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# Growth performance of *Ailanthus excelsa* through progeny test

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**Abstract**
Investigations were carried out to draw out information in 30 progenies of *Ailanthus excelsa* Roxb. Genetic resources to elicit information on the growth performance among the biometric estimations. The performance of selected trees was studied through progeny evaluation at Forest College and Research Institute, Mettupalayam. The observations on the biometric attributes indicated wide range of variability and three progenies *viz.,* FCRI AE 6, FCRI AE 16 and FCRI AE 26 registered its superiority.

**Keywords:** *Ailanthus excels*, biometric attributes, genetic resources, growth performance, progeny test

## Introduction
*Ailanthus excelsa* Roxb.is a tree belonging to family Simaroubaceae, indigenous to Central and Southern India and commonly it is known as Tree of Heaven. It is a large deciduous tree and will be growing 18-25 m tall with straight trunk and 60 to 80 cm in diameter. It is mainly used to making plywood as well as match splint production (Orwa *et al.* 2009) [16]. Due to the demand of both plywood and match wood this study has conceived. Rapid socio-economic changes are having profound impacts on all sectors including forestry. Societal transformations are changing people's perceptions of forests, while growing and often conflicting demands for forest-derived goods and services have increased the complexity of forest management. Concerns over climate change, escalating energy prices and deepening water deficits have moved forestry into the spotlight of global and national development. Currently, the forest area in the country is around 23.81 per cent and in the state of Tamil Nadu it is around 17.59 per cent which is much low against the demanded requirement of 33.0 per cent. The productivity in terms of MAI is also one of the lowest comparing to the global average (FSI, 2011). The annual estimated production of wood from forest is estimated to be 3.173 million $m^3$ and the annual potential production of wood from outside the forests is estimated to be 42.77 million $m^3$ (FSI, 2011). The country's timber imports value I growing at 12 per cent per annum and is likely to increase in years ahead. The liberalization of imports has benefited the domestic timber market, otherwise faced paucity of the desired wood in the required quantity and quality. However, there is a potential to increase the domestic production of industrial wood through tree planting, afforestation and reforestation programmes (Manoharan, 2001). Hence shrinking forest area associated with low productivity established a total mismatch between the demand and supply of both domestic and industrial wood requirement besides creating environmental disequilibrium (Parthiban *et al.,* 2011) [19]. The current supply of raw materials for industries like match wood, pulpwood, plywood, furniture and biomass energy in India particularly in Tamil Nadu is far behind the demand. Hence, to meet the growing raw material demand and also to meet the National Forest Policy (1988). Guidelines, the industries must expand sharply its plantation programme. There are over 400 small-scale sector Splints and Veneer Industry involved in the manufacturing of veneers and splints in southern India of which 75% are located in Kerala (Bansal *et al.,* 2002) [2]. Per capita consumption of matches in India increased steadily from 2.45 sticks per capita in 1970 to 8.35 in 2013. There are wide fluctuations in the annual growth rate in the consumption of matches varying from as low as 3 per cent (before 1970) to as high as 28 per cent. The rising levels of income, growing urbanization, swelling numbers of smokers, and changes in fuel consumption patterns indicates that the future rate of growth could be higher than the 6 per cent as supported by past trends (FAO, 2015). The major raw materials used in the production of safety matches are soft woods. Safety matches manufactured in India are of the standard type

with wooden veneer or cardboard boxes and wooden splints. Historically the Indian match industry depended on imported wood including Aspen (*Populus tremula*) from Sweden, Canada, America, and Russia; Cotton Wood (*Populus deltoides*) from Canada; Balsam Poplar (*Populus balsamifera*) from Manchuria; and Linden (*Tilia japonica*) from Japan. But the government quickly moved to encourage the use of indigenous woods by restricting the import. Even though there are number of alternative match wood species are available to replace the imported wood, *Ailanthus excelsa* occupies predominant position because of its suitability for the production quality match splints. However there is no systematic evaluation or improvement programme in order to utilize the existing genetic variation among broader genetic base population which warrants a systematic tree improvement programme in *Ailanthus excelsa* which will also address the shortage of suitable raw material to the match industries.

## Materials and methods

### Materials

The species *Ailanthus excelsa* was chosen as the experimental material for the present study which consists of 30 progenies established as a progeny evaluation trial.

### Methods

#### Estimation of morphometric attributes

#### Source of progenies

The predominant eleven *Ailanthus excelsa* distributed districts of Tamil Nadu *viz*. Coimbatore, Tiruppur, Erode, Salem, Theni, Dindigul, Virudhunagar, Dharmapuri, Krishnagiri, Villupuram, and Karur were surveyed and a total number of 30 candidate plus trees were selected. These selected CPTs were given with the accession number as FCRI AE. The details on the actual locations of the 30 selected candidate plus trees are presented in table 1.

**Table 1:** Details of *Ailanthus excelsa* genetic resources and their location

| SI. No. | District | Sources | Name of sources | Latitude | Longitude |
|---|---|---|---|---|---|
| 1 | Coimbatore | Akkarai sengapalli | FCRI AE 1 | 11$^{0}$19’28”N | 77$^{0}$04’53”E |
| 2 | Coimbatore | S. Pungampalayam | FCRI AE 2 | 11$^{0}$03’24”N | 77$^{0}$19’51”E |
| 3 | Coimbatore | Cherannagar-1 | FCRI AE 3 | 11$^{0}$03’05”N | 76$^{0}$56’32”E |
| 4 | Coimbatore | Cherannagar-2 | FCRI AE 4 | 11$^{0}$03’05”N | 76$^{0}$56’32”E |
| 5 | Coimbatore | Teachers colony | FCRI AE 5 | 11$^{0}$09’37”N | 76$^{0}$56’33”E |
| 6 | Coimbatore | Annur-1 | FCRI AE 6 | 11$^{0}$14’03”N | 77$^{0}$06’19”E |
| 7 | Coimbatore | Annur-2 | FCRI AE 7 | 11$^{0}$14’03”N | 77$^{0}$06’19”E |
| 8 | Coimbatore | Alamelu mangapuram | FCRI AE 8 | 11$^{0}$02’45”N | 76$^{0}$58’40”E |
| 9 | Coimbatore | Vaikalpalam | FCRI AE 9 | 10$^{0}$58’53”N | 76$^{0}$55’17”E |
| 10 | Tiruppur | Pogalur | FCRI AE 10 | 11$^{0}$15’25”N | 77$^{0}$02’26”E |
| 11 | Tiruppur | Samundipuram | FCRI AE 11 | 11$^{0}$07’28”N | 77$^{0}$18’60”E |
| 12 | Tiruppur | Kulathu thottam | FCRI AE 12 | 11$^{0}$03’33”N | 77$^{0}$15’56”E |
| 13 | Tiruppur | Salakkudi | FCRI AE 13 | 10$^{0}$41’04”N | 77$^{0}$36’22”E |
| 14 | Tiruppur | Chettipalayam | FCRI AE 14 | 11$^{0}$08’38”N | 77$^{0}$20’28”E |
| 15 | Erode | Appachimar madam | FCRI AE 15 | 11$^{0}$19’51”N | 77$^{0}$28’47”E |
| 16 | Erode | Perundurai | FCRI AE 16 | 11$^{0}$16’26”N | 77$^{0}$35’18”E |
| 17 | Salem | Pethanayakkanpalayam | FCRI AE 17 | 11$^{0}$38’51”N | 78$^{0}$30’20”E |
| 18 | Salem | Idapadi | FCRI AE 18 | 11$^{0}$35’05”N | 77$^{0}$50’20”E |
| 19 | Theni | Uthamapalayam | FCRI AE 19 | 9$^{0}$48’20”N | 77$^{0}$19’40”E |
| 20 | Theni | Thevaram | FCRI AE 20 | 9$^{0}$53’44”N | 77$^{0}$16’31”E |
| 21 | Theni | Bodi | FCRI AE 21 | 10$^{0}$01’00”N | 77$^{0}$21’00”E |
| 22 | Dindugal | Kallimandayam | FCRI AE 22 | 10$^{0}$35’28”N | 77$^{0}$44’11”E |
| 23 | Virudhunagar | Srivilliputhur | FCRI AE 23 | 9$^{0}$30’44”N | 77$^{0}$38’03”E |
| 24 | Dharmapuri | Harur | FCRI AE 24 | 12$^{0}$03’05”N | 78$^{0}$28’49”E |
| 25 | Dharmapuri | Papparettipatti | FCRI AE 25 | 11$^{0}$54’49”N | 78$^{0}$21’57”E |
| 26 | Krishnagiri | Oothangarai | FCRI AE 26 | 12$^{0}$15’57”N | 78$^{0}$32’07”E |
| 27 | Villupuram | Thiruvakkarai | FCRI AE 27 | 12$^{0}$01’34”N | 79$^{0}$39’06”E |
| 28 | Villupuram | Mathangadipattu | FCRI AE 28 | 11$^{0}$57’59”N | 78$^{0}$45’28”E |
| 29 | Villupuram | Pudupattu | FCRI AE 29 | 11$^{0}$58’21”N | 78$^{0}$53’52”E |
| 30 | Karur | Salikaraipatti | FCRI AE 30 | 10$^{0}$45’04”N | 78$^{0}$10’70”E |

#### Growth performance of progenies

A progeny evaluation trial has been laid out at Forest College and Research Institute, Mettupalayam during January 2013. Progenies of 30 different genotypes were planted in a Row Column Design with three replications. The spacing adopted was 3 x 3 m with 9 seedlings per progeny. The observations were recorded on all the nine plants at 2, 4, and 6 Months after Planting (MAP) as described below.

#### Survival percentage

The survival percentage was calculated by counting the established seedlings 2 MAP in the field and their mean was expressed in percentage.

#### Plant height

The plant height was measured from ground level to the tip of the stem and expressed in cm.

#### Basal diameter

Basal diameter was measured at the base of the stem (near the ground level) and expressed in cm.

#### Volume index

V.I. = (Collar diameter)$^{2}$ X Height (cm)
(Hatchel, 1985; Manavalan, 1990)

**Results**

Observations on morphometric traits *viz.*, survival percentage, plant height, basal diameter, number of branches and volume index were recorded in 30 progenies of *Ailanthus excelsa*. The morphometric traits were measured at four growth periods *viz.*, initial, 2 MAP, 4 MAP and 6 MAP.

Non significance was encountered among the 30 progenies of *Ailanthus excelsa* with respect to survival percentage. However, the survival percentage ranges from 66.66 percent (FCRI AE 13) to 100 per cent (FCRI AE 2, FCRI AE 6 and FCRI AE 16. Among the 30 progenies evaluated, significant differences were observed for this parameter. The initial plant height had ranged from 8.61 cm (FCRI AE 13) to 22.22 cm (FCRI AE 29). Among the 30 progenies investigated, four progenies *viz.*, FCRI AE 29 (22.22 cm), FCRI AE 6 (18.52 cm), FCRI AE 16 (18.50 cm) and FCRI AE 25 (18.43 cm) recorded significantly higher plant height compared to general mean (14.54 cm) at initial stage (Table 3). The highest plant height was recorded by the progeny FCRI AE 29 (22.22 cm) which is 34.56 per cent higher than the general mean. At 2 MAP, the plant height was ranged from 17.67 cm (FCRI AE 20) to 36.25 cm (FCRI AE 29). The general mean was 25.95 cm. The highest plant height was recorded by the progeny FCRI AE 29 (36.25 cm) which is 28.41 per cent higher than the general mean. However, three progenies *viz.*, FCRI AE 29 (36.25 cm), FCRI AE 16 (35.72 cm), and FCRI AE 6 (33.00 cm) had recorded significantly higher plant height compared to grand mean (25.95 cm). The general mean was 38.47 cm. The highest plant height was recorded by the progeny FCRI AE 16 (51.94 cm) followed by FCRI AE 5 (51.65 cm) and FCRI AE 6 (51.32 cm). The percentage increase in plant height by FCRI AE 16 over general mean was 25.02 per cent. The lowest plant height was exhibited by the progeny FCRI AE 13 (27.17 cm). Three progenies *viz.*, FCRI AE 16 (51.94 cm), FCRI AE 5 (51.65 cm) and FCRI AE 6 (51.32 cm) registered its consistent superiority even at 4 MAP but on par with each other. Significant variation was observed for plant height at 6 MAP. The minimum plant height was registered by the progeny FCRI AE 13 (36.11cm) against the general mean of (49.99 cm). Whereas, the maximum plant height were recorded by FCRI AE 16 (70.11 cm) at 6 MAP followed by FCRI AE 5 (67.21 cm) and FCRI AE 6 (69.36 cm).The per cent increase in plant height of FCRI AE 6 over the grand mean was 28.69. Considering all the growth periods into account two progenies *viz.*, FCRI AE 16and FCRIAE 6 had proved significant superiority consistently (Table 2).

**Table 2:** Variation in survival percentage (%) and plant height (cm) among the *Ailanthus excelsa* progenies

| Name of the Progeny | Survival Percentage | Plant Height (cm) | | | |
|---|---|---|---|---|---|
| | | **Initial** | **2 MAP** | **4 MAP** | **6 MAP** |
| FCRI AE 1 | 77.77 | 16.59 | 24.67 | 35.98 | 45.56 |
| FCRI AE 2 | 100.00 | 15.71 | 29.89 | 43.84 | 56.89 |
| FCRI AE 3 | 100.00 | 15.27 | 26.89 | 41.73 | 55.78 |
| FCRI AE 4 | 100.00 | 12.31 | 20.94 | 32.30 | 45.55 |
| FCRI AE 5 | 88.89 | 15.70 | 27.78 | 51.65* | 67.21* |
| FCRI AE 6 | 100.00 | 18.52* | 33.00* | 51.32* | 69.36* |
| FCRI AE 7 | 88.89 | 10.20 | 20.89 | 30.64 | 39.63 |
| FCRI AE 8 | 88.89 | 12.62 | 26.29 | 41.27 | 53.80 |
| FCRI AE 9 | 100.00 | 12.42 | 24.94 | 35.34 | 44.80 |
| FCRI AE 10 | 100.00 | 16.39 | 27.78 | 43.10 | 55.95 |
| FCRI AE 11 | 100.00 | 17.10 | 30.00 | 42.54 | 55.61 |
| FCRI AE 12 | 77.78 | 13.38 | 25.50 | 37.97 | 49.06 |
| FCRI AE 13 | 66.66 | 8.61 | 17.94 | 27.17 | 36.11 |
| FCRI AE 14 | 77.77 | 16.58 | 27.17 | 43.30 | 56.44 |
| FCRI AE 15 | 77.78 | 11.59 | 22.94 | 33.97 | 42.65 |
| FCRI AE 16 | 100.00 | 18.50* | 35.72* | 51.94* | 70.11* |
| FCRI AE 17 | 88.89 | 11.50 | 21.33 | 31.12 | 39.93 |
| FCRI AE 18 | 77.77 | 11.99 | 24.56 | 41.27 | 56.99 |
| FCRI AE 19 | 100.00 | 15.64 | 29.78 | 43.71 | 58.51* |
| FCRI AE 20 | 77.77 | 10.90 | 17.67 | 31.25 | 42.94 |
| FCRI AE 21 | 88.89 | 16.30 | 25.89 | 31.84 | 38.23 |
| FCRI AE 22 | 88.89 | 12.24 | 24.33 | 36.00 | 46.76 |
| FCRI AE 23 | 88.89 | 15.54 | 26.22 | 40.44 | 52.15 |
| FCRI AE 24 | 77.78 | 14.31 | 20.17 | 28.58 | 36.28 |
| FCRI AE 25 | 77.77 | 18.43* | 24.31 | 31.88 | 38.67 |
| FCRI AE 26 | 100.00 | 15.72 | 27.44 | 39.16 | 48.57 |
| FCRI AE 27 | 100.00 | 15.58 | 29.56 | 40.19 | 49.95 |
| FCRI AE 28 | 100.00 | 11.43 | 21.78 | 34.27 | 43.89 |
| FCRI AE 29 | 100.00 | 22.22* | 36.25* | 40.71 | 49.43 |
| FCRI AE 30 | 100.00 | 13.02 | 26.78 | 39.61 | 50.68 |
| Mean | 90.37 | 14.54 | 25.95 | 38.47 | 49.92 |
| SEd | 13.61 | 1.74 | 3.46 | 6.41 | 3.82 |
| CD (p=0.05) | 27.25 | 3.49 | 6.93 | 12.84 | 7.66 |

Basal diameter differed significantly among the 30 evaluated progenies at four growth periods *viz.*, initial, 2 MAP, 4 MAP and 6 MAP. At initial stage, the Basal diameter was ranged between 0.32 cm (FCRI AE 13) and 0.68 cm (FCRI AE 16). The highest basal diameter was recorded by the progeny FCRI AE 16 (0.68 cm) which is 27.94 per cent higher than the general mean. Compared to general mean (0.49 cm) three progenies *viz.*, FCRI AE 16 (0.68 cm), FCRI AE 26 (0.66 cm), and FCRI AE 6 (0.65 cm) were recorded significantly highest value. Significant difference in basal diameter was observed at 2 MAP. The basal diameter ranged between 0.86 cm (FCRI AE 25) and 2.17 cm (FCRI AE 16). The highest basal diameter was recorded by the progeny FCRI AE 16 (2.17 cm) followed FCRI AE 6 (2.14 cm), and FCRI AE 26 (2.13 cm) and they were on par with each other 40.09 was the per cent increase in basal diameter over the general mean 1.38. The significantly higher value for Basal diameter was recorded by four progenies FCRI AE 26 (3.05 cm), FCRI AE 16 (3.00 cm), FCRI AE 2 (2.99 cm) and FCRI AE 6 (2.97 cm) at 4 MAP compared to general mean (2.10 cm). The lowest basal diameter was recorded by the progeny FCRI AE 13 (1.57 cm) at 4 MAP whereas FCRI AE 26 exhibited highest basal diameter of 3.05 cm. The per cent increase was 31.14 over the general mean. At 6 MAP also significant difference was observed for this trait. It was ranged between 3.92 cm and 1.66 cm. The highest basal diameter at 6 MAP was recorded by the progeny FCRI AE 2 (3.92 cm) against the general mean of 2.70 cm which is 31.12 per cent increase over the general mean. However, the progenies *viz.,* FCRI AE 26 (3.90 cm), FCRI AE 16 (3.89 cm), and FCRI AE 6 (3.88 cm) had also registered significantly higher basal diameter but on par with each other. Considering all the four growth periods into account three progenies *viz.,* FCRI AE 26, FCRI AE 16 and FCRI AE 6 consistently proved its superiority by registering significantly higher values in all the growth periods (Table 3).

**Table 3:** Variation in basal diameter (cm) among the *Ailanthus excelsa* progenies

| Name of the Progeny | Basal Diameter (cm) | | | |
|---|---|---|---|---|
| | Initial | 2 MAP | 4 MAP | 6 MAP |
| FCRI AE 1 | 0.57 | 1.19 | 1.84 | 2.03 |
| FCRI AE 2 | 0.58 | 1.85 | 2.99* | 3.92* |
| FCRI AE 3 | 0.55 | 1.40 | 2.13 | 2.71 |
| FCRI AE 4 | 0.54 | 1.38 | 2.09 | 2.39 |
| FCRI AE 5 | 0.59 | 1.45 | 2.30 | 2.76 |
| FCRI AE 6 | 0.65* | 2.14* | 2.97* | 3.88* |
| FCRI AE 7 | 0.46 | 1.28 | 2.04 | 2.66 |
| FCRI AE 8 | 0.46 | 1.35 | 2.31 | 3.02 |
| FCRI AE 9 | 0.45 | 1.29 | 1.93 | 2.41 |
| FCRI AE 10 | 0.56 | 1.50 | 2.28 | 2.85 |
| FCRI AE 11 | 0.58 | 1.30 | 1.89 | 2.43 |
| FCRI AE 12 | 0.49 | 1.33 | 2.18 | 2.92 |
| FCRI AE 13 | 0.32 | 1.01 | 1.57 | 2.04 |
| FCRI AE 14 | 0.57 | 1.61 | 2.38 | 3.02 |
| FCRI AE 15 | 0.38 | 1.14 | 1.69 | 2.14 |
| FCRI AE 16 | 0.68* | 2.17* | 3.00* | 3.89* |
| FCRI AE 17 | 0.52 | 1.20 | 1.67 | 2.01 |
| FCRI AE 18 | 0.41 | 1.31 | 2.28 | 3.12 |
| FCRI AE 19 | 0.45 | 1.35 | 1.80 | 2.44 |
| FCRI AE 20 | 0.40 | 1.11 | 1.80 | 2.32 |
| FCRI AE 21 | 0.43 | 1.20 | 1.52 | 1.88 |
| FCRI AE 22 | 0.42 | 1.19 | 1.80 | 2.28 |
| FCRI AE 23 | 0.40 | 1.27 | 2.22 | 2.96 |
| FCRI AE 24 | 0.32 | 1.06 | 1.66 | 2.14 |
| FCRI AE 25 | 0.43 | 0.86 | 1.31 | 1.66 |
| FCRI AE 26 | 0.66* | 2.13* | 3.05* | 3.90* |
| FCRI AE 27 | 0.57 | 1.57 | 2.35 | 3.01 |
| FCRI AE 28 | 0.36 | 1.15 | 1.86 | 2.44 |
| FCRI AE 29 | 0.40 | 1.22 | 1.86 | 2.43 |
| FCRI AE 30 | 0.45 | 1.47 | 2.20 | 2.85 |
| Mean | 0.49 | 1.38 | 2.10 | 2.68 |
| SEd | 0.05 | 0.24 | 0.43 | 0.34 |
| CD (p=0.05) | 0.11 | 0.49 | 0.87 | 0.69 |

Among the 30 progenies, significant differences were observed for this parameter at all the growth periods *viz.*, initial, 2 MAP, 4 MAP and 6 MAP. The initial volume index had ranged from 0.96 $cm^3$ (FCRI AE 13) to 8.45 $cm^3$ (FCRI AE 16). Among the progenies, three progenies *viz.*, FCRI AE 16 (8.45 $cm^3$), FCRI AE 6 (7.76 $cm^3$), and FCRI AE 26 (6.92 $cm^3$) recorded significantly higher plant height compared to general mean (3.84 $cm^3$) at initial stage. The highest volume index was recorded by the progeny FCRI AE 16 (8.45 $cm^3$) which is 54.55 per cent higher than the general mean. At 2 MAP, the volume index was ranged from 18.33 $cm^3$ (FCRI AE 25) to 167.83 $cm^3$ (FCRI AE 16). The general mean was 59.61 $cm^3$. The highest volume index was recorded by the progeny FCRI AE 16 (167.83 $cm^3$) which is 64.48 per cent higher than the general mean. However, four progenies *viz.*, FCRI AE 16 (167.83 $cm^3$), FCRI AE 6 (151.54 $cm^3$), FCRI AE 26 (124.59 $cm^3$) and FCRI AE 2 (103.06 $cm^3$) had recorded significantly higher plant height compared to grand mean (59.61 $cm^3$). The general mean was 208.3 $cm^3$. The highest volume index was recorded by the progeny FCRI AE 16 (481.10 $cm^3$) followed by FCRI AE 6 (451.80 $cm^3$) and FCRI AE 2 (424.60 $cm^3$). The percentage increase in volume index by FCRI AE 16over general mean was 56.70. The lowest volume index was exhibited by the progeny FCRI AE 25 (55.60 $cm^3$). Three progenies *viz.,* FCRI AE 16 (481.10 $cm^3$), FCRI AE 6 (451.80 $cm^3$) and FCRI AE 2 (424.60 $cm^3$) registered its consistent superiority even at 4 MAP. Significant variation was observed for volume index at 6 MAP. The minimum volume index was registered by the progeny FCRI AE 25 (105.68 $cm^3$) against the general mean of (405.70 $cm^3$). Whereas, the maximum volume index were recorded by FCRI AE 16 (1070.18 $cm^3$) at 6 MAP followed by FCRI AE 6 (1043.39 $cm^3$), FCRI AE 2 (873.79 $cm^3$) and FCRI AE 26 (742.67 $cm^3$) (Table 4). The per cent increase in plant height of FCRI AE 16 over the grand mean was 62.09. Considering all the four growth periods into account three progenies *viz.*, FCRI AE 16, FCRI AE 6, and FCRI AE 26 consistently proved its superiority by registering significantly higher values for all the parameters irrespective of the growth periods.

**Table 4:** Variation in volume index ($cm^3$) among the *Ailanthus excelsa* progenies

| Name of the Progeny | Volume Index ($cm^3$) | | | |
|---|---|---|---|---|
| | **Initial** | **2 MAP** | **4 MAP** | **6 MAP** |
| FCRI AE 1 | 5.80 | 43.87 | 155.7 | 193.41 |
| FCRI AE 2 | 5.32 | 103.06* | 424.6* | 873.97* |
| FCRI AE 3 | 4.90 | 63.42 | 234.3 | 443.92 |
| FCRI AE 4 | 3.75 | 52.47 | 201.1 | 258.64 |
| FCRI AE 5 | 5.46 | 71.39 | 318.5 | 520.37 |
| FCRI AE 6 | 7.76* | 151.54* | 451.8* | 1043.39* |
| FCRI AE 7 | 2.23 | 35.57 | 133.3 | 279.26 |
| FCRI AE 8 | 3.06 | 50.64 | 230.0 | 497.45 |
| FCRI AE 9 | 2.51 | 44.18 | 136.3 | 262.14 |
| FCRI AE 10 | 5.25 | 64.05 | 231.5 | 456.71 |
| FCRI AE 11 | 5.65 | 57.13 | 174.9 | 332.65 |
| FCRI AE 12 | 3.27 | 47.62 | 210.7 | 419.02 |
| FCRI AE 13 | 0.96 | 27.29 | 105.7 | 149.14 |
| FCRI AE 14 | 5.53 | 72.33 | 278.1 | 512.99 |
| FCRI AE 15 | 1.70 | 37.95 | 137.0 | 195.59 |
| FCRI AE 16 | 8.45* | 167.83* | 481.1* | 1070.18* |
| FCRI AE 17 | 3.21 | 34.87 | 98.7 | 163.56 |
| FCRI AE 18 | 2.24 | 43.36 | 226.9 | 572.07 |
| FCRI AE 19 | 3.29 | 57.18 | 161.8 | 360.72 |
| FCRI AE 20 | 1.86 | 23.00 | 104.0 | 238.58 |
| FCRI AE 21 | 3.08 | 41.70 | 76.2 | 138.38 |
| FCRI AE 22 | 2.30 | 35.05 | 118.8 | 244.47 |
| FCRI AE 23 | 2.70 | 58.87 | 244.5 | 462.37 |
| FCRI AE 24 | 1.51 | 27.94 | 104.4 | 167.85 |
| FCRI AE 25 | 3.48 | 18.33 | 55.6 | 105.68 |
| FCRI AE 26 | 6.92* | 124.59* | 367.0 | 742.67* |
| FCRI AE 27 | 5.05 | 74.69 | 230.8 | 475.03 |
| FCRI AE 28 | 1.52 | 38.86 | 195.4 | 264.50 |
| FCRI AE 29 | 3.60 | 60.03 | 155.1 | 292.76 |
| FCRI AE 30 | 2.70 | 59.54 | 204.1 | 433.56 |
| Mean | 3.84 | 59.61 | 208.3 | 405.70 |
| SEd | 1.08 | 21.61 | 97.43 | 106.55 |
| CD (p=0.05) | 2.16 | 43.27 | 195.06 | 213.31 |

## Discussion

In forestry selection, superior genotypes are very important as it forms the basis for tree improvement. The success of any tree improvement programme depends upon the amount of genetic variability in a tree species and it is of significant importance for developing effective tree improvement strategies (Vakshasya *et al.* 1992) [29]. The largest, cheapest and fastest gains in forestry tree improvement programmes will accrue if use of suitable species and seed sources within species is assured (Zobel and Talbert, 1984) [33]. Against this backdrop the current study has been designed to evaluate and assess 30 progenies of *Ailanthus excelsa* in order to identify a superior progeny for higher productivity amenable for various forest based industries. Plant height, basal diameter, number of branches and volume index are the important morphometric trait which decides the growth and development of plants (Sharma *et al.,* 2011) [26]. Genetic improvement of the planting stock through progeny evaluation can play a very important role in improving productivity, yields, quality of produce and profitability. Seeds from proven source or plus trees are the back bone of any successful improvement programme. In order to adopt strategies of conservation and improvement, it is necessary to estimate the amount and distribution of genetic variation in preselected progenies (Chavan and Keerthika, 2013) [3]. Most of the economic characters in trees are quantitative in nature. There is a wide range of variability in these characters which depends upon the genetic makeup of the individuals and the environment in which they are grown. Breeders use this variability for achieving improvement in economic characters through efficient selection techniques (Safavi *et al.*, 2011) [24] and acknowledge of genetic parameters are required to formulate breeding strategies, as well as estimated breeding values and gains from selection (Wright, 1921) [32]. The presence of significant variations in different biometric attributes were earlier documented in the species like *E. tereticornis* (Otegbeye, 1990) [17]; *Azadirachta indica* (Kundu and Tigerstedt, 1997) [12]; *Dalbergia sissoo* (Dogra *et al.*, 2005) [4]; *Acacia catechu* (Nautiyal *et al.* 2006) [15]; *Eucalyptus* (Vennila, 2009) [30]; Willow tree (Sharma *et al.* 2011) [26]; *Melia dubia* (Saravanan, 2012) [25] and *Leucaena leucocephala* (Chavan and Keerthika, 2013) [3] were already reported. Similarly in teak variations in several growth characters, stem and morphological characters were evident due to provenance differences (Rawat *et al.* 1998) [22]. Teak provenances differed significantly in terms of survival and other physical characters in field conditions (Rao *et al*., 2001) [21]. The *M. dubia* progeny evaluation trial had also expressed sufficient variability among the morphometric traits suggesting that these progenies need to be tested further under field conditions (Kumar, 2011) [11]. Against the backdrop, progeny evaluation trial was established using 30 progenies of *Ailanthus excelsa*. The main focus of this study was not only to provide base population for selection of plus trees, but also to produce improved seeds for new plantings, through converting progeny trial into seedling seed orchard. The progeny differed significantly under field condition for all the biometric attributes as well as in all the growth periods. Among the 30 progenies evaluated, three progenies *viz.,* FCRI AE 16, FCRI AE 6, and FCRI AE 26 consistently proved its superiority by registering significantly higher values for all the growth parameters *viz.,* plant height, basal diameter, number of branches and volume index irrespective of the growth periods. Hence these progenies are under lime light for further improvement in terms productivity. The findings of the current study was also attested by the earlier superfluity of workers who reported the existence of significant differences and superiority of few seed sources, progenies and provenances in various tree species like *Acacia nilotica (*Padmini and Banerjee, 1986) [18], *Eucalyptus tereticornis* (Otegbeye, 1990) [17], *Santalum album* (Bagchi and Veerendra, 1991) [1], *Tecomella undulata* (Jindal *et al*., 1991) [10], *Terminalia arjuna* (Srivastava *et al.,* 1993) [27], *Lagerstroemia* spp. (Jamaludheen *et al*., 1995), *Albizia lebbeck* (Radhakrishnan, 2001) [20]; *Dalbergia sissoo* (Rawat and Nautiyal, 2007) [23], *Pinus elliottii* var. *elliottii* (Vergara *et al.,* 2011) and *Acacia catechu* (Nautiyal *et al.,* 2006) [15]; *Eucalyptus* (Vennila, 2009) [30]; Willow tree (Sharma *et al.,* 2011) [26]; *Melia dubia* (Saravanan, 2012) [25]; *Leucaena leucocephala* (Chavan and Keerthika, 2013) [3]; which thus lend support to the current findings in *Ailanthus excelsa.*.

In the present study out of 30 progenies evaluated three progenies *viz.*

FCRI AE 16, FCRI AE 6 and FCRI AE 26 consistently proved superior in terms of growth attributes during different growth stages of observation. Genetic selection of rapid juvenile growth rate was also advocated as a means of improving competitive ability of forest trees (Gall and Taft, 1973 and Steiner, 1986) [6, 28] which extend the scope of selection of three progenies in current study based on early superiority from 6 months of evaluation. Thus the earlier findings corroborate the results of the current study.

## Summary and Conclusion

Among the 30 progenies evaluated under field condition, three progenies *viz*. FCRI AE 6, FCRI AE 16 and FCRI AE 26 consistently expressed superiority for all four biometric traits *viz*., plant height, basal diameter, branch and volume index at four growth periods and these progenies could be exploited for current utilization and future tree improvement programme.

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