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Identification of best performing ardu (*Ailanthus excelsa*) genotypes in semi-arid ecosystems of Rajasthan

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ABSTRACT

An experiment was conducted during 2006–08 to screen 18 genotypes of ardu (*Ailanthus excelsa* Roxb.) and to select the best amongst all for semi-arid regions of Rajasthan. Among the genotypes, 'Sel 9' and 'Sel 7' performed consistently with higher growth characteristics in both the years. The highest plant height 40.7, 100.7, 150.0 and 251.3 cm was recorded in 'Sel 9' at 6, 12, 18 and 24 months after planting, respectively. Maximum crown diameter was observed in 'Sel 9' (1.50 cm) which was at par with 10 genotypes ('Sel 1-7, 10, 12 and 14') at 6 months after planting over other selections. At 12, 18 and 24 months after planting of ardu, 'Sel 7' gave the highest 3.92, 5.73 and 9.34 cm crown diameter, respectively. 'Sel 7 and 9' accumulate more leaf area over all the genotypes. At 12 and 18 months after planting 'Sel 9' was recorded 139.2 and 95.4 cm^2 leaf area/leaflet, respectively which was significantly at par with other 10 genotypes. The mean values of drymatter accumulation/plant were 0.014, 0.168, 0.215 and 0.434 recorded at 6, 12, 18 and 24 months after planting. At 12, 18 and 24 months after planting, the highest values of drymatter accumulation was recorded (0.35, 0.34 and 0.75 kg/plant) with 'Sel 9' and it was at par with 'Sel 1-3, 5-7, 10, 12 and 14' than the rest of the selections. In genotype 'Sel 9', the highest value of plant growth rate (1.91, 1.91 and 4.19 g/day/plant) was recorded at 12, 18 and 24 months after planting over other genotypes of ardu. The genotypes 'Sel 9' and 'Sel 7' were identified as the best for multiplication in the field to increase the fodder yield for small ruminants and fuelwood and timber for burgeoning human population in the semi-arid areas.

Key words: *Ailanthus excelsa,* Ardu, Genotypes, Growth performance, Identification, Selections

Ardu (*Ailanthus excelsa* Roxb.) was first described by William Roxburgh in 1795 for the Circas of the eastern parts of India as a comparatively fast-growing tree (Sandhu 1984). It spread in the arid and semi-arid regions and it grows successfully in the region where minimum average annual rainfall is about 400 mm. Ardu is a suitable tree for resource-poor farmers of semi-arid areas of Rajasthan, to meet out the demand of green leaf fodder for small ruminants (sheep and goat) during lean period of the year (April-May and November-December) and also supplemented the green fodder availability during rest of the months (Mann *et al*. 1989, Mann 1994). Ardu is not only grown as homestead agroforestry on field boundaries as shelterbelts but also grown as a shade and avenue tree in most of the semi-arid areas of Rajasthan to supply the green leaf fodder, fuelwood and timber. Ardu provides nutritious green fodder during the lean period to the small ruminants. Ardu leaves are best among all the fodder trees from palatability and nutritive value (19% protein) point of view (ICAR 1990). In semi-arid regions of Rajasthan ardu leaves are used as a green fodder to small ruminants because of its high nutritive value, palatability and digestibility. The green leaves contains 19.87% crude protein, 12.72% crude fibre, 3.53% ether extract, 11.97% total ash, 2.11% calcium and 0.24% phosphorus (Singh and Patnayak 1977). Ardu is also recognized as a valuable tree in sustainable development and enhancing livelihoods of resource-poor farmers in semi-arid regions because of its wider adaptability, fast growth and higher tolerance to biotic and abiotic stresses, supplying green leaf fodder and timber for plywood (Gupta 1980). It is very imperative and/or demands of time to identify the fast-growing multipurpose tree (ardu) which is highly suited for agroforestry systems on sandy loam soils of semi-arid agro-ecosystem to meet out the demand of human and cattle population without degradation of land and forest resources by growing ardu on degraded lands. Ardu being cross pollinated crop offers tremendous scope for selection of high-yielding genotypes to increase the productivity. Hence, identification of an

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appropriate genotype suitable for specific region is an important factor. In some of the regions the ardu performing better and in some regions not up to the potential because of location-specific characteristics. Looking to the importance of ardu as a nutritious and palatable multi-purpose fodder tree in the semi-arid regions, the present study was conducted to identify the best performing genotypes of ardu on the basis of growth and productivity characteristics.

MATERIALS AND METHODS

The study was carried out during 2006–08 at Central Sheep and Wool Research Institute (CSWRI), Avikanagar. It lies between 26° 15' to 26° 25' N latitude and 75° 25' to 75° 28' E longitude, in the central-east of Rajasthan. The experiment location lies in 326 m above mean sea level with annual rainfall range of 350–475 mm. Geologically this site belongs to the Pleistocene era and the main deposits are aeolian and alluvial in nature. The soil was sandy loam in texture with medium to high infiltration rate, having *p*H 8.4 and low in organic carbon 0.22%, and contained 134.3, 16.4 and 168.2 kg/ha of available NPK, respectively. The maximum temperature reaches up to 47°C during June and minimum temperature reaches 0.5°C during January. More than 80% of the rainfall is received by south-west monsoon (June to September) and rest by north-east monsoon (January–February). To identify the best performing genotypes, a survey was carried out during 2004–05 to study the performance of ardu (*Ailanthus* spp) on the basis of growth parameters in the eastern part of *Aravalli* range (oldest mountain range in the world) covering 18 arid and semi-arid districts of Rajasthan. The biometrical observations, viz age, plant height and crown diameter were recorded in September–October when plant attains full bloom stage. The best trees/genotypes were selected on the basis of biometrical characteristics and tagged for seed collection at different locations. The seeds from the different genotypes were collected in April and sown in the nursery in June. In nursery, complete package of practices were followed to save the plants from hot winds, insect, pests and diseases. Timely watering (once in 15 days during summer and winter and fertilizer (10 kg farmyard manure, 100 g nitrogen, 50 g phosphorus and 50 g potash/plat was given during first year and it was doubled in the same proportion during second year) were applied as per requirement of the plants as suggested by Jat *et al*. (2006). The transplanting was done in August in the main experimental field. The experimental material/different genotypes were collected from the 18 arid and semi-arid districts of Rajasthan, viz Jaipur ('Sel 1'), Sikar ('Sel 2'), Nagaur ('Sel 3'), Jhunjhunu ('Sel 4'), Alwar ('Sel 5'), Bharatpur ('Sel 6'), Karauli ('Sel 7'), Dausa ('Sel 8'), Swaimadhopur ('Sel 9'), Bundi ('Sel 10'), Kota ('Sel 11'), Bhilwara ('Sel 12'), Ajmer ('Sel 13'), Tonk ('Sel 14'), Udaipur ('Sel 15'), Rajsamand ('Sel 16'), Sirohi ('Sel 17'), and Chittorgarh ('Sel 18'). All the 18 genotypes were planted during 2006 in a randomized block design with 3 replications at spacing of 10 m×5 m. Three plants from the each genotype were planted in the field. Recommended package of practices were followed and observations were recorded at 6-monthly interval for 24 months during 2006, 2007 and 2008 on various growth-attributing characters, viz plant height (cm), crown diameter (cm), leaf area/leaflet (cm^2), leaf area index, leaf dry matter accumulation/plant (kg/plant) and plant growth rate (g/day/plant). An adequate plant protection measure was done as and when required. Observations on growth-attributing characters were recorded and analyzed statistically by adopting the procedure of Gomez and Gomez (1984).

RESULTS AND DISCUSSION

The plant height ranged from 15.0 to 41.7 cm at 6 months after planting, 34.3 to 100.7 cm at 12 months after planting, 46.3 to 150.0 cm at 18 months after planning and 88.0 to 251.3 cm at 24 months after planting in different genotypes. The variation was significant among different genotypes (Table 1). Maximum plant height was observed in 'Sel 9' (41.7 cm) which was at par with 10 genotypes ('Sel 1-2, 4-7, 9-10 and 13-14') at 6 months after planting than rest of the selections. The same trend of plant height was observed at 12, 18 and 24 months after planting in all 10 genotypes. However, the plant height was also at par in 'Sel 3' at 18 and 24 months after planting over the other genotypes. The highest plant height 40.7, 100.7, 150.0 and 251.3 cm was recorded in 'Sel 9' at 6, 12, 18 and 24 months after planting, respectively. 'Sel 9' genotype from Swaimadhopur was superior over all the genotypes.

The crown diameter of the plant was significantly affected under different genotypes of ardu. Maximum crown diameter was observed in 'Sel 9' (1.50 cm) which was at par with 10 genotypes ('Sel 1-7, 10, 12 and 14') at 6 months after planting over the other selections. At 12, 18 and 24 months after planting of ardu, 'Sel 7' gave the highest 3.92, 5.73 and 9.34 cm crown diameter, respectively (Table 1). These values were at par with 'Sel 1-6, 8, 9, 12 and 14' genotypes at 12, 18 and 24 months after planting. Whereas, 'Sel 13' was also at par with 'Sel 7' at 24 months after planting then rest of the genotypes. The genotype selection from Karauli ('Sel 7) was performing better than the others with respect to crown diameter but there was no much difference with the values of 'Sel 9'.

Leaf area indicates the size of the leaf which results in higher production of green leaf fodder. 'Sel 7 and 9 showed better performance over all the genotypes of ardu (Table 1). Maximum leaf area/leaflet was recorded in 'Sel 7' at 6, 18 and 24 months after planting, however, 'Sel 9' showed highest at 12 months after planting. The leaf area/leaflet in 'Sel 7' (69.9 cm^2) was at par with other genotypes ('Sel 1–2, 4, 6, 9-10, 12 and 14-15') then rest of the selections at 6 months after planting. At 12 months after planting 'Sel 9' was significantly at par with 'Sel 1-2, 4-7, 10, and 12-15' over

Table 1 Effect of different ardu genotypes on different growth characteristics

Genotype	Plant height (cm)				Crown diameter (cm)				Leaf area/leaflet (cm^2)			
	6 MAP	12 MAP	18 MAP	24 MAP	6 MAP	12 MAP	18 MAP	24 MAP	6 MAP	12 MAP	18 MAP	24 MAP
'Sel 1'	36.67	84.00	135.33	214.00	1.33	3.31	4.95	7.75	69.05	117.18	84.74	74.38
'Sel 2'	25.83	84.33	145.33	221.00	0.86	3.18	4.42	8.12	45.25	115.14	78.50	87.86
'Sel 3'	21.00	62.67	114.33	197.33	0.56	2.72	4.35	8.05	15.91	71.53	85.35	61.71
'Sel 4'	40.33	76.00	112.00	201.67	1.30	3.24	4.40	7.95	63.37	85.47	54.79	80.17
'Sel 5'	26.33	76.67	126.33	222.67	1.19	3.00	4.71	8.46	27.21	96.20	107.53	93.67
'Sel 6'	33.00	86.00	137.33	228.33	1.32	3.85	5.06	8.34	60.55	104.97	85.81	80.59
'Sel 7'	35.33	88.00	131.33	206.67	1.43	3.92	5.73	9.34	69.91	111.13	118.93	98.33
'Sel 8'	19.67	39.67	76.67	135.67	0.40	1.55	2.85	5.52	15.07	52.76	38.35	37.46
'Sel 9'	40.67	100.67	150.00	251.33	1.50	3.74	5.38	8.85	62.92	139.15	95.94	95.45
'Sel 10'	31.67	68.67	115.33	199.33	1.20	3.47	4.84	8.75	42.14	100.95	85.43	79.70
'Sel 11'	22.33	41.00	68.33	165.00	0.41	1.44	2.71	7.07	26.46	63.67	80.29	46.61
'Sel 12'	41.67	90.67	137.00	231.33	1.17	3.37	4.42	8.08	43.02	112.97	86.26	66.83
'Sel 13'	27.00	70.00	118.67	215.33	0.40	2.25	3.86	8.30	20.00	96.80	83.42	57.12
'Sel 14'	29.33	89.67	126.00	205.67	1.51	3.90	4.88	8.28	56.18	131.09	95.81	79.32
'Sel 15'	25.67	67.67	96.00	188.00	0.73	2.36	3.37	7.30	34.64	106.89	63.14	45.07
'Sel 16'	15.00	36.33	62.00	145.00	0.33	1.18	2.61	5.48	6.59	48.58	49.02	44.93
'Sel 17'	19.00	34.33	46.33	88.00	0.36	0.67	1.31	3.73	13.41	29.65	18.15	16.46
'Sel 18'	21.00	49.33	77.33	175.00	0.29	1.66	2.46	5.93	25.73	46.00	32.26	27.10
SEm±	5.50	11.15	14.42	19.37	0.29	0.50	0.48	0.59	13.05	21.19	13.41	13.49
CD (P=0.05)	15.89	32.20	41.63	55.90	0.82	1.44	1.37	1.71	37.67	61.15	38.69	38.93

MAP, Months after planting

Table 2 Effect of different ardu genotypes on leaf area index (LAI), leaf dry matter accumulation (DMA)/plant (kg) and plant growth rate (g/day/plant)

Genotype	LAI				Leaf DMA/plant (kg)				PGR (g/day/plant)			
	6 MAP	12 MAP	18 MAP	24 MAP	6 MAP	12 MAP	18 MAP	24 MAP	6 MAP	12 MAP	18 MAP	24 MAP
'Sel 1'	2.58	3.51	1.94	2.15	0.031	0.172	0.216	0.470	0.170	0.953	1.197	2.609
'Sel 2'	1.83	3.43	2.63	2.90	0.001	0.233	0.233	0.533	0.117	1.284	1.331	2.963
'Sel 3'	2.17	2.87	3.00	2.49	0.001	0.144	0.305	0.675	0.028	0.820	1.668	3.681
'Sel 4'	2.20	1.93	3.37	2.57	0.000	0.133	0.233	0.567	0.154	0.767	1.169	3.089
'Sel 5'	2.29	2.48	2.14	2.84	0.009	0.232	0.218	0.619	0.050	1.291	1.209	3.439
'Sel 6'	2.84	2.03	3.32	1.57	0.015	0.215	0.319	0.530	0.083	1.196	1.773	2.946
'Sel 7'	2.40	2.29	3.09	2.73	0.028	0.284	0.298	0.673	0.155	1.580	1.653	3.737
'Sel 8'	1.84	3.84	6.85	1.18	0.007	0.065	0.105	0.157	0.037	0.361	0.581	0.873
'Sel 9'	1.87	2.92	4.18	2.27	0.023	0.349	0.344	0.754	0.129	1.936	1.913	4.189
'Sel 10'	2.08	2.54	2.63	2.16	0.014	0.232	0.202	0.586	0.077	1.286	1.119	3.254
'Sel 11'	2.07	2.94	4.23	0.95	0.008	0.042	0.110	0.245	0.046	0.233	0.611	1.362
'Sel 12'	2.11	3.26	3.78	1.31	0.008	0.353	0.249	0.552	0.045	1.958	1.383	3.065
'Sel 13'	0.98	3.12	4.54	1.22	0.015	0.096	0.228	0.411	0.085	0.533	1.267	2.284
'Sel 14'	1.86	3.39	5.10	1.30	0.024	0.223	0.315	0.462	0.133	1.238	1.749	2.564
'Sel 15'	1.17	1.67	2.86	0.91	0.012	0.067	0.217	0.274	0.069	0.374	1.206	1.521
'Sel 16'	1.93	2.90	2.38	1.36	0.004	0.077	0.191	0.191	0.024	0.430	1.063	1.059
'Sel 17'	1.45	4.57	2.55	0.49	0.003	0.044	0.035	0.049	0.019	0.245	0.195	0.269
'Sel 18'	1.54	3.73	2.39	0.65	0.008	0.066	0.080	0.104	0.042	0.364	0.443	0.576
SEm±	0.53	0.69	1.49	0.38	0.005	0.071	0.079	0.143	0.033	0.396	0.435	0.791
CD (P=0.05)	NS	NS	NS	NS	0.016	0.205	0.227	0.412	0.096	1.143	1.255	2.282

MAP, Months after planting

other genotypes of ardu. The leaf area/leaflet in 'Sel 7' (118.9 cm^2) was at par with other genotypes (('Sel 1, 3, 5, 6, 9, and 10-14') at 18 months after planting then rest of the selections. However, it was (98.3 cm^2) at par with 'Sel 1-6, 9, 10, 12 and 14') over other genotypes at 24 months after planting.

Leaf area index (LAI) was not significantly affected by different genotypes of ardu at 6, 12, 18 and 24 months after planting (Table 2). The maximum LAI was 2.80, 4.57, 9.80 and 2.90 recorded at 6, 12, 18 and 24 months after planting, respectively. LAI depends not only on leaf area but also on the plants ground area, thus no clear trends was observed in selections of ardu genotypes.

Leaf dry matter accumulation was increased with the time in all the genotypes of ardu. The mean values of dry matter accumulation/plant were 0.014, 0.168, 0.215 and 0.434 recorded at 6, 12, 18 and 24 months after planting (Table 2). 'Sel 1 and 7' was recorded (0.03 kg/plant) significantly higher leaf dry matter accumulation over other genotypes of ardu at 6 months after planting. At 12 months after planting the highest values of dry matter accumulation was recorded with 'Sel 9' (0.35 kg/plant) and it was at par with 'Sel 1-3, 5-7, 10, 12 and 14' then rest of the selections. The maximum dry matter accumulation was observed in 'Sel 9' (0.34 kg/plant) and it was at par with all other selections of ardu except 'Sel 17 and 18' at 18 months after planting. The dry matter accumulation per plant was observed very less about 0.17 kg/plant at 12 months after planting and 0.22 kg/plant at 18 months after planting. It might be due to the low temperature during winter season, when the plants growth becomes negligible. The highest values of dry matter accumulation was observed with 'Sel 9' (0.75 kg/plant) at 24 months after planting and it was at par with 'Sel 1-7, 10, and 12-14' then other genotypes of ardu.

Plant growth rate showed the overall performance of the plant with respect to all the characters. 'Sel 9' showed the better performance over rest of the selections at 12, 18 and 24 months after planting (Table 2). Maximum plant growth rate was recorded with 'Sel 1' (0.17 g/day/plant) which was at par with 'Sel 2, 4, 7, 9, and 14' over other genotypes of ardu. In genotype 'Sel 9', the highest value of plant growth rate (1.91, 1.91 and 4.19 g/day/plant) was recorded at 12, 18 and 24 months after planting. At 12 months after planting the highest values of plant growth rate was recorded with 'Sel 9' (1.94 g/day/plant) which was at par with 'Sel 1-7, 10, 12 and 14' then rest of the genotype selections. The maximum plant growth aret was observed in 'Sel 9' (1.91 g/day/plant) which was at par with'Sel 1-7, 10 and 12-16' over other genotypes. In 'Sel 1-7 and 9-14', the results are significantly at par and higher over the other selections.

Thus, results indicated that 'Sel 9' genotypes performed at par with 'Sel 7' in a similar trend with respect to all the growth characteristics. Among the genotypes, 'Sel 9' and 'Sel 7' performed consistently with higher growth characteristics over the 2 years study. Ardu selection from Swaimadhopur ('Sel 9') was found superior with respect to all the characteristics which was closely followed by the selection from Karauli ('Sel 7'). The growth performance of all the genotypes showed positive trend with the age of the plants. In semi-arid areas of Rajasthan, to meet out the demand of green leaf fodder for small ruminants and to supplement the green fodder availability under resource-poor farmer's conditions, selection of suitable tree species for any specific region is very crucial for sustaining livelihood and rural development.

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