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Research Article

Carbon sequestration potential of tree borne oilseeds for dryland areas of Karnataka

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Abstract : A field experiment was carried out at Regional Agricultural Research Station, Bijapur (Karnataka) during 2004 to 2010 to evaluate the carbon sequestration potentials of different tree borne oil (TBO's) seed tree species in drylands of northern dry zone of Karnataka. Results of the study indicated that, among six TBO's, the total biomass production was highest in *Azadirachta indica* (18.43 t ha^{-1}, 43.63 t ha^{-1}, 57.52 t ha^{-1}, 58.06 t ha^{-1}, respectively during these years)) with a carbon sequestration potential of 9.22 t ha^{-1}, 21.82 t ha^{-1}, 28.76 t ha^{-1} and 29.03 t ha^{-1}, respectively during 4^{th}, 5^{th}, 6^{th} and 7^{th} year of planting followed by *Simarouba glauca* and *Pongamia pinnata.* Hence, considering all these parameters, it may be inferred that TBO's *viz., Pongamia pinnata, Simarouba glauca,* and *Azadirachta indica* species are the most promising to fast growing nature which are suitable to grow in shallow black soils of northern dry zone of Karnataka under rain fed situation (annual rainfall 594 mm) with higher potentials of carbon trading.

Key Words : Carbon sequestration, TBO's, Dryland, Biomass

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INTRODUCTION

In context of fossil fuel crises and its high price in India, option of using tree borne oil seeds (TBO's) gained importance looking to their renewable, biodegradable and environmentally safety nature (Parthiban *et al.,* 2009). The country has vast potential of more than 50 lakh tones of tree borne oilseeds (TBO's). However, only 8-10 lakh tones is being collected resulting in 1.5 to 2.0 lakh tones of oil from tree origin resources. The diverse agro-climatic conditions of the country are favourable for growing all the tree borne oilseeds. There are ten agro-climatic zones in Karnataka, out of which five are classified as dry zones. Northern dry zone is the largest of all the zones in the state of Karnataka and second largest zone in the country which occupies an area of 4.19 million hectares (m ha) and out of which only 6.6 per cent is under forests and rest of the area is under arable crops or fallow. The dryland ecosystems of north Karnataka lie in typical semi arid environment with an annual rainfall of 594 mm occurring in 39 rainy days which is highly erratic and ill distributed resulting in frequent droughts. The track consists of vertisols to the tune of 80 per cent which are further classified as deep soils, medium deep and shallow soils. The unscientific management of soil resources and uneven nature of the terrain have lead to conversion of the shallow soils in to denuded soils which have become either unproductive or under productive. The dryland ecosystems are devoid of required cover of perennial vegetation

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to maintain ecological balance. All these conditions have aggravated the status of land quality in terms of soil, water and vegetation resources of the tract. Hence, there is urgent need of incorporating the perennial vegetation in shallow soil ecosystems to bring sustainability in terms of ecological conservation and economic returns. Trees included in dry land ecosystems not only conserve the ecology but also adds to farmers economic returns in terms of its tangible benefits. With increasing awareness of carbon trading, it is attracting the researchers, planners and farmers as an important economic source to the farmers in the days to come. Looking to the importance of planting tree species in drier areas with respect to current global carbon trading demand, evaluation of carbon sequestration potentials of different TBO's under dry land ecosystems is highly valued. Keeping these points in view, the present investigation was carried out to evaluate the carbon sequestration potentials of different TBO's for dryland areas of Karnataka.

EXPERIMENTAL METHODS

The field experiment was carried out at Regional Agricultural Research Station, Bijapur (Karnataka) during 2004 to 2010. The soils of the experimental site were analyzed for various physico-chemical properties (Sand 25%, Silt 23 %, Clay 52%, bulk density 1.43 g/cc, pH- 8.5, EC- 0.34 dSm^{-1}, $CaCO_3$ 18.5 per cent and soil depth 30-35 cm). The average rainfall of the site is 585 mm with 39 rainy days. Hence, the site conditions can be treated as low to moderate in its production potential.

The experiment was laid out in Randomized Block Design with four replications having six oil yielding tree species *viz., Azadirachta indica*, *Melia azedarach*, *Jatropha curcas*, *Pongamia pinnata*, *Erythrena indiaca* and *Simarouba glauca* planted in each pit (1 cu. ft) with a spacing of 2 m x2 m. In each replication the treatment was represented by 25 plants of same species, of which only the middle 9 plants were used for recording observations on various silvicultural parameters, *viz.,* tree height (m), diameter at breast height (DBH) (cm) and crown spread (m). The observations were recorded for the last four years by using standard techniques and the same was used for interpreting results.

The data recorded on various characters during the course of investigation were subjected to Fisher's method of analysis of variance and interpretation of data was made as per the procedure given by Gomez and Gomez (1984). These parameter were further used to calculate total volume (Chaturvedi and Khanna, 1984) and biomass yield (Mac Dicken, 1997).

The above ground biomass of standing trees were estimated to find out the amount of carbon sequestration by reducing the total biomass yield to its 50 per cent (Khajuria and Chauhan., 2003) or converting biomass by multiplying 0.5 (Mac Dicken., 1997).

EXPERIMENTAL RESULTS AND ANALYSIS

The three years data (4th, 5th, 6th and 7th) on tree height (m), diameter at breast height (cm) and crown spread of trees are presented in Table 1. Among the TBO's, till 6th year after planting *Melia azadirachta* has recorded the highest tree height (4.90m, 5.19m and 5.77m, respectively), however which was overtook by *Pongamia pinnata* at 7th year after planting. Collar diameter over the years was highest in *Jatropha curcas* (10.45cm, 11.95cm, 12.77cm and 11.77cm, respectively) and highest crown spread was recorded in *Pongamia pinnata* (E-W: 3.11 m, N-S: 2.98 m; E-W: 3.71 m, N-S: 3.64 m; E-W: 4.03 m, N-S: 4.08 m and E-W: 4.18 m, N-S: 4.17 m, respectively) followed by *A. indica* and *S. glauca*. The lowest values were observed in *J. curcas* except collar diameter. The poor performance of *M. azadirachta* and *J. curcas* after 6th year of planting is due to their high casualty. However, the performance of Pongamia *pinnata* was

Table 1: Silvicultural parameters of TBO's over the years under dryland condition

Treatments	04th Year				05th Year				06th Year				07th Year			
	Height (m)	DBH (cm)	Crown spread (m)		Height (m)	DBH (cm)	Crown spread (m)		Height (m)	DBH (cm)	Crown spread (m)		Height (m)	DBH (cm)	Crown spread (m)	
			E–W	N–S			E–W	N–S			E–W	N–S			E–W	N–S
Azadirachta indica	4.21	6.55	2.48	2.31	4.62	9.62	3.27	3.13	4.77	10.87	3.54	3.57	4.78	10.91	3.29	3.28
Melia azedarach	4.90	5.73	2.52	2.47	5.19	8.10	2.78	2.74	5.57	8.57	2.70	2.67	4.71	5.85	1.99	2.09
Jatropha curcas	2.13	10.45	2.02	2.03	2.36	11.95	2.40	2.39	2.84	12.77	2.59	2.68	2.59	11.77	2.23	2.16
Pongamia pinnata	3.64	4.78	3.11	2.98	3.95	7.97	3.71	3.64	4.38	9.38	4.03	4.08	5.11	10.33	4.18	4.17
Erythrena indica	3.37	6.91	1.24	1.22	3.87	10.38	1.74	1.75	4.25	10.63	2.07	2.02	4.38	11.23	2.31	2.22
Simarouba glauca	3.78	6.87	2.60	2.69	4.20	10.25	3.37	3.44	4.42	10.62	3.39	3.37	4.64	10.91	3.48	3.49
S.E.±	0.16	0.59	0.17	0.18	0.20	0.50	0.19	0.19	0.22	0.67	0.19	0.19	0.34	0.97	0.27	0.26
C.D. (P=0.05)	0.48	1.77	0.51	0.56	0.59	1.51	0.58	0.56	0.65	2.03	0.58	0.58	1.01	2.93	0.83	0.77

Table 2 : Wood volume, biomass and carbon sequestration potentials of different TBO's over the years under dryland condition

Treatments	04th Year			05th Year			06th Year			07th Year		
	Wood volume (M^3ha^{-1})	Biomass (t/ha)	Carbon (t/ha)	Wood volume (M^3ha^{-1})	Biomass (t/ha)	Carbon (t/ha)	Wood volume (M^3ha^{-1})	Biomass (t/ha)	Carbon (t/ha)	Wood volume (M^3ha^{-1})	Biomass (t/ha)	Carbon (t/ha)
Azadirachta indica	28.36	18.43	9.22	67.13	43.63	21.82	88.49	57.52	28.76	89.33	58.06	29.03
Melia azedarach	25.26	16.42	8.21	53.46	34.75	17.37	64.23	41.75	20.87	25.31	16.45	8.22
Jatropha curcas	36.52	23.74	11.87	52.91	34.39	17.20	72.71	47.26	23.63	56.33	36.62	18.31
Pongamia pinnata	13.06	8.49	4.24	39.39	25.61	12.80	60.50	39.33	19.66	85.61	55.65	27.82
Erythrena indica	25.26	16.42	8.21	65.46	42.55	21.28	75.40	49.01	24.50	86.72	56.37	28.18
Simarouba glauca	28.01	18.21	9.10	69.28	45.03	22.52	78.27	50.87	25.44	86.71	56.36	28.18

consistent in this condition.

The data on total wood volume production, biomass and above ground carbon sequestration was found highest in *J. curcas* till 6th year after planting but it showed high casualty due to moisture stress during 7th year. The better performance in wood volume production was by *A. indica* (28.38 m^3 ha^{-1}, 67.13 m^3 ha^{-1}, 88.49 m^3 ha^{-1} and 89.33 m^3 ha^{-1}, respectively) in all the four years *i.e.*, 4th, 5th, 6th and 7th year of planting followed by *S. glauca*, *E. indica* and *P. pinnata* which were at par with each other (Table 2). According to Gupta (1993), 18.75-23.75 m^3 of average annual wood can be harvested from Leucaena on marginal site with 6-8 year rotation.

The biomass production among the TBO's was highest in *A. indica* (18.43 t ha^{-1}, 43.63 t ha^{-1}, 57.52 t ha^{-1}, 58.06 t ha^{-1}, respectively during these years) followed by *S. glauca* (18.21 t ha^{-1}, 45.03 t ha^{-1}, 50.87 t ha^{-1}, 56.36 t ha^{-1}, respectively during these years) which was at par with *E. indica* and *P. pinnata* over the years.

Among the TBO's the amount of above ground carbon sequestration was found highest in *A. indica* (9.22 t ha^{-1}, 21.82 t ha^{-1}, 28.76 t ha^{-1} and 29.03 t ha^{-1}, respectively during 4th, 5th, 6th and 7th year of planting) with an increasing trend over the years followed by *S. glauca* (9.10 t ha^{-1}, 22.52t ha^{-1}, 25.44 t ha^{-1}, 28.18 t ha^{-1}, respectively during these years) which was at par with *E. indica* and *P. pinnata* over the years. However, high consistency in growth and potentiality in carbon sequestration was observed in *S. glauca, P. pinnata* and *A. indica*.

Considering the all these parameters, it may be inferred that the tree borne oilseed tree species *viz., Pongamia pinnata, Simarouba glauca,* and *Azadirachta indica* species were the most promising to fast growing nature which is suitable for the dryland areas of the Karnataka for oilseed purpose (Devaranavadgi *et al.,* 2005) as well as for their carbon sequestration potential.

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