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RESEARCH ARTICLE

Carbon sequestration potential of subabul (*Leucaena leucocephala*) genotypes for shallow vertisols of northern dry zone of Karnataka

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SUMMARY

A field experiment was carried out at Regional Agricultural Research Station, Bijapur (Karnataka) during 1999 to 2010 to evaluate the carbon sequestration potentials of subabul *(Leucaena leucocephala)* genotypes under shallow vertisols of northern dry zone of Karnataka. Results of the study indicated that, among eight subabul genotypes, the total biomass production was highest in S-10 (59.22 t ha^{-1}, 80.39 t ha^{-1}, 106.08 t ha^{-1} and 125.93 t ha^{-1}, respectively during 8^{th}, 9^{th}, 10^{th} and 11^{th} year of planting with an carbon sequestration potential of (29.61 t ha^{-1}, 40.19 t ha^{-1}, 53.04 t ha^{-1} and 62.97 t ha^{-1}, respectively during 8^{th}, 9^{th}, 10^{th} and 11^{th} year of planting) followed by K-636 and S-24. Hence, considering all these parameters, it may be inferred that Leucaena genotype, S-10, is the most promising 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, Subabul genotypes, Vertisols, Biomass

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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 semiarid 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 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

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respect to current global carbon trading demand, evaluation of carbon sequestration potentials of different genotypes of Leucaena under dry land ecosystems is highly valued. Subabul is an important multipurpose tree species which grows with versatile nature in low rainfall areas with vertisols. Hence, a study has been conducted to evaluate carbon sequestration potentials of different subabul species in shallow vertisols of northern dry zone of Karnataka.

MATERIALS AND METHODS

The field experiment was carried out at Regional Agricultural Research Station, Bijapur (Karnataka) during 1999 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% 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 three replications during July 1999, having eight genotypes *viz.,* K-8, K-28, K-29, K-67, K-409, K-636, S-10 and S-24 planted in pit (1 cu. ft). In each replication the treatment was represented by 25 plants of same species. The seedlings were planted with a spacing of 2m x 2 m in five rows, of which only the middle 9 plants were used for recording various observations, *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).

RESULTS AND DISCUSSION

The four years data (8th, 9th, 10th and 11th) on tree height (m), diameter at breast height (cm) and crown spread of trees are presented in Table 1. The genotype S-10 recorded the highest tree height (9.00m, 9.03m, 10.09m and 11.70m, respectively), diameter at breast height (8.03cm, 9.34cm, 10.15cm and 10.27cm, respectively) and crown spread (E-W: 2.45 m, N-S: 2.53 m; E-W: 2.93 m, N-S: 2.81 m; E-W: 3.02 m, N-S: 3.01 m) over the years followed K-636 and S-24. The lowest values were observed in genotype K-29. Guled *et al.* (1996) reported that on marginal soils at Bijapur a plant height of 8.21 m with a rotation of six years was obtained for genotype K-8. Similarly, Gupta (1993) reported that on marginal sites at Dehradun the plant height of 7.4m was obtained in K-8 genotypes with 66 month's rotation.

The data on total wood volume production of four years revealed that genotype S-10 had produced 91.11 m^3 ha^{-1}, 123.67 m^3 ha^{-1}, 163.20 m^3 ha^{-1} and 193.74 m^3 ha^{-1}, respectively in all the four years *i.e.*, 8, 9, 10 and 11th year of planting, respectively, followed by K-636 and S-24 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. At Bijapur on marginal soils 102.50 m^3 wood was harvested with 6 year rotation (Guled *et al.,* 1996).

The biomass production of the subabul varieties varied among the varieties over the years with highest biomass production by S-10 (59.22 t ha^{-1}, 80.39 t ha^{-1}, 106.08 t ha^{-1}, 125.93 t ha^{-1}, respectively during these years) followed by K-

Table 1: Silvicultural parameters of subabul genotypes over the years

Treatments	08th Year				09th Year				10th Year				11th 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
T_1 : K - 8	8.31	7.48	2.27	2.28	8.45	8.91	2.80	2.89	9.47	8.99	2.88	2.93	10.34	9.34	3.13	3.33
T_2 : K - 28	7.65	6.56	2.07	2.26	8.14	8.17	2.53	2.62	9.17	8.24	2.60	2.66	9.81	8.52	3.08	3.17
T_3 : K - 29	6.64	4.84	2.16	2.33	6.45	5.76	2.74	2.79	7.57	5.82	2.76	2.75	8.44	5.84	2.97	3.15
T_4 : K - 67	7.44	5.62	2.28	2.38	7.45	7.33	2.43	2.55	8.47	7.39	2.50	2.57	9.53	7.53	3.19	2.81
T_5 : K - 409	8.24	6.45	2.49	2.42	8.22	7.51	2.87	2.71	9.18	7.59	2.93	2.97	10.82	7.62	2.88	3.01
T_6 : K - 636	8.50	7.41	2.39	2.58	8.94	9.20	2.79	2.87	9.96	10.04	2.87	2.92	11.60	10.13	3.21	3.14
T_7 : S - 10	9.00	8.03	2.45	2.53	9.03	9.34	2.93	2.81	10.09	10.15	3.02	3.01	11.70	10.27	3.42	3.47
T_8 : S - 24	8.25	7.23	2.29	2.36	8.87	9.19	2.82	2.83	9.91	10.02	2.91	2.93	11.53	10.09	3.13	2.98
S.E.±	0.432	0.08	0.11	0.12	0.36	0.47	0.14	0.18	0.25	0.25	0.09	0.09	0.40	0.41	0.16	0.16
C.D. (P=0.05)	1.31	0.84	NS	NS	1.10	1.41	NS	NS	0.76	0.77	0.26	0.27	1.22	1.24	0.48	0.49

NS= Non-significant

Table 2 : Wood volume, biomass and carbon sequestration potentials of different subabul genotypes over the years

Treatments	08th Year			09th Year			10th Year			11th 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)
T_1 : K - 8	73.00	47.45	23.73	105.32	68.46	34.23	120.16	78.10	39.05	141.62	92.05	46.03
T_2 : K - 28	51.69	33.60	16.80	85.30	55.45	27.72	97.75	63.54	31.77	111.80	72.67	36.34
T_3 : K - 29	24.42	15.87	7.94	33.60	21.84	10.92	40.26	26.17	13.08	45.19	29.37	14.69
T_4 : K - 67	36.89	23.98	11.99	62.84	40.85	20.42	72.62	47.20	23.60	84.81	55.13	27.56
T_5 : K - 409	53.82	34.98	17.49	72.79	47.31	23.66	83.03	53.97	26.98	98.67	64.14	32.07
T_6 : K - 636	73.27	47.63	23.81	118.80	77.22	38.61	157.63	102.46	51.23	186.94	121.51	60.76
T_7 : S - 10	91.11	59.22	29.61	123.67	80.39	40.19	163.20	106.08	53.04	193.74	125.93	62.97
T_8 : S - 24	67.71	44.01	22.01	117.60	76.44	38.22	156.21	101.54	50.77	184.24	119.76	59.88

636 (47.63 t ha^{-1}, 77.22 t ha^{-1}, 102.46 t ha^{-1}, 121.51 t ha^{-1}, respectively during these years) and K-8 (47.45 t ha^{-1}, 68.46 t ha^{-1}, 78.10 t ha^{-1}, 92.05 t ha^{-1}, respectively during these years).

Among the varieties the amount of above ground carbon sequestration was found highest in S-10 (29.61t ha^{-1}, 40.19 t ha^{-1}, 53.04 t ha^{-1} and 62.97 t ha^{-1}, respectively during 8, 9, 10 and 11th year of planting) with an increasing trend over the years followed by K-636 (23.81 t ha^{-1}, 38.61 t ha^{-1}, 51.23 t ha^{-1}, 60.76 t ha^{-1}, respectively during these years) and K-8 (23.73 t ha^{-1}, 34.23 t ha^{-1}, 39.05 t ha^{-1}, 46.03 t ha^{-1}, respectively during these years).

Considering the all these parameters, it may be inferred that the subabul genotypes, S-10, is the most promising to grow on shallow vertisols of northern dry zone of Karnataka for minor timber purpose as well as its carbon sequestration potential.

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