J. Agrofor. Environ. 5 (1): 55-58, 2011 ISSN 1995-6983

Performance of crops during hedge establishment period of alley cropping

S. Basak, M.A. Mondol, M.K. Ibrahim, M.O. Sharif, and M.A. Wadud
Department of Agroforestry, Bangladesh Agricultural University, Mymensingh-2202
E-mail: awadudaf@yahoo.com

Abstract: A field experiment was conducted at the Agroforestry Farm of Bangladesh, Agricultural University, Mymensingh, during the period from July 2010 to March 2011 to know the existing fertility status, to establish the hedgerow for alley cropping and to evaluate the performance (growth and yield) of maize, soybean, and wheat during hedge establishment period of alley cropping. Existing soil fertility status of the study field was very low. It was estimated in SRDI research laboratory. Existing Soil pH, organic matter, N, P, K, S and Zn were estimated. Average Soil pH, Organic matter, N, P, K, S and Zn were 5.28, 0.58%, 0.57%, 11.81 ppm, 13.58me/100 g soil, 7.22 ppm and 2.9 ppm, respectively. Hedge for alley cropping was successfully established using Ipil-ipil *(Leucaena leucocephala)*, Bakphul (*Sesbania grandiflora*), Minjiri (*Cassia siamea)* and Grilicidia (*Grilicidia sepium*) tree species. Distance between two hedgerows was 12 ft. During hedge establishment period maize, wheat, tomato, red amaranth and soybean were cultivated in the alley of hedgerow species using three different treatments. Treatments were T_1 (with recommended fertilizer), T_2 (with manure) and T_3 (without fertilizer and manure). The experiment was laid out in a Randomized Complete Block Design (RCBD) with 3 replications. The result of the experiment was revealed that the yields of all crops were statistically similar in the fertilizer and manure utilized plots. Yields in plots without manure and fertilizer application plots were very low and it reduced 40-45% compared to manure and fertilizer utilized plots. Due to low fertile condition yields of all crops were low compared to fertilizer and manure utilized plot. So, alley cropping system will be helpful for fertility development as organic way. Future fertility analysis status of manure and fertilizer utilized plots will confirm the benefits of alley cropping or organic farming.
Key words: Alley cropping, hedgerow, soybean, maize, wheat, agroforestry

Introduction

Agroforestry, the integration of tree and crop or vegetable on the same area of land is a promising production system for maximizing yield and maintaining friendly environment (Nair, 1990). Vegetables are grown in Bangladesh throughout the year but the production is not sufficient. The demand for vegetable is increasing but the area under vegetable production is decreasing. Unfortunately these limited areas are decreasing due to increasing the area of Boro rice and wheat in winter season. On the other hand, a country needs 25% of forest land of its total area for ecological stability. So, the effective area of forest (5.4) in Bangladesh is neither in a position to fulfill the requirements of the people's fuel and timber nor to stabilize the climatic condition. Under these circumstances it is necessary to find out a suitable alternative to overcome this situation. Since there is no scope for expanding forest area and sole grain crops area. The 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.

Alley cropping is an agroforestry system for food production involving growing of arable crops in spaces (alleys) between hedgerows of plated fallows of woody shrubs or trees, preferably leguminous species. The fallow species are periodically pruned during the companion crops. Alley farming also reduces soil temperature which increase microbial activities as well as increase organic matter supply to the soil by increasing mineralization rate. Alley cropping is a good option for partially degraded, unfertile and medium high land. Organic farming is the form of agricultural that relies on crop rotation, green manure, compost, biological pest control, and mechanical cultivation to maintain soil productivity and control pests, excluding or strictly limiting the use of synthetic fertilizers and synthetic pesticides, plant growth regulators, livestock antibiotics, food additives, food additives, and genetically modified organisms. *Leucaena leucocephala*, *Gliricidia sepium*, *Cassia siamea* and *Sesbania grandiflora* are the nutrient-efficient trees for alley cropping.

Some of the beneficial effects that have been claimed for alley cropping include: improved crop performance due to the addition of nutrients and organic matter to the soil/plant system a reduction of the use of chemical fertilizers, improve the physical nature of the soil environment, the addition of mulch can lower soil temperatures, reduce evaporation, improve soil fauna activity and soil structure resulting in better infiltration, reduced runoff and improved water use efficiency on sloping land, the tree rows act as a physical barrier to soil and water movement, resulting in significant reductions in erosion losses (Paningbatan, *et al.* 1989), the provision of additional products such as forage, firewood or stakes when a multipurpose tree legume is used as the hedgerow.

For the reclamation of partially degraded unfertile land alley cropping as organic farming can be suitable in Bangladesh. So it is necessary to examine the efficiency as organic farming of this promising agroforestry system in Bangladesh. In view of the current national and international interest on organic farming for safe environment it is needed to assess suitability of alley cropping as organic farming. For alley cropping management species selection for hedgerow, hedgerow establishment and hedgerow management are necessary requirement. After establishment of hedgerow crop can be cultivated as organic farming system.

Materials and Methods

The experiment was carried out at the experimental farm, Department of Agroforestry, Bangladesh Agricultural University, Mymensingh, during the period from July 2010 to March 2011. The place is geographically located at about 24°75" North latitude and 90°50' East longitudes (FAO, 1988). In this study four trees species were used for hedge establishment viz. Ipil-ipil (*Leucaena leucocephala*), Minjiri (*Cassia siamea*), Bakphul (*Sesbania grandiflora*)

and Gliricidia (*Gliricidia sepium*). Three different crops were used as study species and these were: soybean, maize and wheat. Each crop was laid out using the Randomized Complete Block Design (RCBD) with single factorial arrangement with three replications as separate experiment. Individual plot size was 12ft x 8ft = 8.92 m^2. Three treatments were used in this study. For every experiment treatments were as; T_1 = with recommended fertilizer; T_2 = with manure and T_3 = without fertilizer and manure. For alley cropping hedge establishment is the first requirement. The distance between hedgerows of each species was 12 feet. Total 12 rows were prepared for planting seeds/plant materials of the selected species. During July 2010, along the rows soil were prepared for sowing plant materials and 15th July plant materials of all species (seeds for ipil-ipil, minjiri and bakphul; cuttings for gliricidia) were planted. Before crop cultivation soil sample were collected from each alley. At first five soils sample were collected from each plot and made sixty soil samples. After this soil sample was analyzed in SRDI laboratory. The experimental land was first opened on 15 October 2010 and the operation was done by spade. Then the land was fallow for few days. All crop residues and weeds were removed from the field and finally the land was properly leveled. The seeds of Ipil-ipil (*Leucaena leucocephala*), Minjiri (*Cassia siamea*), Bakphul (*Sesbania grandiflora*) and Gliricidia (*Gliricidia sepium*) were line sown in the hedge line of experimental plot on 15 September 2010. The seeds were sown continuously 30 cm apart lines. Soybean, maize and wheat seeds were sown in the experimental plot on 15 November 2010 by hand dibbling method at a depth of 4-5 cm maintaining the spacing of 15 x 15 cm from plant to plant. Plant samples of soybean, maize and wheat were collected randomly from all rows of the respective plots. Ten representative sample plants were selected from each plot for data collection, in case of soybean, plant height, number of pods $plant^{-1}$, number of seeds pod^{-1}, number of seeds $plant^{-1}$ and yield (t ha^{-1}); in case of maize, the parameter such as plant height, number of cobs per plant, seeds cob^{-1} and yield (t ha^{-1}) and in case of wheat, plant height, spike length, number of sterile spike lets, number of seeds per tiller and yield (t ha^{-1})were recorded at the final harvesting period. The collected data were analyzed statistically by using PC M-STAT software package to find out the statistical significance of the experimental results. The means for all the treatments and analysis of variance of all the characters were calculated by Duncan's Multiple Range Test (DMRT).

Results and Discussion

Fertility status of existing soil of experimental plot: Before crop cultivation soil samples were collected from field and all the soil samples were analyzed in the SRDI Research laboratory. Analyzed results were presented in the Table 1. Existing soil pH, Organic matter, Nitrogen, Phosphorus, Potasium, Sulphur, Zink were determined. Average soil pH, Organic matter(%), Nitrogen (%), Phosphorus (ppm), Potasium (me/100g soil), Sulphur (ppm), Zink (ppm) were 5.28, 0.58, 0.57, 11.81, 13.58, 7.22 and 2.98, respectively. This indicates that the initial fertility status was very low.

Table 1. Existing soil fertility status of experimental plot

Alley No.	pH	Organic matter	N (%)	P (ppm)	k me /100 g S (ppm)		Zn (ppm)
1	4.7	0.32	0.075	12.9	13.5	7.5	2.6
2	5.1	0.5	0.078	11.2	11.34	7.2	3
3	5.3	0.45	0.012	10	12.45	7.1	3.2
4	4.6	0.52	0.068	13.2	12.3	7.8	2.9
5	5.5	0.6	0.075	13	13.9	6.9	3.1
6	6	0.82	0.058	11.6	13.5	7.5	2.4
7	5.5	0.6	0.078	10.6	14.6	7.2	2.8
8	5.3	0.78	0.062	12.5	16	6.9	3.5
9	5.5	0.6	0.06	10.6	13.6	7.2	2.8
10	5.3	0.58	0.072	12.5	14	6.9	3.5
Mean	5.28	0.58	0.57	11.81	13.58	7.22	2.98

Hedge establishment: Hedge development was the primary requirement for alley cropping. In this experiment hedges were establish using Ipil-ipil (*Leucaena leucocephala*), Bakphul (*Sesbania grandiflora*), Minjiri (*Cassia siamea*) and Grilicidia (*Grilicidia sepium*). Total 12 alleys were developed maintaining 12 feet distance between the two hedgerows. Planting materials of these species were sown in the month of September 2010. Crops of selected species were cultivated in the beginning of November 2010. Necessary intercultural operation (weeding, thinning, irrigation and pest management) were done from September to October for hedge plants. Before the crop cultivation time average plant height of ipil-ipil, bakphul, minjiri and gliricidia were 25, 28, 16 and 18 cm, respectively (Table 2). After the cropping season average plant height of ipil-ipil, bakphul, minjiri and gliricidia were 45, 50, 38 and 41 cm, respectively (Table 2). These results indicate that due to short plant height there was no shading effect on crops to the alleys by the hedge plant.

Table 2. Hedge status before and during cropping season

Hedge plant species	Planting/sowing date	Plant height before cropping (cm)	plant height after cropping season (cm)
Ipilipil	15-Sep	25	45
Bakphul	15-Sep	28	50
Minjiri	15-Sep	16	38
Gliricidia	15-Sep	18	42

Morphological characters of crops and vegetables during hedge establishment period

Soybean: Different treatment significantly influenced the Morphological characters of soybean (Table 3). Plant height, number of leaves per plant, number of pods/plant, number of seeds per pod, and number of seeds per plant were significantly lower in without manure and fertilizer treated plot and the value were 30cm, 15, 30, 2, and 60, respectively. This lower yield may be due to low fertile condition similar result also observed by Ali (1998), in case of Mungbean. Highest Plant height, number of leaves per plant, number of pods per plant, number of pods/plant, number of seeds per pod, and number of seeds per plant were observed in the recommended fertilizer treated condition and the value were 67 cm, 30, 62, 4 and 250, respectively. This higher yield may be due to optimum use of chemical fertilizer and similar result also observed by Tanni (2010). Statistically similar Plant height, number of leaves per plant, number of pods per plant, number of pods/plant, number of seeds per pod, and number of seeds

per plant was found in the manure treated condition and the value were 65 cm, 28, 60, 4 and 240, respectively, similar result also observed by Satish *et al.* (2003).

Maize: Morphological characters of Maize were significantly influenced by the different treatment (Table 3). Plant height, number of leaves per plant, cob length, number of cobs/plant and weight of seeds per plant were significantly lower in without manure and fertilizer treated plot and the value were 100cm, 14, 9cm, 4, and 0.21kg, respectively. This lower value may be produced due to low fertile condition similar result also observed by Ali (1998), in case of Mungbean. Except Plant height highest number of leaves per plant, cob length, number of cobs/plant and weight of seeds per plant were observed in the manure treated condition and the value were 21, 18cm, 10 and 0.72kg, respectively. Relatively taller plant (156cm) was found in chemical fertilizer treated condition. This higher value of morphological characters of maize may be due to use of cow dung as organic fertilizer, may be maize grow in organic fertilizer treated condition. Statistically similar number of leaves per plant, cob length, number of cobs/plant and weight of seeds per plant was found in the chemical fertilizer treated condition and the value were 20, 17cm, 9 and 0.71kg, respectively.

Table 3. Morphological characters of soybean, maize and wheat in the alley during hedge establishment period

Treatments	Soybean					Maize					Wheat				
	Plant height (cm)	No. of leaves / plant	No. of pods / plant	No. of seeds / pod	No. of seeds / plant	Plant height (cm)	No. of leaves / Plant	Cob length (cm)	No. of cob / plant	weight of seed / plant (kg)	Plant height (cm)	No. of tiller/ plant	Spike length (cm)	No. of spikelet / plant	Wt. of 1000 seeds
With fertilizer	67 a	30 a	62 a	4 a	250 a	156 a	20 a	17 a	9 a	0.71 a	95 a	5 a	10 a	45 a	32 a
With manure	65 a	28 a	60 a	4 a	240 a	150 a	21 a	18 a	10 a	0.72 a	92 a	5 a	9.5 a	44 a	33 a
Without fertilizer and manure	30 b	15 b	30 b	2 b	60 b	100 b	14 b	9 b	4 b	0.21 b	45 b	2 b	5 b	20 b	18 b
LSD at 5%	2.75	2.36	2.12	2.28	0.94	1.72	2.65	9.82	0.01	5.3	0.76	0.72	1.64	6.1	0.92
CV (%)	7.51	6.39	9.84	10.53	6.67	7.74	3.6	7.32	13.61	12.12	9.88	8.95	8.54	18.12	4.51

Figures in a column having common letters do not differ at 5% level of significance, CV% = Coefficient of variation

Wheat: Morphological characters of wheat were significantly influenced by the different treatments (Table 3). Plant height, number of tiller per plant, spike length, number of spike lets/plant and weight of 1000 seeds were significantly lower in without manure and fertilizer treated plot and the value were 45cm, 2, 5cm, 20, and 18g, respectively. This lower value may be produced due to low fertile condition similar result also observed by Ali (1998), in case of Mungbean. Taller plant, maximum number of tiller per plant, spike length, and number of spike lets/plant were observed in the chemical fertilizer treated condition and the value were 95cm, 5, 10cm and 45, respectively. Statistically similar Plant height, number of tiller per plant, spike length and number of spike lets/plant was found in the manure treated condition and the value were 92cm, 5, 9.5cm and 44, respectively. Big sized spike lets was found in manure treated condition.

Though the morphological characters of soybean, maize and wheat were statistically similar both in chemical fertilizer and manure treated condition but the sustainability of production will be more in manure treated condition this will be confirm by next soil analysis report.

Yield: Like morphological characters of soybean, maize and wheat yield also significantly influenced by the different treatments (Fig. 1). Lowest yield recorded in without chemical fertilizer and manure treated condition and the value was 1.5, 1.5 and 1.3 t/ha for soybean, maize

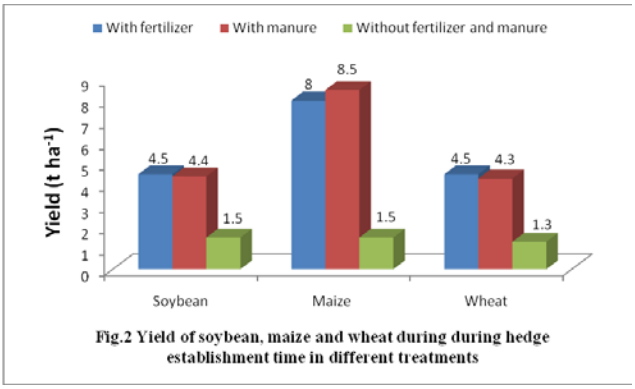

Fig.2 Yield of soybean, maize and wheat during during hedge establishment time in different treatments

and wheat, respectively. Statistically similar yield was found in both manure and chemical fertilizer treated. Though numerically higher yield obtained in chemical fertilizer treated condition but sustainability of soybean, maize and wheat production using chemical fertilizer will be very low this will confirm by next subsequent two or three season soil analysis report. Oswald *et al.* (1994) reported similar result in sweet potato where using manure production was more sustainable than chemical fertilizer.

The result of the experiment revealed that the yields of all crops were statistically similar in the fertilizer and manure utilized plots. Yields in the without manure and fertilizer utilized plots were very low and it reduced 40-45% compared to manure and fertilizer utilized plots. Due to low fertile condition yield all crops were low compared to fertilizer and manure utilized plot. So, alley cropping system will be helpful for fertility development as organic

way. Future fertility analysis status of manure and fertilizer utilized plots will confirm the benefits of alley cropping or organic farming.

References

Ali, M.A. 1998. Growth and yield of mungbean genotype under sun and shade condition. M.S. Thesis, BSMRAU, Gazipur, Bangladesh.

FAO. 1988. Tropical forestry resources assessment project (GEMD): Tropical Africa, Tropical Asia, Tropical America (4 Vol.), FAO/UNDP, Rome.

Nair, P.K.R. 1990. An introduction to agroforestry. Kluwer Academic publishers, ICRAF.

Oswald, A., Alkamper J. and Midmore, D.J. 1994. The effect of different shade level on growth and tuber yield of sweet potato. J. Agron. Crop Sci. 173(1): 41-52.

Paningbatan, Preseglove J.W., Brown,E.G.,Green, C.L. Robbins, S.R.J. 1989.Spices.Longman Scientific and Technical,John Willey and Sons,Inc., New York.p.117.

Satish, K., Pannu, R.K., Kadinn, V.S. and Mumar, S. 2003. Effect of shade duration on wheat varieties. Ann. Biol. 19(1): 17-20.

Tanni, A.D. 2010. Influence of *Zylia dolabiformis* on the growth and yield of four winter crops. M.S.Thesis, BAU. Mymensingh, Bangladesh.