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Hedgerow Intercropping of Pigeonpea in Rainfed Upland Ecosystems of Bangladesh

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Abstract: A field experiment of hedgerow intercropping of pigeonpea with rice and mungbean followed by blackgram and groundnut, respectively, as alley crops was conducted to determine the effect of hedgerow crop on the yield of alley crops, the productivity of hedgerow crop and its contribution to the alley crops. Alley cropping of rice-blackgram and mungbean-groundnut crop sequences with 1.5 and 2.5 m hedgerow distance of pigeonpea along with sole cropping sequences were evaluated. Grain yield of all crops were affected by hedgerow intercropping systems. Significantly highest rice equivalent yields and gross returns were obtained by hedgerow intercropping systems with 2.5 m hedgerow distance for both the crop sequences in both 1995 and 1996. The highest gross margin and the highest benefit-cost ratio (BCR) were resulted from hedgerow intercropping at 2.5 m distance with rice-blackgram crop sequence and the system was found profitable.

Key words: Hedgerow intercropping, alley crop, pigeonpea (*Cajanus cajan* [L.] Mill sp.)

Introduction

Upland ecosystem is characterized by low soil fertility and crop productivity. The cropping intensity of the upland ecosystem is also very low compare to other ecosystems. To improve the upland productivity as well as soil fertility, it is worth to grow two or three crops together either in inter or mixed cropping which can protect crop from total failure due to natural hazards.

The farmers of Bangladesh grow traditional low yielding upland rice cultivar as mono crop following the onset of monsoon under rainfed condition. The subsistence farmers often do not use costly fertilizer and other input for upland rice because of its unstable yield. Inclusion of legume crop in the upland cropping systems is important which provide opportunities for increasing N availability to rice and thus increasing the protein content in human and animal diet (Bhagat *et al.*, 1996; Libboon *et al.*, 1988). Some researchers have also postulated that there is a transfer of nitrogen fixed by the legume to the associated cereals (Frances, 1986; Willey, 1979).

Pigeonpea is a long duration multipurpose upland legume crop which provide protein, fuel and organic nitrogen. It is a nutritious pulse yielding 20.4% protein (Razzaque *et al.*, 1986). But due to its long life cycle farmers do not prefer to grow it as a mono crop. The intercropping of upland rice with pigeonpea (Singh *et al.*, 1991) and mungbean (Khan *et al.*, 1991) were found to be economically more profitable than rice monoculture. But little or nothing is known in Bangladesh about hedgerow intercropping of pigeonpea in upland rice cropping system. Therefore, the present study was undertaken to determine the effect of hedgerow intercropping of pigeonpea on the yield of alley crops and the productivity of hedgerow crop and the total productivity of the upland ecosystem.

Materials and Methods

The experiment was conducted on the upland of BRRI farm, Gazipur in 1995 and 1996 (April to December). Hedgerow intercropping of pigeonpea at two hedgerow distances, 1.5 and 2.5 m, with alley cropping of rice-blackgram and mungbean-groundnut crop sequences along with sole cropping of rice-blackgram and mungbean-groundnut were tested. The experiment was conducted in randomized complete block design. The unit plot size was 8 x 6.5 m^2. The rice variety BR21, mungbean variety Kanti, groundnut variety Dhaka-1 and local blackgram and pigeonpea were used. Number of lines per hedgerow was two having 50 cm between rows. The distances between alley crop rows was 25 cm. Pigeonpea, rice and mungbean were sown on the same day on April 30 in 1995 and on April 28 in 1996. The crops were fertilized with 60-40-40 kg/ha N-P_2O_5-K_2O and 20-40-40 kg/ha N-P_2O_5-K_2O for rice and mungbean, respectively. For mungbean total amount of fertilizers were applied basally and for rice all P_2O_5, K_2O and one third of N were applied basally and the remaining N was topdressed in two equal splits at 15 and 35 days after sowing (DAS). Each topdressing was followed by a hand weeding.

Pigeonpea was clipped twice. First clipping was done at 45 DAS at 30 cm plant height and second clipping was done after harvesting of rice and mungbean at one meter height. Pigeonpea biomass of first clipping was chopped and spreaded on the soil surface of the same plot and biomass of the second clipping was incorporated into the soil.

Rice and mungbean were harvested on August 14 and July 28, respectively, in 1995 and on August 12 and July 25, respectively, in 1996. Blackgram and groundnut were sown within 7 days after harvesting of rice and mungbean, respectively, in both the years. Both the crops were fertilized with 20-40-40 kg/ha N-P_2O_5-K_2O. All the fertilizers were applied basally and normal cultural practices were followed in both the years.

Mungbean, groundnut and pigeonpea were harvested on November 10, December 20 and December 25, respectively, in 1995 and on November 10, December 18 and December 22, respectively, in 1996.

Yields of all crops were recorded at harvest. The rice equivalent yields (REY) were computed by converting yields of mungbean, blackgram, groundnut and pigeonpea into the yield of rice following Singh *et al.*(1993) as follows:

$$\text{REY of the crop} = \frac{\text{Grain yield of the crop (kg/ha)} \times \text{Market price of the crop (Tk/kg)}}{\text{Market price of rice (Tk/kg)}}$$

The REYs were analyzed statistically and the means were compared by the DMRT(Gomez and Gomez, 1983). A simple economical analysis of both sole and hedgerow intercropping systems were done.

Results and Discussion

Grain yields of rice and mungbean were affected by hedgerow intercropping of pigeonpea (Table 1). The highest grain yields were obtained by sole cropping of both rice and mungbean in both the years (Table 1). Similarly grain yields of blackgram and groundnuts were reduced when grown as alley crops after rice and mungbean, respectively. Grain yields were reduced due to sacrifice of rows for hedgerow intercropping of pigeonpea. Moreover, the taller growing pigeonpea shaded the crop canopy grown as alley crops and reduce dry matter partitioning to grain (Moinbasha and Singh, 1988) . It was found that pigeonpea in hedge at 2.5 m distance yielded higher grain than that in 1.5 m distance (Table 1). Although the number of rows per plot was lower in case of

Table 1: Agronomic productivity of hedgerow intercropping of pigeonpea with rice - blackgram and mungbean - groundnut crop sequences in rainfed upland environment, 1995 and 1996, BRRI, Gazipur

Treatment[a] Kharif-I	Early Rabi	Hedgerow distance (m)	Grain yield (t/ha) 1995 BR21/MB	BG/GN	PP	REY[b]	1996 BR21/MB	BG/GN	PP	REY
BR21-	BG	No hedgerow	2.86	0.64	-	4.67d	2.67	0.69	-	4.60d
BR21-	BG	1.5	2.33	0.04	1.26	5.23c	2.13	0.12	1.35	5.44c
BR21-	BG	2.5	2.44	0.42	1.64	7.32b	2.35	0.53	1.59	7.33a
MB-	GN	No hedgerow	0.86	1.05	-	7.01a	0.81	1.02	-	6.71b
MB-	GN	1.5	0.67	0.09	1.28	5.80c	0.61	0.07	1.31	5.56c
MB-	GN	2.5	0.69	0.44	1.61	7.79b	0.65	0.38	1.55	7.30

[a]Figures in the column followed by common letter are not significantly different at 5 % level by DMRT
[a] BG = Blackgram, MB = Mungbean, GN = groundnut and PP = pigeonpea
[b]Rice equivalent yield was computed based on the farmgate price of rice = 5.00 Tk/kg, mungbean = 20.00 Tk/kg, blackgram = 14.00 Tk/kg, groundnut = 17.00 Tk/kg and Pigeonpea = 11.00 Tk/kg.

Table 2: Economic productivity of hedgerow intercropping of pigeonpea with rice-blackgram and mungbean-groundnut crop sequences in rainfed upland environment, 1995 and 1996, BRRI, Gazipur

Treatment Kharif-I-	Early rabi	Hedgerow distance(m)	Economic productivity 1995 Gross-retun ('000Tk/ha)	Variable cost ('000 Tk/ha)	Gross margin ('000 Tk/ha)	BCR	1996 Gross retun ('000 Tk/ha)	Variable cost ('000 Tk/ha)	Gross margin ('000 Tk/ha)	BCR
BR21-	BG	No hedgerow	23.25	16.28	6.97	1.43	23.00	16.78	6.22	1.37
BR21-	BG	1.5	26.15	17.04	9.11	1.53	27.20	17.75	9.45	1.53
BR21-	BG	2.5	36.60	17.04	19.56	2.15	36.65	17.75	18.90	2.06
MB-	GN	No hedgerow	35.05	25.33	9.72	1.38	33.55	26.10	7.45	1.29
MB-	GN	1.5	29.01	26.08	2.93	1.12	27.80	27.30	0.50	1.02
MB-	GN	2.5	38.95	26.08	12.87	1.49	36.50	27.30	9.20	1.34

Table 3: Yield components of pigeonpea as hedgerow in the hedgerow intercropping with rice -blackgram and mungbean-groundnut crop sequences in rainfed upland environment, 1995 and 1996, BRRI, Gazipur

Treatment Kharif-I-	Early Rabi	Hedgerow distance (m)	Yield components of pigeonpea 1995 Plant/m^2 (no.)	Pods/plant (no.)	Seed/pod (no.)	100-seed wt(g)	1996 Plant/m^2 (no.)	Pods/plant (no.)	Seed/pod (no.)	100-seed wt (g)
BR21-	BG	No hedgerow	-	-	-	-	-	-	-	-
BR21-	BG	1.5	17.2	69.6	3.2	8.9	18.0	68.5	3.2	9.0
BR21-	BG	2.5	16.6	88.2	3.0	8.9	16.5	85.3	3.1	8.9
MB-	GN	No hedgerow	-	-	-	-	-	-	-	-
MB-	GN	1.5	17.4	68.3	3.1	8.7	17.8	67.9	3.1	8.9
MB-	GN	2.5	16.4	89.7	3.2	9.1	16.2	84.8	3.1	8.7

Table 4: Nitrogen yield of mungbean, blackgram, groundnut and pigeonpea top cutting in the hedgerow intercropping systems under rainfed upland environment, 1995 and 1996, BRRI, Gazipur

Treatment Kharif-I-	Early Rabi	Hedgerow distance (m)	Nitrogen yield (kg/ha) 1995 MB	PP	BG	GN	Total	1996 MB	PP	BG	GN	Total
BR21-	BG	No hedgerow	-	-	12.5	-	12.5	-	-	12.7	-	12.7
BR21-	BG	1.5	-	25.3	0.9	-	26.2	-	23.1	1.1	-	24.2
BR21-	BG	2.5	-	23.2	8.2	-	31.4	-	21.5	9.5	-	31.0
MB-	GN	No hedgerow	18.7	-	-	21.3	40.0	17.5	-	-	22.2	39.7
MB-	GN	1.5	15.6	25.3	-	1.7	42.6	15.0	23.5	-	1.5	40.0
MB-	GN	2.5	16.7	27.0	-	7.8	51.5	16.2	24.7	-	6.5	47.4

2.5 m hedgerow distance, the higher grain yield might be attributed to more number of pods per plant (Table 3).

Significantly highest REY and gross return was obtained by hedgerow intercropping systems with 2.5 m distance for both rice-blackgram and mungbean-groundnut crop sequences in both 1995 and 1996 (Table 1 & 2). The highest gross margins was resulted from hedgerow intercropping at 2.5 m hedgerow distance with rice-blackgram alley crop, in both 1995 (TK.19560/ha) and in 1996 (TK.18900/ha) which was followed by mungbean-groundnut crop sequence with same hedgerow distance (TK.12870/ha) in 1995 and rice-blackgram crop sequence with 1.5 m hedgerow distance (TK.9450/ha) in 1996 (Table 2). The highest BCR (2.15 and 2.06, respectively, in 1995 and 1996) was resulted from hedgerow intercropping at 2.5 m hedgerow distance with rice-blackgram alley crops. Similarly higher REY, gross margin and BCR were obtained by intercropping of pigeonpea with rice-blackgram crop sequence than sole cropping (Mollah *et al.*, 1997) and hedgerow intercropping of pigeonpea with rice-blackgram and mungbean-blackgram crop sequences than respective sole cropping (BRRI, 1998). The lowest REY, gross return and gross margin were resulted from sole cropping of rice followed by mungbean in both the years.

Nitrogen yields of mungbean, blackgram, groundnut and pigeonpea top cuttings are presented in Table 4. Among the different cropping systems, mungbean followed by groundnut with 2.5 m pigeonpea hedgerow distance added the highest amount of nitrogen (51.5 and 47.4 kg/ha) in to the soil which was followed by the same cropping sequence with 1.5 m hedgerow distance in both the years. In rice-blackgram crop sequence hedgerow intercropping with 2.5 m distance added the highest amount of nitrogen.

Considering the gross margin, BCR, soil health, farmers diversified need for cereal starch and legume protein, it may be concluded that hedgerow intercropping of pigeonpea with rice followed by blackgram at 2.5 m hedgerow distance is a profitable cropping system for rainfed upland ecosystem of Bangladesh and the system may be recommended for the farmers of this ecosystem.

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