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Yield performance of transplanted aman rice under different multipurpose tree species

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Abstract: A field experiment was conducted at the Agroforestry Farm, Department of Agroforestry, Hajee Mohammad Danesh Science and Technology University, Dinajpur during June 2006 to November 2006 to evaluate the performance of transplanted aman rice grown under different multipurpose trees at various shading condition. Five varieties *cv.* BR10, BR11, BRRIdhan33, BRRIdhan39 and Sorna were cultivated under three different tree species namely, Kalo koroi, Guava and Mango. The partial shade effect was significantly found in unfilled grain / panicle, 1000 grain weight and grain yield. In partial shade condition the highest unfilled grain / panicle (16.16) was found under Guava and lowest (12.1) in open field. The highest weight of 1000 grain was 20.40g obtained in open field followed by mango (20.22g) and the lowest weight of 1000 grains was 20.12g found under Guava. The highest yield of rice (3.86 t/ha) was produced in open field followed by Kalo Koroi (3.78 t/ha) and the lowest (3.66 t/ha) under guava. The result showed that the production of rice might be ranked as Open field > Kalo koroi > Mango > Guava. Therefore, it may be predicted that most of the modern transplanted aman rice varieties can be grown in association with early aged multipurpose trees; but their degree of suitability might be prescribed as BR11 > BR10 > BRRIdhan33 > BRRI dhan39 > Sorna. The study also revealed that BR11 with Kalo koroi was the best association for maximum grain yield of rice.
Key words: Yield, transplanted aman rice, multipurpose trees

Introduction

Rice (*Oryza sativa* L.) is the principle food of Bangladesh and it is the world's second important food grain. It is grown worldwide on 150 million hectares (ha) with the total production of about 563 million tons of unmilled rough rice (FAO, 1999). Bangladesh is not only a rice growing country but also has a rice-eating people. It is the forth-largest country in the world with respect to rice area and production (IRRI, 2000). Rice is cultivated in Bangladesh throughout the year as aush, aman and boro. Among these transplanted aman is the most important and occupies about 46.30% of the rice cultivated land.

Agroforestry has been a collective term for land-use systems and practices in which woody perennials are deliberately integrated with crops and/or animals on the same land-management unit, either in a spatial mixture or a temporal sequence. The trees in agroforestry practices generally fulfill multiple purposes, involving the protection of the soil or improvement of its fertility, as well as the production of one or more products (Cooper *et al.,* 1996). The domestication of these agroforestry trees should enhance their capacity to fulfill either or both of these service or production functions. Domestication should also aim at increasing the social and economic benefits of agroforestry, through improved profitability, reduced risks and diversified sources of income to buffer against crop failure (Sanchez 1995). This will act as an incentive for adoption by farmers. On the other hand, total forest land area of the country covers about 13.36% of the land area (BBS, 2003). However according to forest master plan and surveys by multilateral donor agencies a total of 76900 ha or 6% of the country land mass has actual tree coverage (Bangladesh State of Environmental Report, 1999). But to enjoy benefit of nature we should have at least 25% of our land covered with forest species.

Considering the above facts cropland Agroforestry is the best alternative to meet the entire requirement as it is a production technique or method that combines agricultural crops and forestry / fruit trees on a piece of land to maximize the utilization of natural resources (land sunlight water etc) (Chowdhary and Mahat, 1993). Introduction of fruit trees in rice field and their association behavior is very important for study. Keeping this view in mind the research has been under taken to assess the yield behavior of transplanted aman rice varieties grown under Kalokoroi, Guava and Mango.

Materials and Methods

A field experiment was carried out at the Agroforestry Farm, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur, during June 2006 to November 2006 to evaluate the performance of 5 transplanted aman rice varieties under 3 multipurpose tree species as agroforestry system. The site of the experiment is situated between 25º13' Latitude and 88º23' longitude at the elevation of 37m above the sea level and land type a medium high land belonging to the AEZ old Himalayan piedmont plain area. The soil texture was sandy loam with p^H 5.1. The structural class of the soil was fine and the organic matter content was around 1.06%. The characteristics of the soil were previously tested in the Soil Resource Development Institute (SRDI), Dinajpur.

The experiment was conducted in newly established orchard of multipurpose tree species namely *Mangifera indica* (Mango), *Albizia lebbeck (*Kalo Koroi) and *Psidium guazava* (Guava) the tree saplings were planted at the spacing 3m×3m in the year 2004 (3 years old). The experiment included four recommended modern transplanted aman rice varieties (BR10, BR11, BRRIdhan 33, DRRIdhan 39) and another is locally adapted named Sorna. The experiment was laid out following a split plot design with four replications where trees (Mango, Guava, Kalo koroi) in main plots and rice varieties in sub plots. The unit plot size was 2.5m×2.5 m ($6.25m^2$). Before transplanting, the land was well pulverized by spading and fertilized by using fertilizer rate 180 kg/ha Urea, 100 kg/ha TSP, 70 kg/ha MP and 5-7 ton cow dung respectively. Urea fertilizer was used 3 times in equal portion 1st application during final land preparation, 2nd 15 DAT and finally 45 DAT in top dressing method followed by irrigation. Seeds of rice were sown 4th June 2006 in seedbed and 10th July transplanted in to the main plots.

After transplanting necessary intercultural operations (weeding, irrigation and pesticide applications) were done accordingly. Eight (two from each orientation) hills were randomly selected from each unit plot for recording different data. Length of panicle (cm),Number of grain panicle$^{-1,}$Number of unfilled grain panicle^{-1},1000 grain weight (g) were recorded at harvesting stage and grain yield was recorded plot-wise on 14% moisture basis then it is converted in to ton /ha. The data were analyzed statistically and means were adjudged by Duncan's Multiple Range Test (DMRT).

Results and Discussion

Main Effect of trees: Panicle length (cm): The panicle length of rice was not significantly affected by the tree due to shading condition. (Table1). The highest panicle length was 24.62 cm obtained in T_1 (Open field) and the lowest length was 22.80 cm under T_4. (Mango). This may be due to minimum shade of small canopy of early aged plantation.

Number of grain panicle^{-1}: The number of grain per panicle of rice was not significantly affected by the shading of trees. (Table1). The highest number of grains per panicle was found 157.4 in T_1 (open field) followed by T_2 (kalo koroi) and the lowest number of grains per panicle was found (146.4) under T_3 (Guava).

Unfilled grain Panicle^{-1}: Unfilled grains Panicle^{-1} of rice was significantly affected by the trees (Table-1).The highest unfilled grain Panicle^{-1} was found 16.16 under T_3 (Guava) followed by T_2 (14.42) and the lowest unfilled grain Panicle^{-1} was found (12.10) in T_1 (open field) which was statistically similar to that of T4 (Mango). This variation might be due to different translocation rate of photosynthetic meterial to the grain in different shade levels.

1000-grain weight: Weight of 1000 grain(g) of rice was significantly affected by the tree due to the shedding effect (Table1). The highest weight of 1000 grain was 20.40g obtained in T_1 (open field) followed by T_4(20.22g). Weight of 1000 grain found in T_2 was statistically similar to that of T_4 and significantly the lowest weight of 1000 grains was 20.12g found under T_3 (Guava).

Table 1. Main effect tree on yield and yield contributing characters

Tree	Panicle length (cm)	No of grain/ Panicle	Unfilled grain/ Panicle	1000 grain weight (g)	Yield (t/ha)
T_1	24.62	157.40	12.10c	20.40a	3.855a
T_2	23.97	150.90	14.42b	20.18b	3.78 b
T_3	23.35	146.40	16.16a	20.12c	3.50 c
T_4	22.80	147.50	12.79c	20.22b	3.66 b
Level of Significance	NS	NS	*	*	*
CV%	9.72	6.27	8.33	11.29	8.85

In a column, figures having the similar letter (s) or without letter (s) do not differ significantly as per DMRT. Where, T_1= Control (open field), T_2= Kalo koroi, T_3= Guava, T_4= Mango trees; ** = Significant at 1% level of probability, * = significant at 5% level of probability, NS= Not significant.

Table 2. Effect of variety on yield and yield contributing characters of transplanted aman rice

Variety	Panicle length (cm)	No of grain/ Panicle	Unfilled grain/ Panicle	1000 grain weight (g)	Yield (t/ha)
V_1	24.57ab	151.10b	11.36c	20.31b	4.51 a
V_2	25.38a	162.60a	9.57d	21.63a	4.74 a
V_3	23.58bc	151.10b	16.90a	21.22ab	3.18b
V_4	22.77c	146.40bc	17.47a	20.31c	3.11b
V_5	22.13c	141.60c	14.04b	17.43d	2.83c
Level of Significance	**	**	**	**	**
CV%	9.72	6.27	8.33	11.29	8.85

In a column, figures having the similar letter (s) or without letter (s) do not differ significantly as per DMRT. Where, V_1= BR10, V_2= BR11, V_3= BRRI Dhan33, V_4= BRRI Dhan39, V_5= Sorna; ** = Significant at 1% level of probability, * = significant at 5% level of probability, NS= Not significant.

Grain yield :Grain yield of rice was significantly affected due to the different types of tree species (Table1). Significantly the highest grain yield 3.86 t ha^{-1}was recorded in T_1 (open field) and T_2 (Kalokoroi) and significantly the lowest yield of rice 3.50 t ha^{-1} was found under Guava (T_3).

Effect of varieties: Panicle length (cm): The panicle length of rice was significantly influenced by the varietal effects (Table-2). The maximum panicle length (25.38 cm) was found in BR11 (V_2) and minimum length (22.13 cm) was found in Sorna (V_5). The panicle length of BR10 (V_1) was 24.57 cm which was statistically similar to V_2. Panicle length of BRRIdhan 33 , BRRIdhan39 and sorna were statistically similar and the values were 23.58, 22.77 and 22.13 cm respectively.

Number of grain panicle^{-1} : The number of grains per panicle was significantly influenced due to the varieties (Table 2). Significantly the highest number of grain per panicle (162.6) was obtained from V_2 (BR11) followed by V_1 (151.1) & V_3 (151.1). Significantly the lowest grain per panicle (141.6) was found in V_5 (Sorna).

Unfilled grain Panicle^{-1} : Unfilled grain Panicle^{-1} of rice was also significantly influenced due to the varietals effect (Table 2). The maximum unfilled grain Panicle^{-1} was obtained 17.47 in V_4 (BRRIdhan 39) and minimum unfilled grain panicle^{-1} was obtained 9.57 in V_2 (BR11). The second highest was obtained 16.90 in V_3 (BRRIdhan 33) which was statistically similar to V_4 (BRRIdhan 39). Significantly the lowest value was found in V_1.

1000-grain weight**:** 1000 grain weight of rice was also significantly influenced by varietals effect (Table 2). The maximum weight of 1000 grain was found (21.63g) in V_2 (BR11) followed by V_3 (21.22g), V_2 and V_3 was also statistically identical and the minimum weight of 1000 grain was (17.43 g) found in V_5 (Sorna).

Grain yield : The maximum grain yield was produced (4.74 t ha^{-1}) in BR11 (V_2) and the second highest yield was recorded (4.51 t ha^{-1}) in BR10 (V_1) which was statistically similar to V_2 and the third highest yield was found (3.18 t ha^{-1}) in BRRIdhan33 (V_3) which was statistically similar to BRRIdhan39 (V_4). Significantly the lowest grain yield was produced (2.83 t ha^{-1}) in Sorna (V_5)

Interaction effect between trees and varieties: The interaction effect of trees and rice varieties was not significant on panicle length. (Table 3). The highest panicle length was found 26.17 cm, in T_1V_2 combination and the lowest 19.58 cm in T_4V_5 combination. Interaction effect on unfilled grain Panicle^{-1} of rice was significant (Table 3) the highest unfilled grain Panicle^{-1} was found (20.88) in T_3V_4 followed by T_2V_3 (18.58) combination and the lowest unfilled grain Panicle^{-1} was found (7.18) in T_1V_2 combination. Weight of 1000 grain of rice was found not significant due to interaction of trees and varieties (Table 3). The highest weight of 1000 grain was 21.73g in T_1V_2 combination and the lowest 1000 grain weight was (17.38g) in T_1V_5 combination. Interaction effect between trees and rice varieties showed significant variation on grain yield (Table-3). The highest grain yield was found 5.00 t ha^{-1} in T_1V_2 followed by T_2V_2 combination (4.82 t ha^{-1}). The lowest grain yield was found 2.65 t ha^{-1} in both T_3V_5 and T_4V_5 combination.In tree rice association V_2 (BR 11) performed the best under Kalo koroi than any other combinations. The reasons might be less shade casting of Kalo koroi as it possesses low canopy size (100 cm) and highest plant height (3.8 m) than mango and guava. Guava exhibited low performance because of its dense crown which causes maximum shade and minimum photosynthesis. In case of control treatment yield and yield contributing parameters showed the best performance. These results well agreed with Hocking and Islam (1995), who reported that rice cultivars grown under *Acacia nilotica* and *Borassus flabellifer* tree produced lower grain yield, dry matter yield and grains/ panicle compared with crops grown in the open field.

Table 3. Interaction effect between tree and variety on yield and yield contributing characters

Interaction		Panicle length (cm)	No of grain/ Panicle	Unfilled grain/ Panicle	1000 grain weight (g)	Yield (ton/ha)
	V_1	25.38	154.00	8.85h	4.75b	20.38
	V_2	26.17	172.50	7.18i	5.00a	21.73
T_1	V_3	24.63	166.00	16.63c	3.37e	21.27
	V_4	23.77	148.80	16.80c	3.17f	20.27
	V_5	23.15	146.00	11.05fg	2.97fg	17.38
	V_1	24.30	152.50	13.93e	4.52bc	20.30
	V_2	25.35	168.30	11.13g	4.82b	21.70
T_2	V_3	23.63	148.80	18.58b	3.25e	21.08
	V_4	23.35	148.30	15.70c	3.25e	20.33
	V_5	23.23	146.50	12.77ef	3.05f	17.50
	V_1	24.33	149.00	13.57e	4.27c	20.17
	V_2	24.75	157.50	11.05fg	4.57bc	21.42
T_3	V_3	22.58	145.00	18.55b	3.05f	21.27
	V_4	22.55	145.00	20.88a	2.95fg	20.27
	V_5	22.55	135.80	16.75c	2.65h	17.45
	V_1	24.27	149.00	9.10h	4.47c	20.40
	V_2	25.25	162.00	8.93h	4.57bc	21.65
T_4	V_3	23.48	144.50	13.85de	3.05f	21.25
	V_4	21.40	143.80	16.50c	3.05f	20.38
	V_5	19.58	138.30	15.58cd	2.65h	17.40
Level of Significance		NS	NS	**	NS	*
CV%		9.72	6.27	8.33	11.29	8.85

In a column, figures having the similar letter (s) or without letter (s) do not differ significantly as per DMRT. Where, T_1= Control (open field), T_2= Kalo koroi, T_3= Guava, T_4= Mango trees; V_1= BR10, V_2= BR11, V_3= BRRI Dhan 33, V_4= BRRI Dhan 39, V_5= Sorna; ** = Significant at 1% level of probability, * = significant at 5% level of probability, NS= Not significant.

It was observed out of tree-rice association highest yield of rice (3.78 ton/ha) was recorded under T_2 (Kalo koroi) followed by (3.66 ton/ha) under T_4 (Mango). The lowest grain yield (3.5 t ha^{-1}) was obtained under T_3 (Guava). This result is more or less similar to the findings of Roy *et al*. (2005) they reported that grain and straw yields of rice were significantly influenced by tree species. The highest grain yield (3.27 t ha^{-1}) and straw yield (3.82 t ha^{-1}) were obtained from plots with *M. azedarach* and the lowest grain (2.57 t ha^{-1}) and straw (2.87 t ha^{-1}) yield were obtained from plot with *Albizia lebbeck.*

Reduction of yield and yield contributing characters of rice varieties under different tree-rice association in the present investigation might be due to shading (lack of appropriate light intensities) effect. However, research report is not available in relation to the research lower grain yield under shade was due to the cumulative effect of reduction in the number of effective tillers $hill^{-1}$, number of grains $panicle^{-1}$ and plant height and increase in sterility of panicles, 1000 grain weight. Jadhav (1987) and Chaturvedi and Ingram (1989) have reported similar results.

From the results and aforementioned discussion, it is clear that mono cropping is the best practice for maximum production of t.aman rice irrespective of varieties but in association of tree species, BR11 performed the best with Kalo Koroi. The grain yield found under mango was statistically similar to that of kalo koroi.Hence,we can conclude that early aged mango and kalo koroi orchard may be utilized as a profitable farmland agroforestry practice utilizing BR11.

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