Rice cultivation along the north-south orientation of a five years old strip plantation of akashmoni tree

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Abstract: The experiment was carried out at the Agroforestry Farm of Bangladesh Agricultural University, Mymensingh, during the period from August 2014 to December 2014 determine the effect of shade of akashmoni tree row on growth and yield of Aman rice (BRRI dhan 34). The experimental design was followed by Randomized Complete Block Design (RCBD) with three replications. Two factors i.e. different distances of experimental plot from tree row (i.e. 0.0 - 2.0 m, 2.0 - 4.0 m, 4.0 - 6.0 m and shade free condition) and different direction of tree row (North and South direction) were included in the study. Different treatments in each direction were T_1 (0.0 – 2.0 m distance from the tree row), T_2 (2.0 – 4.0 m distance from the tree row), T_3 (4.0 – 6.0 m distance from the tree row) and shade free condition which was treated as control (T_4) treatment in both direction. In this study, different growth parameters viz. plant height, total no. of tillers per hill, no. of effective tillers per hill, length of panicle, grain per panicle, sterile grain per panicle, no. of effective grain per panicle, 1000-grain weight, straw weight and grain yield of rice were analyzed for observing the effect of akashmoni tree on rice production. In both directions, it was found that growth and yield of rice was gradually decreased towards the akashmoni tree base. Result showed that optimum values of all the growth parameters of rice were highest in shade free condition (T_4) which was almost similar to treatment T_3 of south direction followed by T_3 of north direction, T_2 of south direction, T_2 of north direction, T_1 of south direction and the lowest in T_1 of north direction. In both direction growth of rice towards akashmoni tree base were varied in a similar trend but numerical value of the all growth parameters were relatively better in south direction compare to north. Moreover, yield of rice was also gradually decreased towards the akashmoni tree base in both directions. Grain yield reduction of rice at north and south direction in the treatment T_1, T_2 and T_3 were 88.67, 49.64, 21.01% and 72.45, 40.38, 0.75%, respectively compare to control condition. It was found that grain yield reduction of rice was relatively higher (13.59%) in north direction compare to south direction may be due to more shade cast in north direction during winter season.
Key words: Rice, Akashmoni, Agroforestry.

Introduction

Bangladesh is a "Next Eleven" emerging economical country located in the north-eastern part of South Asia. It is also the world's eighth-most populous country, with over 160 million people and among the most densely populated countries. There are 1015 people live in per square kilometer area with growth rate 1.37% (BBS, 2011). Due to huge population we have small amount of arable land and forest covered area. We have only 0.24 and 0.040 acre cultivated and forest lands per capita, respectively (BBS, 2012). Bangladesh has a primarily agrarian economy. Agriculture is the single largest producing sector of the economy since it comprises about 16.33% of the country's GDP and employs around 47.5% of the total labor force. Rice is the dominant cereal crop being grown widely and it is the main staple food for the people of Bangladesh. It is currently the world's sixth-largest producer. Total production of rice is 346 lakh MT in 115.65 lakh hectare of land where aman is 132.76 lakh MT. The yield of rice is depended on solar radiation. The edges (boundary) of crop fields remain fallow. To utilize this fallow land, trees are planted on the crop field boundary. When trees are established in the boundary, proper management practices is necessary, to reduce the harmful effect of tree on crop. Bangladesh has a long tradition of agroforestry practices. But management has always been extremely poor. It is reported that about 10% of homestead trees are being removed annually without replacement (Abedin and Quddus, 1991). Akashmoni is an exotic plant cultivating as legume tree in Bangladesh and it also provides good quality timber. Recently plantation of more tree species along the agricultural lands is being emphasized. Cultivating rice along with tree row of akashmoni at different distances have profound effect on the performance of aman rice. This is actually cropland agroforestry system. Less yield of rice near the boundary plantation trees might be due to shading effect of trees. Shading effects are also found in north compare to south direction due to winter season. Again the trees compete with crop for water and nutrient also. Sometimes weed infestation and allelopathic effects also exert negative influence on crop yield under boundary plantation. So it is very much essential to evaluate the shading effect of boundary plantation on the yield of rice. Therefore, the present study was undertaken to see the shading effect of tree row on rice at different distances and also in different directions (north and south).

Materials and Methods

Study site: The experiment was carried out at the experimental farm, Department of Agroforestry in Bangladesh Agricultural University, Mymensingh during the period from 10 August 2014 to 20 December 2014. The place is geographically located between 24·75´North latitude and 90·50´ East longitude.

Plant materials: Plant materials of this study were akashmoni (*Acacia auriculiformis*) as tree and rice (*Oryza sativa*) var. BRRI dhan 34 as cultivated annual crop.

Seed bed preparation and raising of seeding: Healthy and vigorous seeds of aman rice (BRRI dhan 34) were collected from the BRRI (Bangladesh Rice Research Institute), Joydebpur, Gazipur. Seeds were then immersed in water in bucket for 24 hours. Then seeds were taken out of water and kept thickly in gunny bags. The seeds started sprouting after 48 hours and were sown after 72 hours in the nursery bed. A piece of high land was puddled well with country plough followed by clearing and leveling with a ladder, per germinated seeds were sown in the wet nursery bed on 1 August 2014.

Land preparations for transplanting: The experimental field was ploughed in wet condition with power tiller followed by laddering on 2 September 2014 and then by country plough on 5 September 2014. The land was

puddled thoroughly by ploughing and cross ploughing followed by laddering in order to level the soil. Weed and stubble were removed from the field.

Uprooting and transplanting of seedling: The nursery beds were kept wet by application of water both in the morning and evening on the previous day of uprooting the seedlings. Forty day old seedlings were uprooted and transplanted in well puddle fields on l0 September 2014. During uprooting proper care was taken to avoid any injury to the crops.

Experimental design and treatment combination: The experimental design was followed by Randomized Complete Block Design (RCBD) with three replications. Two factors i.e. different distances of experimental plot from tree row (i.e. 0.0 - 2.0 m, 2.0 - 4.0 m, 4.0 - 6.0 m and shade free condition) and different direction of tree row (North and South direction) were included in the study. Different treatments in each direction were T_1 (0.0 – 2.0 m distance from the tree row), T_2 (2.0 – 4.0 m distance from the tree row), T_3 (4.0 – 6.0 m distance from the tree row) and shade free condition which was treated as control (T_4) treatment in both direction.

Intercultural operation: Different intercultural operations such as fertilization, weeding, thinning, gap filling, irrigation etc. were done for better growth of rice. To keep the plots free from weeds, weeding was done several times for experimental plots and control plots. All the plots were irrigated whenever needed by using watering cane to supply sufficient soil moisture for the vegetables.

Harvesting: Rice was harvested at its full maturity. Rice under different treatments was harvested at 110 DAT in 20th December.

Sampling and Data Collection: Two types of sampling were collected. One for data collection on growth parameters and the other sampling was for data collection on yield and yield components at harvest. At each sampling, ten selected hills (excluding border hills) from each condition i.e. ten hills from shading condition and ten hills from shade free area under each direction of plot were measured at field. Plant height, number of tillers hill^{-1} and number of leaves hill^{-1} were counted there. The data on total tillers hill^{-1}, number of effective tillers hill^{-1}, number of panicle hill^{-1}, panicle length, filled grain panicle^{-1}, unfilled grain panicle^{-1}, panicle weight (g), straw weight (g), 1000 grains weight (g), grain yield (t ha^{-1}), straw yield (t ha^{-1}), biological yield (t ha^{-1}) and harvest index (%) were recorded at final harvest.

Statistical analysis: The data were collected from the experiment at different stages of various growths and then analyzed statistically by using PC MA-STAT, MSTAT-C Package programme and wasp2 software package to find out the statistical significance of the experimental results. 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

Shade effect of akashmoni (*Acacia auriculiformis*) tree on rice is presented as morphological characters and yield attributes of rice, here.

Morphological characters of rice

Plant height (cm): At harvesting stage, there some significant differences were seen among the values of different parameters displayed in Table 1. It was observed that at this stage, highest plant height (122.80 cm) was found in treatment T_4 (control or shade free area) which is statistically similar to the treatment T_3 (4.0 – 6.0 m from the base of tree row) of south direction and the third highest plant height (118.63 cm) in T_3 (4.0 – 6.0 m from the base of tree row) of north direction. Similar result was also recorded by Rahman (2013) and Islam *et al*. (2008).. On average plant height was increased in south direction than north direction due to greater effect of shade on north direction.

Total no. of tiller per hill: The result revealed that the highest no. of tiller (9.33) per hill was produced by treatment T_4 (control). The second highest no. of tiller (9.00) per hill was found under treatment T_3 (4.0 – 6.0 m from the base of tree row) of south direction and the lowest result (4.00) was observed at T_1 (0.0 – 2.0 m from the base of tree row) of north direction. Similar type of effect was observed by Bithi *et al.* (2014) in an agroforestry practice with Brinjal and Chilli cultivation along with Lohakat (*Xylia dolabriformis*).

Total no. effective tiller per hill: It was noted that no. of effective tiller per hill was meaningfully increased with the rise of distance from tree base (Table 1). The result showed that highest no. of effective tiller per hill (9.00) was noted in treatment T_4 (shade free area). The next maximum no. of effective tiller per hill (7.00) was shaped under treatment T_3 of south direction. The third highest no. of effective tiller (5.66) per hill was recorded under treatment T_3 of north direction. At 2.0 m distance from the tree base, the lowest no. of effective tiller (3.66) per hill was perceived (Table 2). Similarly Roy (2014) found the effect of shading on crop in different distances an agroforestry practice on Mango–Sweet Gourd Based Agroforestry System.

Length of Panicle (cm): The result showed that the length of the panicle (31.80 cm) was increased in shade free condition (T_4) which is statistically similar to the treatment T_3 of south direction i.e. 31.20 cm (Table 1). The lowest length of the panicle (19.73 cm) was recorded under treatment T_1 (0.0 – 2.0 m from the base of tree row) of north direction (Table 2). It was probably due to poor photosynthetic capacity and nutrients competition between tree and crops. Akter *et al. (*2013) also showed that the yield contributing characters of the carrot increased gradually with the increase of planting distance from the tree.

Grain per Panicle: The result exhibited that grains per panicle varied significantly due to different distance of shade. The shade free treatment (T_4) returns the maximum number of grain per panicle (129.66) (Table 1). Similar result (129.66) was found in treatment T_3 of south direction. In shaded condition, treatment T_1 (0.0 – 2.0 m from the base of tree row) of north direction produced lowest amount of grains than other treatments. Jadhav (1987) reported that partial shading reduced grain yield of rice.

Sterile grains per Panicle: The result showed that at this stage, the highest no. of sterile grain (12.66) per panicle was found in treatment T_4 (control or without shade) which is statistically similar to the no. of sterile grain (12.00) in treatment T_3 (4.0 – 6.0 m from the base of tree row) of south direction. The lowest no. of sterile grain (4.66) was found in treatment T_1 (0.0 – 2.0 m from the base of tree row) of north direction (Table 1).

Table 1. Morphological characteristics of rice in association with Akashmoni at Harvesting days after transplantation

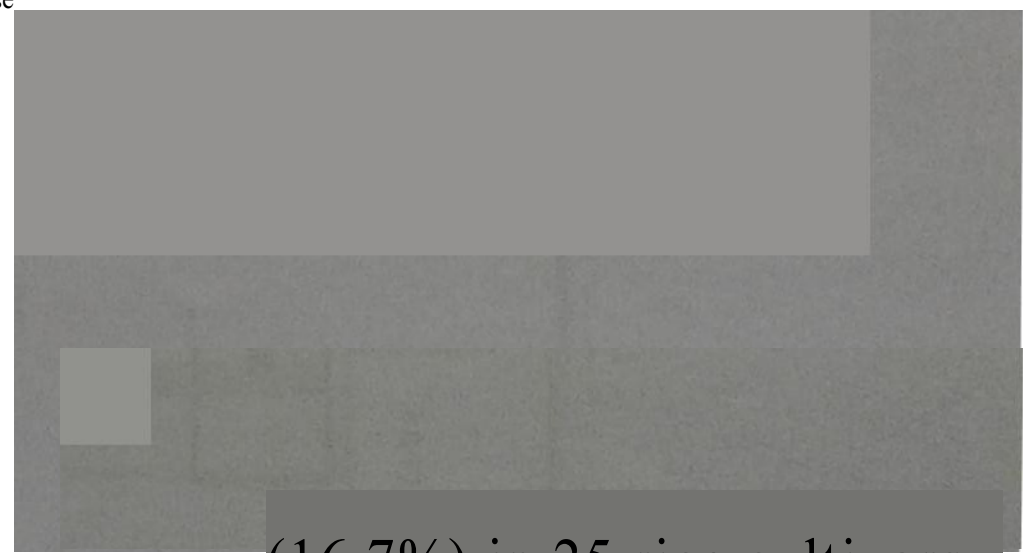
Direction	Treatments	Morphological Characteristics of Rice								
		Plant Height(cm)	Total no. of tillers/hill	No. of effective tillers/hill	Length of Panicle (cm)	Grain/ Panicle	Sterile Spiklets/Panicle	No. Effective Grain/Panicle	1000 grain weight(g)	Straw Weight(g)
North	T_1	67.50d	4.00d	3.66c	19.73d	62.33d	4.66d	57.66d	5.30d	12.73d
	T_2	114.06bc	6.33b	5.00bc	28.40bc	116.00c	10.66a	105.33c	10.82b	20.38bc
	T3	118.63ab	7.33b	5.66ab	29.60ab	125.66b	11.00a	114.66ab	11.80ab	21.83b
South	T1	110.60c	5.00c	3.66c	26.89c	113.00c	7.33b	105.66c	7.10c	19.22c
	T2	115.70b	7.00b	5.00bc	27.33bc	122.66b	12.33a	110.33bc	8.03c	22.20b
	T3	122.10a	9.00a	7.00a	31.20a	129.66a	12.00a	117.00a	12.00a	24.71a
	T4	122.80a	9.33a	7.00a	31.80a	129.66a	12.66a	117.66a	12.14a	24.93a

Means in column followed by the different letter are significantly different by DMRT at $P \leq 0.05$, T_1= 0-2m distance , T_2= 2 - 4 m distance , T_3= 4-6 m distance and T_4 = Control (without

Effective grains per Panicle: The maximum number of effective tillers per hill (117.66) was recorded in shade free treatment (T_4). Approximately similar result (117.00) was recorded in treatment T_3 and the lowest no. of effective tillers per hill (57.66) was produced under treatment T_1 (0.0 – 2.0 m from the base of tree row) of north direction (Table 1).

1000-grains weight (g): It was exposed that, the highest 1000-grain weight of rice (12.14 g) was found in the treatment T_4 (shade free area) which was Close to the grain weight (12.00 g) of treatment T_3 (4.0 – 6.0 m from the base of tree row) at south direction. The second highest 1000-grain weight of rice (11.80 g) was observed in the treatment T_3 (4.0 – 6.0 m from the base of tree row) of north direction. The lowest weight was found in the treatment T_1 (0.0 – 2.0 m from the base of tree row) of north direction. Shukla *et al*. (2008) stated that various plant growth parameters viz., shoot length, dry weight and phosphorus (P) uptake were adversely affected by low light intensity.

Straw weight per hill (g): There are significant differences also appeared in case of weight of straw per hill at different treatments. The highest straw weight (24.93 g) was noted in shade free condition (T_4). The next maximum straw weight (24.93 g) was noted in treatment T_3 (4.0 – 6.0 m from the base of tree row) of south direction and the lowest straw weight (19.22 g) was found



in treatment T_1 (0.0 – 2.0 m from the base of tree row) of south direction (Table 1). Momtaz (2013) also found similar result in case of Bitter Gourd in association with three fruit trees.

Yield: There were some remarkable variation appeared in case of grain yield among different treatments. The result revealed that significant difference was seen among the values of different parameters of rice for the treatments (Fig. 2). It was observed that at this stage highest grain yield (2.65 t ha^{-1}) was found in treatment T_4 (control or without shade) which is statistically similar to the grain yield (2.63 t ha^{-1}) in treatment T_3 (4.0 – 6.0 m from the base of tree row) of south direction. The lowest grain yield (0.30 t ha^{-1}) was found in treatment T_1 (0.0 – 2.0 m from the base of tree row) of north direction. Grain yield of rice produced in the shade area was also lower compare to shade free area. Lower grain yields under shade were due to the cumulative effect of reduction in the number of effective tillers number of grains per panicle and increase in non-effective tillers per hill. Similar results have been reported by Jadhav (1987) and Chaturvedi and Ingram (1989). Higher grain yield per hectare (ha) was due to the effect of increased number of total tillers, effective tillers per hill and number of grains per panicle. Similar results have been reported by Pandey *et al.* (1999).

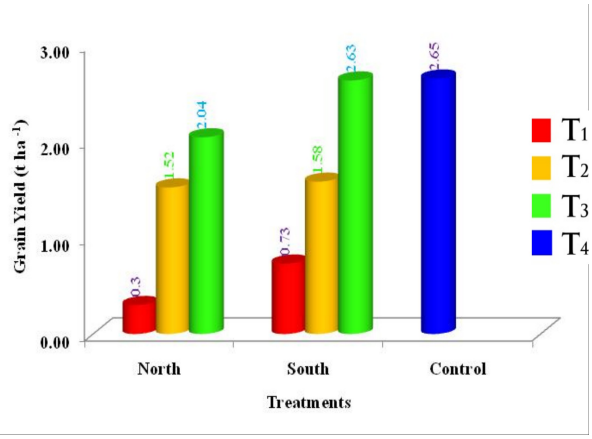


Fig. 1. Grain yield of rice along with different treatments

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