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Study of Seed Orchard population in *Acacia auriculiformis* Through Seed Image Analysis Technique

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ABSTRACT

Acacia auriculiformis is a fast-growing, multipurpose native tree species of Australia and has been introduced to India. It is widely planted for timber, pulp and fuel wood. Seed orchards constitute an important component in most tree improvement programme and seeds from seed orchards are superior to stand seeds.The Institute of Forest Genetics & Tree Breeding (IFGTB), Coimbatore had initiated tree improvement programme on *Acaia auriculiformis* during 1995 with the collaboration of Australian Tree Seed Center, CSIRO, Australia. The Institute had established seedling seed orchards of first and second generation trials of *Acacia auriculiformis* in Southern States (Tamil Nadu and Kerala) of India. We had collected seeds from the first and second generation orchards populations for mating system study. Under this study a preliminary work was carried out for seed variability in orchards population. Therefore the present paper deals about the seed Image analyses of *Acacia auriculiformis* of first and second generation populations. The results of the present study exhibited consistent variation in seed area, length, breadth from the first and second generation seed populations.The seed image data indicated that genetically high quality of seed population were derived from the second generation orchard population.

Key Words:

Acacia auriculiformis, Seed image analysis, First and Second generation populations

INTRODUCTION

Acacia auriculiformis is a fast-growing, evergreen tree belongs to the family Fabaceae and it grows up to 30 m tall. It is native to Australia, Indonesia, Papua New Guinea and has been introduced to India. It has been planted widely for pulp and fuelwood with calorific

value of 4500-4900 kcal/kg in India and Southeast Asia.

The tree is raised as an ornamental purpose, as a shade tree and also used as fodder. The wood has a high basic density (500-650 kg m^{-3}), excellent for turnery articles, toys, carom coins, chessmen, handicrafts and also used for furniture. The bark contains tannin (13-25%) and contains 6-14% of a natural dye suitable for the soga-batik industry. The root system stabilizes eroding land in mine spoils and fixes nitrogen. The plantation has improved in soil physio-chemical properties such as water-holding capacity, organic carbon, nitrogen and potassium through litter fall.

Seeds provide the most natural resources of plant reproduction, preservation of genetic variability, and propagation of plants. Though, viable seeds do not germinate even under favorable environmental conditions. Several internal factors cause dormancy such as seed coat, embryo or inhibitors, which influence the seed germination rate. Seed orchards constitute an important component in most tree improvement programs, and seeds from seed orchards are superior to stand seeds. Seed orchards are the most common and cost-effective means of making available a stable supply of genetically improved seed (Varghese et al. 2000). Seedling seed orchards (SSO) have a broad genetic base because of the large number of parents involved, but the selection differential is less than in the vegetative seed orchard. When the seedlings are grown from open-pollinated seeds collected from selected trees, the cost for raising material and time required for establishment will usually be low in comparison with costs of establishing clonal seed orchards (Toda, 1964). The progress of a seed orchard program depends on a plentiful delivery of viable seed. The final cone and seed yields may be influenced by breakdown of any one of the processes of pollination, pollen grain germination, pollen tube growth, fertilization and embryo development (Brown 1971). Seed orchards have been established with selected superior trees to produce seeds that are physiologically and genetically better than those obtainable from natural stands.

Genetic gain and gene diversity of orchard crops were evaluated in seed orchard populations. High genetic gain could be obtained using orchard management alternatives (*e.g.*, selective cone harvest, genetic thinning), while reasonable gene diversity (measured by status number) was maintained. Effective management of forest genetic resources is a key element in future forestry. In the future, seed orchards must balance genetic gain and gene diversity, in order to ensure high genetic quality of orchard crops (Zobel et al. 1958). Hence, there is a need for information on seed orchard genetics. Furthermore, tree improvement through seed orchards is probably one of the most cost-effective alternatives available to forest managers to improve forest productivity. Orchard seeds yield good forests and give additional protection because they contain the offspring of carefully selected superior parents.

With the technical collaboration of Australian Tree Seed Center, CSIRO, Australia, Institute of Forest Genetics & Tree Breeding (IFGTB), Coimbatore had initiated tree improvement programme during 1995. The Institute had established seedling seed orchards of first and second generation trials of *Acacia auriculiformis* in Southern States (Tamil Nadu and Kerala) of India. Second generation seed orchards were assembled by selecting the best trees in the best families from the progenies of the first generation seed orchard trees. Seeds produced from these orchards would produce seedlings with even better potential for good growth than the first generation orchards. We collected seeds from the first and second generation orchards populations for mating system study. Under this study a preliminary work was carried out for seed variability in orchards population. Therefore the present paper deals about the seed Image analyses of *Acacia auriculiformis* of first and second generation populations.

MATERIALS AND METHODS

Seeds from the pods were collected from ten randomly selected trees in seedling seed orchards of both first and second generation plantations in Tamil Nadu and Kerala, India. One hundred seeds per tree in ten different trees were collected. Around one thousand seeds were studied in each orchard. Image analyzer (Leica Quantimet 500+) was used for measurements. Seeds of above mentioned sample quantity were spread on a glass platform of macro-viewer in replication wise and images were captured and taken into the software called Quantimet 500+ or QWin. The captured images were calibrated to actual scale. The QWin identifies the object based on our specification for seed colour. The QWin measures 2D Surface area, length, breadth, roundness and perimeter of the identified images of seeds. Roundness is shape factor. Roundness gives a minimum value of unity for a circle. This is calculated from the ratio of perimeter square to area (Anon. 1995). The adjustment factor of 1.064 corrects the perimeter for the effect of the corners produced by the digitization of the image. When the seeds are perfectly round the roundness will be one and when the seeds are elliptical and other shapes it ismore than one. The 100 seed weight was taken separately with four replications for each tree.

RESULTS AND DISCUSSIONS

The results of the present study showed that consistent variation exhibited in Seed area, length, breadth and roundness from the first and second generation seed studies (Table1 to Table 4) of *Acacia auriculiformis*. In the location Karunyanager (Tamil Nadu) and Panampalli (Kerala) showed the grand mean of seed area (1.46 cm^2; 1.44 cm^2), standard deviation (0.19; 0.21), the range between maximum seed area (1.86 cm^2; 1.69 cm^2) to minimum (1.05 cm^2;1.03 cm^2) in the first generation orchards, whereas in the second generation orchards (Panampalli and Wadakanchery), the grand mean of seed area cm^2 (1.58 cm^2; 1.73 cm^2), standard deviation (0.19; 0.21), the range between maximum (1.99 cm^2; 2.19 cm^2) to minimum (1.16 cm^2;1.31 cm^2). In seed length the grand mean of first generation values in Karunyanagar was 0.50 cm, standard deviation (0.04), the range between seed length in maximum (0.59 cm) to minimum (0.42 cm) whereas in Panampalli, the seed length was 1.18 cm, standard deviation (0.17), the range between seed length in maximum (1.51 cm) to minimum (0.85cm). The grand mean of seed length of second generation values were in Panampalli was 0.52 cm, standard deviation (0.04), the range between seed length in maximum (0.61 cm) to minimum (0.45cm). Similarly in Wadakanchery, the seed length was 0.54cm, standard deviation (0.04), the range between seed length in maximum (0.62 cm) to minimum (0.46 cm).

Another seed characters such as seed breadth of first generation orchards showed grand mean (0.39cm); standard deviation (0.03), maximum (0.46 cm) and minimum (0.31 cm) of seed breadth in KarunyaNager (Tamil Nadu) and in Panampalli (Kerala) grand mean (0.37cm); standard deviation (0.04), maximum (0.45 cm) and minimum (0.30 cm) of seed breadth. In the second generation orchards, showed grand mean (0.4cm); standard deviation (0.04), maximum (0.47 cm) and minimum (0.32 cm) of seed breadth in Panampalli, Kerala and in Wadakanchery (Kerala) grand mean (0.42cm); standard deviation (0.04), maximum (0.49 cm) and minimum (0.34 cm) of seed breadth.

In the seed image study on roundness in both generations were showed that there was no significant variation in grand mean of roundness (0.13; 0.12; 0.12; 0.12); the standard deviation (0.02; 0.01; 0.01; 0.01) and the roundness range in maximum (0.17; 0.14; 0.15; 0.14) and minimum (0.11; 0.10; 0.10; 0.10) of seed roundness. The effect of seed size and seed weight on growth in plant species have been studied through Image Analyses technique by Vijaya Geetha et al. (2011), Sumathi and Balamurugan (2013), Mandal et al. (2012), Arya and Lehana (2012), Gomes Junior et al. (2014), Dias man et al.

Table 1. Seed image Analysis in first generation Orchard Seeds (Karunyanagar, Tamil Nadu)

Tree	Area (cm^2)				Length (cm)				Breadth (cm)				Roundness			
no.	Mean	Stdev	Max	min	Mean	stdev	Max	min	Mean	stdev	Max	min	Mean	stdev	Max	min
1	1.545	0.216	1.996	0.951	0.522	0.048	0.642	0.439	0.404	0.035	0.484	0.336	0.133	0.017	0.192	0.112
2	1.645	0.217	2.099	1.240	0.534	0.040	0.624	0.445	0.404	0.035	0.484	0.336	0.148	0.024	0.167	0.084
3	1.542	0.198	1.956	1.196	0.511	0.040	0.606	0.443	0.407	0.034	0.480	0.342	0.142	0.029	0.229	0.109
4	1.407	0.225	1.836	0.943	0.503	0.049	0.599	0.408	0.378	0.038	0.451	0.297	0.140	0.025	0.210	0.112
5	1.472	0.200	1.832	1.069	0.503	0.041	0.595	0.425	0.390	0.034	0.455	0.320	0.137	0.024	0.204	0.111
6	1.311	0.195	1.775	0.961	0.472	0.047	0.597	0.394	0.366	0.030	0.430	0.300	0.120	0.013	0.163	0.107
7	1.336	0.171	1.674	0.904	0.478	0.040	0.567	0.394	0.368	0.033	0.436	0.291	0.115	0.010	0.156	0.106
8	1.471	0.169	1.844	1.162	0.496	0.032	0.556	0.429	0.388	0.032	0.452	0.315	0.113	0.005	0.133	0.106
9	1.369	0.193	1.738	0.938	0.485	0.037	0.567	0.411	0.372	0.038	0.439	0.283	0.114	0.005	0.133	0.106
10	1.493	0.159	1.824	1.137	0.507	0.035	0.581	0.435	0.385	0.033	0.460	0.317	0.114	0.004	0.126	0.107
GM	1.46	0.19	1.86	1.05	0.50	0.04	0.59	0.42	0.39	0.03	0.46	0.31	0.13	0.02	0.17	0.11

Table 2. Seed Image Analysis in first generation Orchard Seeds (Panampalli, Kerala)

Tree	Area (cm^2)				Length (cm)				Breadth (cm)				Roundness			
no.	Mean	Stdev	Max	min	Mean	stdev	Max	min	Mean	stdev	Max	min	Mean	stdev	Max	min
1	1.393	0.171	1.764	1.038	0.496	0.042	0.577	0.418	0.369	0.032	0.434	0.314	0.115	0.006	0.134	0.107
2	1.343	0.172	1.650	1.025	0.485	0.039	0.565	0.400	0.365	0.034	0.434	0.297	0.115	0.006	0.136	0.107
3	1.360	0.171	1.744	1.017	0.495	0.043	0.591	0.405	0.363	0.034	0.439	0.303	0.116	0.007	0.139	0.108
4	1.255	0.210	1.648	0.922	1.255	0.210	1.648	0.922	0.347	0.036	0.423	0.283	0.115	0.006	0.139	0.107
5	1.301	0.203	1.664	0.893	1.301	0.203	1.664	0.893	0.350	0.038	0.418	0.277	0.116	0.007	0.144	0.108
6	1.326	0.179	0.035	0.935	1.326	0.179	1.695	0.935	0.362	0.035	0.429	0.284	0.115	0.006	0.131	0.106
7	1.396	0.202	1.846	0.938	1.396	0.202	1.846	0.938	0.367	0.037	0.449	0.284	0.114	0.005	0.134	0.106
8	1.612	0.275	2.152	1.117	1.612	0.275	2.152	1.117	0.391	0.041	0.473	0.313	0.115	0.006	0.139	0.108
9	1.725	0.251	2.218	1.224	1.725	0.251	2.218	1.224	0.410	0.038	0.474	0.332	0.115	0.007	0.138	0.107
10	1.688	0.237	2.169	1.231	1.688	0.237	2.169	1.231	0.400	0.037	0.474	0.322	0.119	0.010	0.150	0.107
GM	1.44	0.21	1.69	1.03	1.18	0.17	1.51	0.85	0.37	0.04	0.45	0.30	0.12	0.01	0.14	0.10

Table 3. Seed Image Analysis in second generation Orchard Seeds (Panampalli, Kerala)

Tree	Area (cm^2)				Length (cm)				Breadth (cm)				Roundness			
no.	Mean	Stdev	Max	min	Mean	stdev	Max	min	Mean	stdev	Max	min	Mean	stdev	Max	min
1	1.431	0.189	1.859	1.064	0.492	0.039	0.571	0.422	0.380	0.033	0.459	0.312	0.116	0.010	0.154	0.107
2	1.522	0.183	1.913	1.137	0.507	0.037	0.586	0.434	0.394	0.034	0.455	0.314	0.114	0.006	0.131	0.106
3	1.597	0.171	1.921	1.275	0.520	0.036	0.604	0.460	0.404	0.032	0.469	0.343	0.114	0.007	0.137	0.106
4	1.736	0.202	2.154	1.253	0.551	0.044	0.637	0.462	0.419	0.038	0.499	0.337	0.118	0.008	0.140	0.106
5	1.664	0.199	2.057	1.213	0.531	0.036	0.610	0.459	0.414	0.040	0.490	0.336	0.118	0.008	0.151	0.108
6	1.577	0.198	2.057	1.200	0.512	0.042	0.602	0.434	0.405	0.034	0.482	0.335	0.119	0.005	0.134	0.110
7	1.595	0.206	2.055	1.152	0.532	0.041	0.623	0.460	0.399	0.037	0.470	0.325	0.121	0.010	0.155	0.108
8	1.662	0.218	2.116	1.169	0.538	0.041	0.650	0.453	0.408	0.040	0.485	0.323	0.116	0.008	0.145	0.108
9	1.508	0.171	1.815	1.076	0.517	0.036	0.593	0.437	0.387	0.034	0.447	0.309	0.119	0.009	0.155	0.108
10	1.523	0.218	1.944	1.083	0.522	0.042	0.619	0.442	0.390	0.046	0.475	0.286	0.123	0.012	0.162	0.110
GM	1.58	0.19	1.99	1.16	0.52	0.04	0.61	0.45	0.4	0.04	0.47	0.32	0.12	0.01	0.15	0.10

Table 4. Seed Image Analysis in second generation Orchard Seeds (Wadakenchery, Kerala)

Tree	Area (cm^2)				Length (cm)				Breadth (cm)				Roundness			
no.	Mean	Stdev	Max	min	Mean	stdev	Max	min	Mean	stdev	Max	min	Mean	stdev	Max	min
1	1.83	0.239	2.304	1.380	0.549	0.039	0.629	0.466	0.434	0.039	0.509	0.358	0.116	0.006	0.133	0.107
2	1.796	0.196	2.166	1.390	0.534	0.035	0.598	0.458	0.436	0.033	0.505	0.365	0.114	0.005	0.126	0.106
3	1.824	0.233	2.282	1.336	0.560	0.040	0.635	0.480	0.425	0.038	0.508	0.351	0.115	0.004	0.123	0.108
4	1.683	0.224	2.251	1.261	0.540	0.041	0.632	0.459	0.409	0.039	0.487	0.331	0.116	0.008	0.142	0.106
5	1.844	0.218	2.330	1.381	0.562	0.043	0.646	0.476	0.433	0.039	0.525	0.359	0.118	0.007	0.142	0.107
6	1.640	0.161	2.039	1.350	0.523	0.037	0.601	0.468	0.411	0.028	0.473	0.360	0.114	0.004	0.126	0.108
7	1.607	0.224	2.082	1.167	0.519	0.043	0.607	0.435	0.402	0.037	0.479	0.330	0.115	0.005	0.132	0.108
8	1.607	0.195	1.973	1.139	0.533	0.037	0.616	0.450	0.397	0.036	0.462	0.309	0.116	0.008	0.138	0.107
9	1.753	0.161	2.088	1.420	0.550	0.033	0.626	0.479	0.423	0.036	0.487	0.350	0.117	0.009	0.146	0.107
10	1.733	0.250	2.337	1.250	0.554	0.047	0.640	0.460	0.413	0.039	0.487	0.327	0.119	0.009	0.148	0.107
GM	1.73	0.21	2.19	1.31	0.54	0.04	0.62	0.46	0.42	0.04	0.49	0.34	0.12	0.01	0.14	0.10

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