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Comparative growth performance of *Albizia procera* seedlings raised in nursery

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Abstract
For this study, the seeds were subjected to different pre-sowing treatments, then sown in different containers which were filled with different potting mixtures, and were investigated to select suitable treatment combinations for quality seedlings for large-scale plantation programs. A complete randomized design was applied with three replications to conduct this experiment. Seedling growth was assessed for height, collar diameter, leaflet number, leaf area, vigor index, and quality index were also calculated for each treatment. Seedlings raised in treatment combination $T_3C_1M_6$ i.e. pre-sowing treatment T_3 (seeds soaked in cow urine for 24 hours), polybag C_1 of size (23 cm x 13 cm), filled with growing medium sand + vermicompost (1:1) (M_6) was found suitable in the nursery for quality seedling production of *Albizia procera*.

Keywords: Pre-sowing treatment, polybag, growing medium, growth parameters, *Albizia procera*

Introduction
Albizia procera (Roxb.) commonly known as safed siris belongs to the family leguminous, and is used for afforestation. It is a good component of the agroforestry system because of its hardy nature, fast growth, excellent fodder, higher calorific value, and can be successfully planted in saline soil. Its hard seediness leading to dormancy develops in seed primarily of seed coat which impedes proper and complete germination. Interest in producing quality seedlings by application of improved and modern nursery techniques has increased in recent years (Gera and Ginwal, 2002) [4]. The success of a plantation program largely depends on prompt germination, enhanced growth by applying different growing media, and even on the containers in which seeds are sown. The present study was initiated to compare *A. procera* seedlings grown in a combination of different pre-sowing treatments, containers, and growing media.

Materials and Methods
Materials
For studying the comparative growth of *Albizia procera*, the seeds were subjected to different treatments. Then, the seeds were sown in different containers which were filled with different potting mixtures. The experiment was conducted in polyhouse in the nursery of the Department of Silviculture and Agroforestry, Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan (Himachal Pradesh).

Details of treatments
a. Pre-sowing treatments (5)

T_1	Soaking in normal water for 24 hours
T_2	Soaking in cooling boiled water for 24 hours
T_3	Soaking in cow urine for 24 hours
T_4	Soaking in beejamrutha for 24 hours
T_5	Control

b. Container type (3)

C_1	Side perforated polythene bag (23 cm × 13 cm)
C_2	Root trainer 150 cc
C_3	Root trainer 275 cc

c. Growing mediums (8)

M_1	Sand: soil: vermicompost (1:1:2)
M_2	Sand: soil: vermicompost (1:2:1)
M_3	Sand: soil: FYM (1:1:2)
M_4	Sand: soil: FYM (1:2:1)
M_5	Sand: FYM (1:1)
M_6	Sand: vermicompost (1:1)
M_7	Soil: FYM (1:1)
M_8	Soil: vermicompost (1:1)

Methods

Height (cm)
Seedling height was recorded in centimeters from ground level to the tip of the stem.

Collar diameter (mm)
The collar diameter of the seedlings was measured in millimeters by using a digital vernier caliper.

Leaflet number (no.)
Leaflet number was counted as the number of leaflets present per seedling.

Leaf area (cM2)
The leaf area of the seedlings was measured in square centimeters by using a leaf area meter.

Vigour index
It was calculated according to Abdulbaki and Anderson (1973) [1] as germination percent × seedling total height i,e. total shoot and root length.

Quality index (QI)
It was developed by Dickson *et al.* (1960) [2] to quantify seedling morphological quality. QI was calculated as follows:

$$QI = \frac{\text{Seedling dry weight (g)}}{(\text{height /diameter}) + (\text{top wt. /root wt.})}$$

Statistical Analysis
The entire data generated from the present investigation were put to statistical analysis under the procedure outlined by Gomez and Gomez (1984) [5].

Results and Discussion

Comparative study of different pre-sowing treatments, container type, and growing media (T×C×M)
Among different treatment combinations in Table 1, $T_3C_1M_6$ recorded significantly the highest height growth of 21.8 cm. However, the significantly lowest value for height growth was noticed in $T_5C_2M_4$ treatment combination of 10.9 cm. In the case of collar diameter $T_3C_1M_6$ treatment combination recorded a significantly highest value i.e., 15.87 mm in the seedlings and the significantly lowest value for collar diameter (0.14 mm) was however, noticed in $T_5C_2M_4$ treatment combination (table 2). From the data represented in Table 3, the $T_3C_1M_6$ treatment combination was recorded significantly the highest number 13 of leaflets. And significantly lowest number (3) of leaflets was, however, noticed in the $T_5C_2M_4$ treatment combination. Table 4, reveals that the seedlings raised after soaking seeds in cow urine for 24 hours (T_6) raised in polybags of size 23 cm × 13 cm (C_1) filled with a growing medium of sand + vermicompost (1:1) (M_6) i.e., $T_3C_1M_6$ recorded significantly highest leaf area of 16.5 cM2, the significantly least value for leaf area (2.56 cM2) was, however, noticed in $T_5C_2M_4$ treatment combination. The perusal of data in Table 5 reveals that *Albizia procera* seedlings raised in $T_3C_1M_6$ resulted significantly highest vigour index of 2521. The significantly least value 508 was obtained for $T_5C_2M_4$. The perusal of data in Table 6 reveals that seedlings raised in $T_3C_1M_6$ resulted in the highest quality index of 0.99. The lowest value of 0.003 was obtained for the $T_5C_2M_4$ treatment combination.

These results conform with Sharma (2013) [7] who reported better germination and growth performance when the medium of soil + sand + compost (1:1:2) and bigger polybags of size were used for *Melia composita*. Karthikeyan *et al*. (2006) [6] observed that the best performance of germination and seedling growth was achieved when seeds were soaked in water and further sown in a germination medium consisting of sand with vermicompost. The studies of Ward *et al.* (1981) [9] and Sood (1997) [8] also reported significant variation in seedling growth due to the interaction effect of different container volumes and growing medium composition. Farhana *et al.* (2010) [3] studied the comparative growth performance of *Albizia procera* seedlings raised in nursery beds, polybags, and root trainers. Results revealed that seeds sown in big containers provided the highest number of leaflets i.e., 12.0 and vigour index i.e, 8825.5.

Table 1: Effect of pre-sowing treatment, container type, growing media and their interaction on height (cm) of *Albizia procera* seedlings

	T_1				T_2				T_3				T_4				T_5				C_1	C_2	C_3	Mean
	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean				
M_1	16.6	17.4	12.8	15.6	16.6	17.4	12.8	15.60	13.7	12.5	15.9	14.0	14.9	12.8	11.5	13.1	12.4	15.7	13.6	13.9	15.1	13.3	14.9	14.4
M_2	17.2	17.9	19.4	18.2	17.2	17.9	19.4	18.16	16.6	14.3	15.3	15.4	14.7	10.6	12	12.5	12.0	11.4	14.1	11.8	16.0	14.0	14.6	14.2
M_3	18.7	14.9	14.4	16.0	18.7	14.9	14.4	15.98	16.0	18.0	17.2	17.0	12.7	11.0	11.7	11.8	11.7	11.0	12.7	11.8	15.7	13.8	14.1	14.5
M_4	17.7	16.7	19.6	18.0	17.7	16.7	18.6	17.68	18.0	18.8	17.3	18.1	12.5	10.7	13.1	12.1	10.0	7.2	9.3	8.33	15.6	11.2	15.6	14.1
M_5	18.0	13.7	18.3	16.7	18.0	13.7	18.3	16.66	21.7	16.9	14.2	17.6	13.4	10.3	13.7	12.5	13.9	11.1	12.1	11.8	16.6	14.6	13.9	15.0
M_6	20.9	17.2	16.7	18.3	20.9	17.2	16.7	18.27	21.8	17.7	18.2	19.2	14.5	10.5	10.4	11.8	14.3	11.2	11.4	12.0	17.9	14.4	15.5	15.9
M_7	20.2	14.3	14.8	16.4	20.2	14.3	14.8	16.43	20.8	17.7	18.5	19.0	14.6	11.4	11.8	12.6	11.0	10.9	11.4	10.4	17.2	13.9	13.8	15.0
M_8	11.3	13.9	15	13.4	11.3	13.9	15	13.41	21.5	16.1	15.5	17.8	14.3	11.0	9.9	11.7	12.2	14.7	10.8	12.6	15.1	13.3	14.9	14.4
Mean	17.6	15.8	16.4	16.6	17.6	15.8	16.2	16.52	18.8	16.5	16.5	17.3	14.0	11.0	11.8	12.3	12.3	12.1	12.2	12.2	16.2	13.6	14.7	

	T	C	M	T × C	C × M	T × M	T × C × M
SEm±	0.18	0.14	0.23	0.31	0.39	0.50	0.87
$CD_{0.05}$	0.50	0.39	0.63	0.86	1.09	1.40	2.43

Table 2: Effect of pre-sowing treatment, container type, growing media and their interaction on collar diameter (mm) of *Albizia procera* seedlings

	T_1				T_2				T_3				T_4				T_5				C_1	C_2	C_3	Mean
	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean				
M_1	3.12	0.84	8.84	4.27	14.77	6.86	12.35	11.33	9.8	9.12	15.77	10.10	6.4	4.9	0.14	3.81	7.47	0.16	3.5	3.71	7.91	4.51	9.32	7.25
M_2	14.11	0.21	9.14	7.82	8.74	9.47	9.74	9.32	11.8	3.15	8.16	7.70	5.62	6.18	13.4	8.43	8.19	0.18	4.4	4.26	9.98	5.57	6.97	7.51
M_3	5.10	0.15	7.44	4.23	12.1	11.11	13.47	12.23	10.46	2.12	4.76	5.78	15.11	6.84	20.1	14.02	4.8	0.17	7.21	4.06	10.13	5.75	8.32	8.06
M_4	7.14	0.15	2.80	3.36	0.16	0.19	0.14	0.17	14.47	6.19	13.13	11.93	0.17	0.25	0.12	0.18	8.57	0.28	2.07	3.64	4.52	3.47	3.58	3.85
M_5	8.12	2.78	5.55	5.48	14.46	0.13	12.78	9.12	13.47	3.17	17.77	11.47	10.12	3.00	7.51	6.87	6.94	0.14	3.12	3.40	9.86	3.9	8.05	7.27
M_6	10.12	3.14	7.55	6.94	15.82	0.16	11.46	9.48	15.87	4.81	11.1	13.13	15.11	0.21	0.17	8.50	8.35	0.28	6.78	5.14	7.93	3.93	12.5	8.13
M_7	4.42	2.45	4.15	3.67	11.84	0.19	0.13	4.05	14.17	3.43	10.47	10.02	0.1	0.19	0.1	0.13	7.64	0.19	6.14	4.66	4.25	3.84	5.43	4.51
M_8	10.12	1.81	4.12	5.35	10.16	13.48	9.13	10.92	11.21	5.17	6.13	7.50	12.77	5.15	8.15	8.69	4.48	0.16	6.13	3.59	7.93	6.36	7.34	7.21
Mean	7.78	1.44	6.2	5.14	11.13	5.2	8.65	8.32	13.15	4.64	11.5	9.76	9.42	3.34	6.22	6.32	7.06	0.19	4.92	4.05	7.81	4.67	7.69	

	T	C	M	T × C	C × M	T × M	T × C × M
SEm±	0.40	0.31	0.50	0.69	0.87	1.13	1.95
$CD_{0.05}$	1.11	0.86	1.40	1.92	2.43	3.14	5.44

Table 3: Effect of pre-sowing treatment, container type, growing media and their interaction on leaflet number of *Albizia procera* seedlings

	T_1				T_2				T_3				T_4				T_5				C_1	C_2	C_3	Mean
	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean				
M_1	7.00	3.00	5.67	6.33	7.33	3.00	5.33	7.00	8.00	4.00	5.00	6.00	7.00	3.67	6.33	5.89	6.00	3.50	4.50	4.67	8.80	3.87	5.80	6.16
M_2	7.33	4.00	4.67	5.22	7.33	4.00	7.00	5.22	11.67	4.33	5.67	5.67	8.00	4.00	5.33	5.67	5.50	3.20	4.33	4.34	7.27	3.67	5.67	5.53
M_3	6.33	5.00	6.00	5.33	8.33	5.00	7.33	6.11	10.33	4.00	6.67	6.89	7.00	4.00	5.67	5.78	5.67	3.40	5.00	4.69	8.27	3.87	5.60	5.91
M_4	8.67	3.67	6.67	5.44	8.67	4.00	7.67	5.89	12.33	4.00	7.33	7.56	8.00	3.33	7.33	5.44	5.33	3.33	4.00	4.22	8.27	4.20	5.27	5.91
M_5	8.33	4.33	3.67	5.78	5.67	5.00	7.00	6.89	10.00	4.67	5.33	7.00	7.33	3.33	5.67	5.56	6.33	3.67	4.67	4.89	7.73	4.40	6.33	6.16
M_6	8.33	2.67	5.67	6.33	9.33	3.00	6.67	6.78	12.67	5.33	6.00	7.89	9.00	6.33	5.33	6.22	5.67	3.67	5.00	4.78	9.20	3.87	6.80	6.62
M_7	8.33	4.00	6.00	5.56	8.33	4.67	6.00	6.33	7.33	4.33	6.00	7.11	8.00	4.00	6.00	6.89	5.00	3.50	4.50	4.33	8.67	4.20	5.93	6.27
M_8	9.33	4.00	5.67	6.11	12.0	4.00	5.00	6.33	7.67	3.00	7.33	5.89	7.67	4.00	6.00	6.00	6.33	4.33	5.00	5.22	7.60	4.40	6.27	6.09
Mean	7.96	3.83	5.50	5.76	8.38	4.08	6.50	6.32	10.00	4.08	6.17	6.75	7.75	4.08	5.96	5.93	5.73	3.58	4.63	4.64	8.23	4.06	5.96	

	T	C	M	T × M	C × M	T × M	T × C × M
SEm±	0.15	0.12	0.19	0.26	0.33	0.42	0.73
$CD_{0.05}$	0.42	0.32	0.53	0.72	0.91	N.S	2.04

Table 4: Effect of pre-sowing treatment, container type, growing media and their interaction on leaf area (cM_2) of *Albizia procera* seedlings

	T_1				T_2				T_3				T_4				T_5					C_1	C_2	C_3	Mean
	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean					
M_1	15.57	8.37	9.73	11.22	8.13	6.00	7.97	7.37	16.33	10.63	11.7	12.99	10.7	5.57	8.27	8.19	13.6	6.00	9.27	3.02	13.6	10.97	6.91	7.79	8.56
M_2	14.47	5.50	8.07	9.34	8.47	8.17	9.17	8.60	12.43	6.20	7.03	8.56	8.10	5.30	6.57	6.66	8.2	3.22	5.20	5.47	8.2	10.33	5.64	7.21	7.73
M_3	8.97	6.17	8.13	7.76	15..5	5.00	11.17	10.89	12.67	7.63	9.3	9.87	9.67	4.70	5.27	6.54	8.13	3.73	7.47	5.44	8.13	11.19	4.85	8.27	8.10
M_4	7.70	4.50	6.57	6.26	12.4	6.17	11.00	9.86	15.29	10.57	14.57	14.56	11.7	6.07	7.63	8.49	8.1	2.56	3.73	2.56	8.1	10.5	6.20	8.33	8.34
M_5	16.47	6.67	7.33	10.52	8.93	6.47	8.57	7.99	6.67	4.93	7.13	6.24	8.87	4.77	6.1	6.58	10.8	3.50	1.03	4.24	10.8	10.57	4.75	6.03	7.12
M_6	14.50	6.40	10.47	10.46	16.5	11.83	13.60	14.66	12.20	8.27	11.23	10.57	6.63	4.30	5.6	5.51	7.7	4.03	4.43	5.39	7.7	11.31	6.97	9.07	9.11
M_7	16.13	5.33	6.80	9.59	16.17	13.17	13.63	13.64	9.29	8.27	7.73	8.43	7.63	6.13	6.4	6.72	5.55	3.23	3.30	4.03	5.55	11.26	7.23	7.57	8.69
M_8	8.47	4.67	6.93	6.69	12.17	9.07	9.50	10.24	11.63	8.63	11.63	10.63	9.47	5.77	7.07	7.43	8.6	4.73	5.90	6.41	8.6	10.07	6.57	8.21	8.28
Mean	12.98	5.95	8.00	8.98	12.51	8.23	10.58	10.41	12.41	8.14	10.04	10.23	9.11	5.33	6.61	7.02	6.86	3.05	3.81	4.57	6.86	10.77	6.14	7.81	

	T	C	M	T × C	C × M	T × M	T ×C × M
SEm±	0.09	0.07	0.11	0.15	0.19	0.25	0.43
$CD_{0.05}$	0.24	0.19	0.31	0.42	0.53	0.69	1.19

Table 5: Effect of pre-sowing treatment, container type, growing media and their interaction on vigour index of *Albizia procera* seedlings

	T_1				T_2				T_3				T_4				T_5				C_1	C_2	C_3	Mean
	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean				
M_1	2114	1806	2278	2066	2017	932	1908	1619	2308	2096	2320	2200	1045	883	1725	1218	2116	713	1284	1371	1934	1462	1757	1717
M_2	2303	1042	1760	1748	2347	1543	1938	1943	1871	2043	1194	1703	2450	1452	1347	2016	1456	699	1013	1056	2027	1636	1477	1713
M_3	1899	1253	2028	1727	2198	1560	2515	2091	2373	1949	2223	2282	2449	1553	1138	1714	1460	719	1405	1195	2225	1673	1506	1802
M_4	2308	1649	1851	2019	2166	1073	1487	1575	2254	2091	2166	2204	1088	900	1774	1254	950	508	865	949	1577	1489	1735	1600
M_5	1914	1655	2172	1914	2125	1288	1730	1714	2323	1581	1655	1881	1273	829	2198	1267	1506	845	889	1080	1818	1291	1904	1671
M_6	2300	1692	2026	2106	2172	1283	1908	1788	2521	2067	2221	2313	1922	956	1308	1395	2130	1379	1835	1782	1981	1807	1774	1854
M_7	2305	1200	1923	1836	1898	934	1308	1380	2183	1589	2231	2101	1902	1418	1307	1542	2005	1926	1661	1864	1864	1597	1772	1745
M_8	2318	1698	1766	1994	2319	1425	1649	1908	1891	2267	2141	2200	2153	1322	937	1471	1108	821	918	774	1682	1668	1658	1669
Mean	2204	1499	1976	1926	2196	1255	1805	1752	2240	1998	2094	2110	1523	1164	1592	1560	1499	1108	1169	1259	1888	1577	1698	

	T	C	M	T × C	C × M	T × M	T × C × M
SEm±	70.41	54.54	84.06	121.95	154.26	199.15	344.93
$CD_{0.05}$	196.2	151.9	165.3	339.8	N.S	554.8	961.0

Table 6: Effect of pre-sowing treatment, container type, growing media and their interaction on the quality index of *Albizia procera* seedlings

	T_1				**T_2**				**T_3**				**T_4**				**T_5**							
	C_1	**C_2**	**C_3**	**Mean**	**C_1**	**C_2**	**C_3**	**Mean**	**C_1**	**C_2**	**C_3**	**Mean**	**C_1**	**C_2**	**C_3**	**Mean**	**C_1**	**C_2**	**C_3**	**Mean**	**C_1**	**C_2**	**C_3**	**Mean**
M_1	0.79	0.03	0.73	0.52	0.73	0.14	0.39	0.42	0.46	0.03	0.03	0.17	0.65	0.08	0.09	0.27	0.11	0.09	0.07	0.08	0.48	0.45	0.69	0.54
M_2	0.44	0.39	0.06	0.3	0.30	0.26	0.27	0.28	0.66	0.01	0.91	0.53	0.71	0.05	0.66	0.47	0.69	0.07	0.36	0.37	0.52	0.21	0.35	0.36
M_3	0.2	0.04	0.45	0.23	0.97	0.09	0.70	0.59	0.89	0.00	0.10	0.33	0.27	0.33	0.08	0.23	0.31	0.08	0.43	0.27	0.65	0.05	0.52	0.41
M_4	0.56	0.05	0.68	0.43	0.83	0.00	0.49	0.44	0.47	0.03	0.08	0.19	0.02	0.05	0.19	0.09	0.73	0.03	0.09	0.27	0.43	0.25	0.34	0.34
M_5	0.52	0.1	0.79	0.47	0.16	0.03	0.10	0.10	0.57	0.10	0.72	0.46	0.55	0.05	1.10	0.57	0.38	0.04	0.40	0.27	0.41	0.89	0.64	0.65
M_6	0.97	0.06	0.15	0.39	0.01	0.00	0.07	0.03	0.99	0.05	0.77	0.60	0.55	1.39	0.19	0.71	0.05	0.09	0.05	0.03	0.56	0.92	0.96	0.81
M_7	0.14	0.03	0.42	0.2	0.47	0.60	0.28	0.45	0.98	0.01	0.47	0.49	0.32	0.00	0.03	0.12	0.94	0.11	0.72	0.59	0.45	0.43	0.23	0.37
M_8	0.65	0.05	0.32	0.34	0.62	0.06	0.01	0.23	0.68	0.00	0.19	0.29	0.13	0.06	0.65	0.28	0.15	0.01	0.01	0.06	0.53	0.47	0.08	0.36
Mean	0.53	0.09	0.45	0.36	0.51	0.15	0.29	0.32	0.71	0.03	0.41	0.38	0.40	0.25	0.37	0.34	0.42	0.05	0.27	0.24	0.50	0.46	0.48	

	T	C	M	T × C	C × M	T × M	T × C × M
SEm±	0.022	0.017	0.028	0.038	0.048	0.062	0.107
$CD_{0.05}$	0.061	0.047	0.083	0.106	N.S	N.S	N.S

Conclusion

Based on the results of the present experiment, it may be recommended that seeds should be treated with cow urine for 24 hours. The rapid growth of seedlings after cow urine treatment might be due to the presence of growth-promoting substances (auxins) and nutrients. The seeds grown in polybags of size 23 cm × 13 cm proposed the best development of seedlings. However, the selection of suitable media for containers is also essential for the growth and development of quality seedlings. Among all growing mediums sand + vermicompost (1:1) is suggested best for the growth of the seedlings. The better growth in vermicompost is due to better soil aeration and texture thereby reducing soil compaction and water retention capacity.

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