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PERFORMANCE AND RELATIVE SUITABILITY OF DIFFERENT TREE SPECIES ON DEGRADED SOILS OF JABALPUR

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ABSTRACT

The present study was conducted on the performance and relative suitability of 14 different tree species planted on degraded sites in the premises of Tropical Forest Research Institute, Jabalpur (M.P.). The survival and growth observations recorded after 14½ years of planting showed that *Albizia procera* as the most suitable species with highest relative score. On the basis of relative suitability indices, plants were grouped into four categories. Species scoring highest number (75-100) were categorized under most suitable, while those with indices below 45 were considered not suitable for planting in these types of degraded soil. *Albizia procera, Cassia siamea, Dalbergia latifolia, Dalberia sissoo* and *Tectona grandis* were found to be most suitable. *Azadirachta indica, Albizia lebbeck, Dendrocalamus stricus, Emblica officinalis, Pongamia pinnata* and *Sterculia urens* were suitable, while *Acacia catechu* was less suitable and *Acacia benthamii* was unsuitable.

INTRODUCTION

Faulty land use and lack of soil conservation or bioreclamation practices resulting in productive soils becoming unproductive or losing their productive potential are called degraded soil (Brandshow 1993, Marrs et al. 1981, Roberts et al. 1981). Degraded soils, in fact, possess unfavourable morphological and physico-chemical conditions, deficient in available plant nutrients and lack of beneficial microbial population resulting in poor survival and growth of plants. The nutrient requirement of different species, their establishment and growth vary particularly in such derelict sites. Therefore , for afforesting these types of lands for better survival and growth, selection of suitable forestry species is essential.

Singh et al. (1992) studied suitability of different tree species for skeletal soil of Sambalpur (Orissa), while Gupta et al. (1994) and Sonkar et al. (1994) studied the suitability and growth performance of different tree species for copper and coal mines overburdens. In order to revegetate and enhance the productivity of degraded sites, selection of site specific suitable species is must. Unfortunately not much work has been done in this field and, hence, the present study was conducted to assess the relative survival and growth performance of 14 different tree species planted on degraded soil after 14½ years of planting.

MATERIALS AND METHODS

For the present study, plantation pits of 45 × 45 × 45 cm were dug in the premises of Tropical Forest Research Institute, Jabalpur (23°5'37" to 23°6'10" N and 79°58'42" to 79°59'42" E) in different patches during April and May 1991. Pits were filled with original soil and ½ kg of farm yard manure. Healthy seedlings of 14 different tree species were planted at 2 × 2 m interval, while *Dalbergia latifolia* and *Dendrocalamus strictus* were planted at 3 × 3 m and 4 × 4 m respectively under DENS plantation programme. With a little variation, the soil conditions were almost similar at all the sites, a brief description of which is given below:

Soil pH	06.90 to 07.10
Organic matter (%)	00.98 to 01.40
CEC (meq/100 g soil)	36.00 to 48.00
Exch. Ca (meq/100g soil)	18.00 to 28.00
Exch. Mg (meq/100g soil)	16.00 to 18.00
Exch. K (meq/100g soil)	23.13 to 00.32
Exch. Na (meq/100gsoil)	24.16 to 00.32
Available N (ppm)	90.00 to 140.0
Available P (ppm)	08.25 to 12.20
Available K (ppm)	130.0 to 180.0

Physiographically the land is convex upland with gentle slope, shallow to moderately deep, well drained to excessively drained. These site characters and physico-chemical properties are an indication of degraded soil. Height and girth at breast height of all the plants were measured by laying out quadrats of 10 × 10 m size with 4 replications in last week of December 2005. Suitability index (SI) of plants was calculated to assess the overall performance of different species by the formula (Singh et al. 1992, Williams et al. 1994) given below:

$$SI = \frac{\text{Mean survival \% of individual species}}{\text{Maximum mean survival \% of the species}} \times 100 + \frac{\text{Mean g.b.h. of individual species}}{\text{Maximum mean g.b.h. of the species}} \times 100 + \frac{\text{Mean g.b.h. annual increment of the species}}{\text{Maximum mean annual increment of g.b.h.}} \times 100 + \frac{\text{Mean height of individual species}}{\text{Maximum mean height of the species}} \times 100 + \frac{\text{Mean annual height increment}}{\text{Maximum mean annual increment of height}} \times 100$$

RESULTS AND DISCUSSION

The survival, girth at breast height (g.b.h.) and height of different tree species with their mean annual increment have been presented in Table 1 and Table 2 respectively, and overall performance and suitability index in Table 3. *Dabergia latifolia* (84%) was found to surpass all other species with survival after 14 ½ years of planting and was followed by *Dendrocalamus strictus* (78%), *Tectona grandis (78%), Dalberiga sissoo* (76%), *Acacia catechu* (74%), *Azadirachta indica* (72%), *Albizia procera* (72%), *Emblica officinalis* (72), *Acacia nilotica* (64%), and *Pongamia pinnata* (66%). *A. benthamii* showed poor performance with 34% survival.

The girth at breast height of different tree species varied greatly, and maximum was noted in *A. procera* (60.84cm) followed by *C. siamea* (48.28cm), *D. latifolia* (44.46 cm), *A. lebbeck* (41.66cm), *D. sissoo* (43.62cm) and *P. pinnata* (40.48cm). Further g.b.h. was recorded between 32.46cm and 37.48cm with *A. nilotica* (32.46cm), *A. indica* (34.48cm), *E. officinalis* (36.62cm), *T. grandis* (37.48cm) and *S. urens* (36.24cm). The g.b.h. of all other species was found to be less than 32.46cm with minimum in *A. benthamii* (13.12cm). The maximum g.b.h. in *A. procera* has also been

Table 1: Survival and g.b.h. of different tree species after 14½ years of planting.

S.No.	Species	Survival (%)	Relative survival (%)	GBH (cm)	Relative GBH(%)	MAI (cm)	Relative MAI (%)
1.	Acacia catechu	74	88.09	26.33	43.27	1.803	43.27
2.	*Acacia benthamii*	24	28.57	13.12	21.56	0.899	21.57
3.	*Acacia nilotica*	64	76.19	32.46	53.35	2.223	53.35
4.	*Albizia lebbeck*	56	66.67	41.66	68.47	2.853	68.47
5.	*Albizia procera*	72	85.71	60.84	100.00	4.167	100.00
6.	*Azadirachta indica*	72	85.71	34.48	56.67	2.362	56.68
7.	*Cassis siamea*	64	76.19	48.28	79.35	3.307	79.36
8.	*Dalbergia latifolia*	84	100.00	44.56	73.24	3.052	73.24
9.	Dalbergia sissoo	72	85.71	43.62	71.69	2.988	71.71
10.	*Emblica officinalis*	72	85.71	36.62	60.19	2.508	60.18
11.	*Pongamia pinnata*	66	78.57	40.48	66.53	2.773	66.55
12.	*Sterculia urens*	76	90.48	36.24	59.56	2.482	59.56
13.	*Tectona grandis*	78	92.86	37.48	61.60	2.567	61.60
14.	*Dendrocalamus strictus*	78	92.86	15.62	25.67	1.069	25.65

MAI = Mean annual increment

Table 2: Height of different tree species and their mean annual increment after 14½ years of planting.

S.No.	Species	Height (m)	Initial height (m)	Net height(%)	Relative height (m)	MAI (m)	Relative MAI(%)
1.	Acacia catechu	05.60	0.30	05.30	40.89	0.363	40.87
2.	*Acacia benthamii*	04.28	0.45	03.83	29.55	0.262	29.50
3.	*Acacia nilotica*	07.14	0.50	06.64	51.23	0.455	51.23
4.	*Albizia lebbeck*	08.36	0.48	07.88	60.80	0.539	60.69
5.	*Albizia procera*	13.40	0.44	12.96	100.00	0.888	100.00
6.	*Azadirachta indica*	07.34	0.50	06.84	52.80	0.468	52.70
7.	*Cassis siamea*	10.04	0.68	09.36	72.22	0.641	72.18
8.	*Dalbergia latifolia*	10.08	0.34	09.74	75.15	0.667	75.11
9.	*Dalbergia sissoo*	09.98	0.55	09.43	72.76	0.646	72.74
10.	*Emblica officinalis*	09.78	0.60	09.18	70.83	0.629	70.83
11.	*Pongamia pinnata*	09.65	0.50	09.15	70.60	0.627	70.60
12.	*Sterculia urens*	05.68	0.08	05.60	43.20	0.384	43.24
13.	*Tectona grandis*	11.50	R/S	11.50	88.73	0.788	88.73
14.	*Dendrocalamus strictus*	10.68	0.62	10.06	77.62	0.689	77.59

MAI = Mean annual increment, R/S = Root/shoot

reported by Singh et al. (1992) in skeletal soils of Sambalpur (Orissa) and in degraded soils of Jabalpur (Sonkar et al. 1999). The maximum mean annual increment in girth at the breast height was noted for *A. procera* (3.9251cm) followed by *C. siamea* (3.1148cm), *D. latifolia* (2.8748cm), *A. lebbeck* (2.6877cm), *D. sissoo* (2.6851cm) and *P. pinnata* (2.6116cm), while the minimum of 0.8464 in *A. benthamii*.

The average height of 14 different tree species was calculated to be 8.069m after 14½ yrs of planting (Table 2). Increment in height was observed to be the maximum in *A. procera* (12.96m) with mean annual increment (MAI) of 0.887m followed of *T. grandis* 11.50m net height and mean annual increment 0.793m, *D. strictus* 10.06m net height and MAI of 0.694m, *C. siamea* 9.36m net height and 0.646 MAI, *D. latifolia* 9.74 net height and 0.672m MAI, *D. sissoo* 9.43 net height and

Table 3: Performance and suitability index of different tree species after 14½ years of planting.

S.No.	Species	Relative Survival (%)	Relative GBH (%)	Relative GBH MAI (%)	Relative Height (%)	Relative Height MAI (%)	Total score	Total Relative (%)	Performance
1.	Acacia catechu	88.09	43.27	43.27	40.89	40.87	256.39	52.78	LS
2.	*Acacia benthamii*	28.57	21.56	21.57	29.55	29.50	130.75	26.91	NS
3.	*Acacia nilotica*	76.19	53.35	53.35	51.23	51.23	285.35	58.74	LS
4.	*Albizia lebbeck*	66.67	68.47	68.47	60.80	60.69	325.10	66.93	S
5.	*Albizia procera*	85.71	100.00	100.00	100.00	100.00	485.71	100.00	MS
6.	*Azadirachta indica*	85.71	56.67	56.68	52.80	52.70	304.56	62.70	S
7.	*Cassis siamea*	76.19	79.35	79.36	72.22	72.18	379.30	78.09	MS
8.	*Dalbergia latifolia*	100.00	73.24	73.24	75.15	75.11	396.74	81.68	MS
9.	*Dalbergia sissoo*	85.71	71.69	71.71	72.76	72.74	374.61	77.12	MS
10.	*Emblica officinalis*	85.71	60.19	60.18	70.83	70.83	347.70	71.59	S
11.	*Pongamia pinnata*	78.57	66.53	66.55	70.60	70.60	352.85	72.64	S
12.	*Sterculia urens*	90.48	59.56	59.56	43.20	43.24	296.00	60.94	S
13.	*Tectona grandis*	92.86	61.60	61.60	88.73	88.73	393.52	81.01	MS
14.	*Dendrocalamus strictus*	92.86	25.67	25.65	77.62	77.59	299.39	61.63	S

MS=Most suitable, S=Suitable, LS=Less suitable, NS=Not suitable

0.646m MAI, *E. officinalis* 9.18 net height and 0.629m MAI, and *P. pinnata* 9.15m net height and 0.631m MAI. Thus, these 10 species registered increment of over 9.02m in height and 0.617m MAI, while *A. lebbeck, A. nilotica, A. indica* and *S. urens* showed increment in height between 7.88m and 5.60m and MAI from 0.543m to 0.386m. The species considered to be not suitable for planting in these sites were *A. benthamii* because its height increment was just 3.83m and MAI of 0.264m only. Better height of *D. sissoo* as compared to other species has also been reported in skeletal soils of Sambalpur, Orissa (Singh et al. 1992), mine over burden of Dalli Rajhara, Durg, M.P. (Bhowmik et al. 1996).

To assess the overall performance of different tree species in degraded soils, a suitability index was worked out on the basis of survival, girth at breast height, mean annual increment of g.b.h. and mean annual increment of height recorded after 14 ½ yrs of planting. The maximum value of each parameter was assigned 100 marks and relative values were calculated for other species with respect to the maximum. Finally, the values of all parameters were summed up. The results so obtained (Table 3) depicted best performance by *A. procera* followed by *D. latifolia, D. sissoo, T. grandis* and *C. siamea.* Other species indicating better performance were *A. indica, E. officinalis, P. pinnata, A. lebbeck, D. strictus* and *S. urens. A. nilotica* and *A. catechu* were found to be less suitable as these species scored the values of 58.83 and 51.34 respectively, while *A. benthamii* was found to be not suitable scoring value less than 45. Sonkar et al. (1998) and Singh et al. (1992) also observed better performance of *D. sisso* and *A. procera* in coal mine overburden of Jayant Singrouli and skeletal soils of Sambhalpur (Orissa) respectively.

On the basis of relative suitability scorings, different plant species may be grouped in the following categories.

Category-I: More suitable species (scoring between 75-100), for instance, *A. procera, C.siamea, D. latifolia, D. sissoo* and *T. grandis.*

Category-II: Suitable species (scoring between 60-75) such as *A. indica, A. lebbeck, E. officinalis, D. strictus, P. pinnata* and *S. urens.*

Category-III: Less suitable (scoring between 45-60): *A. catechu* and *A. nilotica.*

Category-IV: Unsuitable (scoring less than 45): For instance, *A. benthamii.*

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