Environment & Ecology 27 (4) : 1507—1510, 2009
 ISSN 0970-0420

Evaluation of Gamhar *(Gmelina arborea)*—Based Agroforestry Model under Red and Lateritic Tract

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Abstract

Field experiments were conducted during the *kharif* seasons of 2005 and 2006. Four intercrops viz., rice, cowpea, groundnut and blackgram were grown between the row spaces of 14 years aged gamhar plantation to study their growth and productivity and their effect on the growth of tree. Results revealed that the maximum yield was recorded with rice (1.97 t/ha) followed by cowpea (1.03 t/ha) and groundnut (0.69 t/ha) while the lowest yield was obtained with blackgram (0.46 t/ha). However, the return from the crop was highest (Rs 13,800 per ha per year) with blackgram or groundnut. Lowest return was recorded from cowpea followed by rice. Height, dbh and volume yield of gamhar were influenced due to intercropping with legume intercrops (blackgram, groundnut and cowpea).

Key words : *Gmelina arborea,* Intercrops, Growth attributes, Yield, Volume yield.

Agroforestry is an important land use system to meet not only the food, fodder and wood requirement but also to protect the earth from degradation hazards (Agbor and Ebanor 1989). Research work carried out in India and abroad reveals that gamhar *(Gmelina arborea)* tree could be a promising tree species in the agroforestry system particularly in the red and lateritic tract of West Bengal. Gamhar, also known locally as Gamari or White teak is a close relative of teak. Being a strong light demander, it regenerates naturally. The tree coppices well and coppice shoots grow vigorously. It also retums substantial amount of nutrients to the soil, thereby minimizing the nutrient losses to a great extent and contributing to soil productivity (Datta and Dhiman 2001). Under West Bengal condition information on performance of gamhar under intercropping system is meager. The present study was therefore undertaken to evaluate the growth performance of gamhar tree with or without intercrops.

Methods

The experiment was conducted during the *kharif* season of 2005 and 2006 at Regional Research Station (red and laterite zone), Bidhan Chandra Krishi Viswavidyalaya, Jhargram, Paschim Medinipur, West Bengal (22.5^0 N latitude and 87.0^0 E longitude and at an elevation of 78.77 m above mean sea level) under sub-humid sub-tropical climate. Four intercrops viz.,

Table 1. Growth attributes of *Gmelina arborea* grown under sole and intercropping system (14 year old gamhar plantation).

Treatments	Tree height (m)		Bole height (m)		Diameter at breast height (cm)		Volume yield (m^3/ha/year)	
	Dec 2005	Dec 2006	Dec 2005	Dec 2006	Dec 2005	Dec 2006	Dec 2005	Dec 2006
T_1 = Gamhar + rice	6.75	7.34	5.88	6.54	14.26	15.70	3.07	4.05
T_2 = Gamhar + cowpea	7.70	8.27	6.85	7.46	15.12	16.22	3.94	4.87
T_3 = Gamhar + groundnut	7.75	8.30	6.97	7.60	15.16	16.54	3.99	5.09
T_4 = Gumhar + blackgram	7.82	8.35	6.99	7.75	15.55	16.78	4.24	5.27
T_5 = Gamhar (sole tree)	6.90	7.40	6.01	6.77	14.40	15.96	3.20	4.22
SE (±)	0.027	0.018	0.017	0.020	0.092	0.119	-	-
CD (P = 0.05)	0.058	0.039	0.036	0.042	0.199	0.258	-	-

Table 2. Growth and yield attributes of different intercrops grown under *Gmelina arborea* plantation during *kharif* season of 2005 and 2006.

Intercrops	No. of plants or hills/m^2		Average plant height (cm)		No. of branches/plant or plants/hill		Pods/plant or grains/panicle		Yield (t/ha)	
	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
Rice	35	37	83.12	89.68	5	7	114	128	1.88	2.06
Cowpea	10	14	252.0	279.4	4	4	12	14	0.95	1.11
Groundnut	13	19	58.22	62.20	3	5	14	16	0.64	0.74
Blackgram	31	33	48.67	53.93	4	6	15	15	0.44	0.48
SE (±)	1.16	1.20	1.91	2.2	0.20	0.23	0.72	0.79	0.06	0.09
CD (P = 0.05)	2.51	2.60	4.12	4.75	0.45	0.51	1.56	1.70	0.15	0.21

rice (var MW 10) , cowpea (var Cowpea 74), groundnut (var JL 24) and blackgram (var B76/Kalindi) were grown between the row spaces of gamhar plantation (14 year old plantation) to study their growth and productivity, and their effect on the growth of tree so as to evaluate the suitable intercrop (s) for gamhar-based agroforestry systems. The experiment was carried out in upland situation where the soils are coarse textured, acidic (pH 4.0–5.0), poor in organic matter, available phosphorus, potassium and lime content and highly susceptible to erosion hazards. The experiment was laid out in a randomized block design with five treatment combinations (T_1 = Gamhar + rice, T_2 = Gamhar + cowpea, T_3 = Gamhar + groundnut, T_4 = Gamhar + blackgram and T_5 = Gamhar or sole tree) and four replications. The gross plot size was 40 m × 25 m. Gamhar trees were planted at spacing of 5 m × 5 m). All the intercrops were sown in the second week of July (after 50% pruning of tree) during *kharif* season of 2005 and 2006. The seed rate, spacing, fertilizer dose and other agronomic management practices of all the intercrops were used based on recommendation during both the years of experiments. Another plot was provided for sole tree only. After harvesting of different intercrops, composite soil samples were collected from the exposed surface of pit at different depths viz., 0—15 cm, 15—30 cm and 30—60 cm from the cropped (both sole intercropping system) and open land and analyzed. The agronomic management practices of all the intercrops were given following recommendation. Growth attributes of gamhar viz. tree height and diameter at breast height (dbh) was recorded and volume yield was calculated measuring the area of the tree or log at the thin end, middle and

Table 3. Soil fertility status after harvest of different intercrops in association with *Gmelina arborea* (After two cycles of cropping). *Figures in parentheses indicate the percentage increment over open land situation.

Treatments	pH	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)
T_1 = Gamhar + rice	5.2	238.3	36.2	147.7
	(15.55*)	(28.60)	(42.51)	(14.40)
T_2 = Gamhar + cowpea	5.7	247.5	36.5	148.2
	(26.67)	(33.56)	(43.70)	(14.79)
T_3 = Gamhar + groundnut	5.5	249.9	37.6	150.2
	(22.22)	(34.86)	(48.03)	(16.34)
T_4 = Gamhar + blackgram	5.6	240.5	36.8	148.2
	(24.44)	(29.78)	(44.88)	(14.79)
T_5 = Gamhar (sole tree)	5.1	237.1	33.1	145.5
	(13.33)	(27.95)	(30.31)	(12.70)
Land without vegetation	4.5	185.3	25.4	129.1
SE (±)	0.05	7.93	1.46	0.92
CD (P = 0.05)	0.10	17.20	3.16	1.99

Table 4. Economic analysis of *Gmelina arborea* based agroforestry system (mean of two years). Selling price : Wood of gamhar—Rs 20,000.00/m^3, rice—Rs 6,000.00/ton, cowpea–Rs 6,000.00/ton, groundnut–Rs 20,000.00/ton and black gram–Rs 30,000.00/ton.

Treatments	Production of wood (m^3/ha/yr)	Production of intercrops (t/ha/yr)	Return from tree (Rs./ha/yr)	Return from crop (Rs./ha/yr)	Total return from crop and tree (Rs./ha/yr)
T_1 = Gamhar + rice	3.56	1.97	71,200.00	11,820.00	83,020.00
T_2 = Gamhar + cowpea	4.40	1.03	88,000.00	6,180.00	94,180.00
T_3 = Gamhar + groundnut	4.54	0.69	90,800.00	13,800.00	1,04,600.00
T_4 = Gamhar + blackgram	4.75	0.46	95,000.00	13,800.00	1,08,800.00
T_5 = Gamhar (sole tree)	3.71	-	74,200.00	-	74,200.00

thick end (in square units) by employing Newton's formula as described by Chaturvedi and Khanna (1982). Yield of different intercrops was calculated after harvesting of each crop. The data collected during both the years of experiments were analyzed following the method of analysis described by Gomez and Gomez (1984).

Results and Discussion

Growth Performance of Gamhar Tree Under Sole and Intercropping Systems

Growth attributes like tree height, diameter at breast height (dbh) and volume yield of gamhar trees were increased gradually with the increasing age of the tree (Table 1). The height of gamhar was observed to be highest when intercropped with blackgram (8.35 m during December, 2006) and lowest with rice (7.34 m during December, 2006). Higher dbh (16.78 cm during December, 2006) was recorded with blackgram and lower (15.70 cm during December, 2006) with rice. Similar trend of result was also found in bole height and volume yield of tree. This finding was corroborated with that of Mahata et al. (1996).

Growth and Productivity of Intercrops

Different biometrical parameters, yield attribute and yield of all intercrops grown under gamhar-based agroforestry system were slightly higher during second year of cropping as compared to first year (Table 2). This may be attributed to the reason that supplementary or complementary relations between gamhar tree and intercrops implies synergistic gains i.e. helps to improve the fertility status of soil resulting in higher intercrop yield. When averaged over two years, rice, cowpea, groundnut and blackgram produced grain yield of 1.97, 1.03, 0.69 and 0.46 t/ha, respectively (mean of two years).

Status of the Soil

Soil samples, collected from both the cropped and open land, were analyzed to study the influence of the different intercrops in association with gamhar on some chemical properties of soil under the agroforestry system (Table 3). Gamhar + cowpea bought about the highest increment of soil pH (5.7) towards neutrality followed by gamhar + blackgram (5.6) and gamhar + groundnut (5.5). Similar result was also obtained by Amara et al. (1996). Gamhar + groundnut resulted in the highest enhancement in available nitrogen content in soil (249.9 kg/ha) followed by gamhar + cowpea (247.5 kg/ha) and gamhar + blackgram (240.5 kg/ha). Similar result was observed in available phosphorus and potassium content. On the other hand, the moderate increase of pH, available N, P and K content in the soil was obtained under sole gamhar plantation. It is also evident that intercropping with legumes imporved the fertility status of the soil. These findings were corroborated with that of Amara et al. (1996).

Economic Return of Gmelina arborea Based Agroforestry System

The economic retum of *Gmelina arborea* based agroforestry system was calculated in terms of the yield of both gamhar tree and intercrops. The pro-

ductivity of the different intercrops varied considerably under gamhar-based agroforestry system (Table 4). The return from the crop per hectare in monetary value was highest with blackgram or groundnut (Rs 13,800.00/ha). Lowest return from the crop/ha was recorded with cowpea (Rs 6,180.00/ha) followed by rice (Rs 11,800.00/ha). This is due to the reason that blackgram and groundnut fetches more market prices (Rs 30/kg and Rs 20/kg, respectively) than cowpea and rice (Rs 6/kg for both the crops). But among different agroforestry systems, gamhar + blackgram based agroforestry system gave maximum return (Rs 108,800.00/ha per year)closely followed by gamhar + groundnut based agroforestry system (Rs 104,600.00/ha per year).

It may be concluded that out of four intercrops blackgram and groundnut were found to be the most suitable intercrops under *Gmelina arborea* based agroforestry system which gave maximum total retum (Rs 104,600.00 and Rs108,800.00/ha per year), besides improving the fertility status of soil.

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