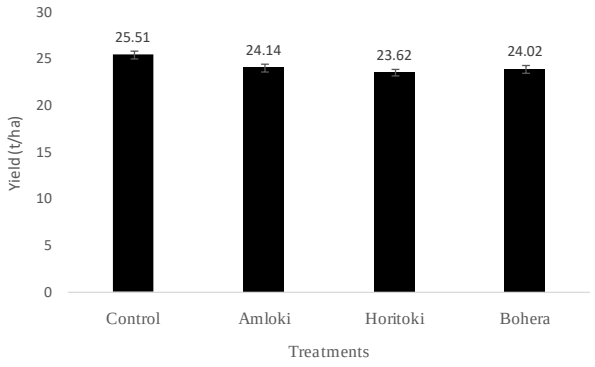

Fig. 5. Yield of carrot in different treatments

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