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Growth, Biomass, and Crop Productivity Under Different Tree Spacings of Gmelina Arborea in Agrisilviculture System

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ABSTRACT

A study of agrisilviculture system comprising Gmelina arborea and soybean (Glycine max) was conducted in the Raipur district of Chattisgarh. The total biomass varied from 10.89 Mg ha-1 to 3.65 Mg ha-1 depending on the tree density. Among the different tree components, stemwood contributed maximum biomass (54.3-79.4%), followed by branches and leaves.. No significant difference was observed in the fine root biomass in different stands. Crop (soybean) growth and productivity varied significantly and it increased with a decrease in tree density. Soybean yield varied between 1.5 Mg ha-1 to 2.1 Mg ha-1.

KEYWORDS Agroforestry, competition, multipurpose tree, productivity

Introduction

Gmelina arborea Roxb. is an important moderate fast growing indigenous tree species of humid and subhumid tropics of India. The tree has assumed great importance in both regular plantations and social forestry programmes as it can be economically harvested in 10-12 years . It has also been planting by farmers under agrisilviculture system with crops like soybean, sunflower and other pulse crops.

Trees in managed system also have a great potential to complement crops by providing partial shade, protecting from direct insolation and strong winds. Whereas, there is a tacit assumption that the shallow rooted trees can compete with associated crops through their root systems, and this may lead to yield depressions and may contribute to the economic failure of land-use-system (Schroth et al. 1995). The planting geometry of trees influences the distribution and biomass .. Thus the present work was an initiative to study the biomass (above- and below- ground) and to study the effects of G. arborea trees on the productivity of soybean (Glycine max) crop.

Materials and methods

Study area

The study was conducted in Raipur situated in Chhattisgarh plains in central India at 21012' N latitude and 81036' E longitude (298.1 m asl). Chhattisgarh plain is one of the largest agroclimatic zones of Chhattisgarh region with hardly 20 per cent of forest cover, of which 50 per cent is either poorly stocked and open or degraded in nature (FSI 1997). The study area is characterised by vertisol soil, which is black deep clayey having fine texture, sticky in nature with angular blocky structure. The soils are low in organic carbon (0.3 %) and available nitrogen (0.013 %); medium in potash (0.9 %) and phosphorus (0.002 %) and pH ranged from 6.5 to 7.0 (Puri et al. 2002). Crop growth parameters (plant density/m2, height, above- and below- ground biomass and nodulation) were recorded after sixty days of establishment. Seed yield and its related parameters were recorded at the time of harvesting (November). .

Results

Stand characteristics and above ground biomass

The dbh of the trees in all stands ranged from 2.1 to 5.0 cm and height from 2.2 to 4.1 m (Table 1). Number of trees falling in different diameter classes was variable. In 2 x 2 m and 2 x 5m spacings most trees belonged to dbh class II (3.1-4.0 cm), whereas the small trees were most common in 2 x 3 m spacing. In the 2 x 4 m spacings dbh class III was the most common. Tree growth measurements showed non significant differences between different stands except for crown length (Table 2). In general, growth in 2 x 2 m stand was numerically higher than trees in other spacings (2 x 3 m, 2 x 4 m and 2 x 5 m). Component wise above ground biomass estimates in different spacings showed that stem biomass varied significantly, whereas branch and foliage biomass differences were not significant (Table 3). Stem biomass was six times more in 2 x 2 m spacing as compared to 2 x 5 m spacing. Similarly, branch and foliage biomass were two times higher in 2 x 2 m spacing. Total above ground biomass was significantly four times higher in close spacings (2 x 2 m) compared to wider density plantations (2 x 5 m). The stem wood contributed a maximum of 78 per cent, while branch wood and foliage contributed 14 and 8 per cent respectively for the above ground biomass (Table 3).

Crop density and above ground biomass in the soybean crop varied significantly under different densities of Gmelina stands. However, plant height, below ground biomass, nodule number and nodule weight differences were not significant (Table 4). Crop density was found to be 20 per cent less in 2 x 2 m spacing when compared with wide spacings (2 x 4 m and 2 x 5 m). Total shoot biomass was maximum in control and decreased with an increase in tree density. A decrease of 36.6 per cent was observed in 2 x 2 m stand. Yield parameters showed that the number of pods per plant and crop yield showed significant variations, while seed weight per plant was found to be not significant . Yield reductions in 2 x 2 m was found 28.6 per cent as compared to sole crop (control). Number of pods per plant increased with an increase in spacing. Crop yield showed no significant differences between control and the crop grown in 2 x 5 m and 2 x 4 m G. arborea stands

Table 1 : Stand characteristics of four year old Gmelina arborea planted at four different spacings

Spacing (m)	Diameter class (cm)	Mean dbh (cm)	Mean height (m)	Density (trees ha-1)
2 x 2	2.1-3.0 (I)	2.5	2.48	833
	3.1-4.0 (II)	3.5	3.31	1330
	4.1-5.0 (III)	4.5	4.10	337
2 x 3	2.1-3.0 (I)	2.5	2.20	933
	3.1-4.0 (II)	3.5	3.12	583
	4.1-5.0 (III)	4.5	3.45	234
2 x 4	2.1-3.0 (I)	2.5	2.57	333
	3.1-4.0 (II)	3.5	3.45	416
	4.1-5.0 (III)	4.5	3.80	501
2 x 5	2.1-3.0 (I)	2.5	2.84	332
	3.1-4.0 (II)	3.5	3.20	534
	4.1-5.0 (III)	4.5	3.45	134

Table 2 : Mean growth characteristics and photosynthetic active radiation (PAR) in four spacings of Gmelina arborea

Spacing (m)	Mean dbh (cm)	Height(m)	No. of branches	Av. Branch length (m)	Clean bole (m)	Crown length (m)	Crown diameter (m)	LAI	PAR (m mol s--1m-2)
2 x 2	3.56	3.12	7.20	1.00	1.61	1.32a	1.22	3.68c	875a
2 x 3	2.90	2.74	5.33	0.70	1.95	0.83b	1.62	2.98ab	950b
2 x 4	3.46	3.16	6.73	0.89	1.93	1.37a	1.16	2.88a	1100c
2 x 5	2.90	2.90	6.86	1.08	1.65	1.35a	1.42	3.05b	1054c
CD at 5%	NS	NS	NS	NS	NS	0.31	NS	0.15	48

Table 3 : Above and below ground biomass (Mg ha-1) of different components in Gmelina arborea stands

Spacing (m)	Above ground biomass				Below ground biomass						Grand	Root :
	Stem wood	Branch	Foliage	Total	Primary laterals	Secondary + tertiary laterals	Tap root	Total coarse root	Fine root	Total	total	shoot
2 x 2	7.14c	1.02	0.83	8.99c	0.746a	0.050	0.623a	1.419a	0.490	1.909a	10.89	0.21a
2 x 3	2.79b	0.67	0.42	3.88b	0.342b	0.036	0.836b	1.214b	0.282	1.496b	5.37	0.33a
2 x 4	2.22ab	0.41	0.24	2.87ab	0.345b	0.032	0.509c	0.886c	0.476	1.362c	4.23	0.48b
2 x 5	1.19a	0.42	0.58	2.19a	0.375c	0.030	0.713d	1.118d	0.351	1.469d	3.65	0.67c
CD at 5%	1.06	NS	NS	1.11	0.024	NS	0.038	0.031	NS	0.035	-	0.12

Means followed by the same letter within a column are not significantly different by DMRT. CD = Critical difference.

Table 4 : Growth, biomass and yield characters of soybean (Glycine max) crop grown as intercrop

Spacing (m)	Density (m2)	Plant height (cm)	Above ground biomass (Mg ha-1)	Root biomass (Mg ha-1)	No. of nodules per plant	Nodules weight (g)	No. of pods/plant	Seed weight/plant (g)	Yield (Mg ha-1)
2 x 2	25.80a	52.5	2.04a	0.90	26.4	0.06	42.2a	5.88	1.50a
2 x 3	28.06a	53.2	4.77b	0.10	38.4	0.08	47.2a	5.54	1.55a
2 x 4	30.78ab	51.6	4.94b	0.11	39.4	0.16	56.5b	6.11	1.88b
2 x 5	32.45b	48.2	4.87b	0.10	34.5	0.11	64.7c	6.48	2.10b
Control (Sole Crop)	32.52b	51.2	5.58bc	0.12	41.2	0.14	65.5c	6.46	2.10b
CD at 5%	2.54	NS	0.62	NS	NS	NS	5.1	NS	0.32

Means followed by the same letter within a column are not significantly different by DMRT. CD = Critical difference.

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