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Introduction

Casuarina equisetifolia L. is the most widely planted species of *Casuarina* in India. It is regarded as the farmer's favourite tree in southern states of the country because of its multiple utility and suitability in agrarian ecosystems. Apart from the traditional uses as fuelwood, poles and small timber, casuarina wood is also used for making paper pulp (Varghese *et al.*, 2001). This nitrogen fixing species has proved to be an excellent soil reformer and finds its inevitable role in sand dune stabilization and protection of coastal zone. Phenotypic variants are reported in *C. equisetifolia* for growth and form traits throughout its cultivation range in India (ICFRE, 1994). Studying the heterogeneity in a 5-year old casuarina plantation, Gurumurthi and Rawat (1989) suggested the need for identifying superior performers and introducing them in plantation forestry. As cloning permits immediate capture of genetic traits, clonal forestry of *C. equisetifolia* is becoming increasingly acceptable (Jayaraj and Savio, 2001). Though India has achieved tremendous progress in raising high yielding eucalypts clonal plantations (Das and Rao, 1999) almost the entire plantations of casuarina are of seed origin (Anandalakshmi *et al.*, 2001). As casuarina can be propagated easily through seed as well as clonal routes, information on comparative growth performance between seedlings and clones will be of utmost importance for the casuarina growers in improving the productivity.

Material and Methods

The experiment was conducted in a clone bank of *C. equisetifolia* established by the Institute of Forest Genetics and Tree Breeding (IFGTB), Coimbatore, Tamil Nadu, India. *Casuarina* being a polygamous species (male, female and monoecious individuals exist) seeds and branchlet cuttings collected from nine 6-year-old female clones (TCR 120202, CH 2703, CP 3501, TCR 040204, TCR 050202, CH 1002, CP 1802, CP 3702 and TCR 060204) selected randomly from the clone bank were used for the study. The clones were maintained as hedges at a height of around 3 m for obtaining juvenile cuttings for clonal propagation. Seeds and cuttings were placed

in root trainers filled with sand and composted coir pith respectively on the same day.

Seed Propagation : Mature infructuscence were spread in plastic trays (clone-wise) and dried in sun until the bracteoles opened. Seeds were then separated by gentle shaking and cleaned using 8 mm sieve (Turnbull and Martensz, 1982). No grading or pre-treatments were given and the fresh seeds were sown in root trainers filled with moist sand and kept for germination in a shade house with 75 per cent shade net. Seeds germinated within 15 days with an average germination percentage of 70.

Clonal Propagation : Branchlet cuttings (5 to 7cm in length) were treated with 0.05 per cent mercuric chloride for 30 seconds to avoid fungal attack and dip smeared in 2000 mg l^{-1} Indole-3-Butyric Acid. Subsequently, the treated cuttings were planted in root trainers (150 cc) filled with pre-soaked composted coir pith and placed in a polytunnel. The polytunnel unit was approximately 180 cm long and 90 cm wide with sloping roof for draining the condensation water on the inner side. The roof and sides of the structure were covered with 400 gauge polythene sheet. The polytunnel was kept on a surface filled with sand to a depth of 30 cm. Root trainers were placed in the tunnel with the sides of the tunnel tightly tucked in sand. Prior to placing the cuttings inside the tunnel, the sandy area was well watered without flooding. This provided a warm-humid (temperature varied approximately from 38 to 42°C with a high humidity range of 80 to 90 per cent) environment, very conducive for rooting process. The tunnel was opened after 15 days when rooting had occurred in the branchlets.

Later, seedlings and rooted cuttings from the respective female clones were transplanted to large size polybags (30 x 45 cm) containing potting medium (red soil: sand: composted coir pith in the ratio 1:2:2, neem cake 10 kg $cu.m^{-1}$, indofil 250 g $cu.m^{-1}$ and phorate 250 g $cu.m^{-1}$). The experiment was laid out in Completely Randomized Design (CRD) with 10 replications. Half yearly observations on total height and collar diameter were recorded from the experiment up to 3 years. Data on shoot length, root length, collar diameter, shoot fresh weight, shoot dry weight, root fresh weight, root dry weight, biomass index and total biomass (fresh weight and dry weight basis) were recorded at the age of 3. Standard deviation and coefficient of variation were worked out and the data were subjected to T Test. Comparative growth performance between seedlings and clones over a period of 3 years was also examined.

Results and Discussion

The results of the T test showed that seedlings of all the nine clones recorded significantly superior values for shoot length, collar diameter and biomass index when compared to rooted cuttings (Table 1). Except for root length, seedlings from eight out of nine clones registered superior values than the plantlets for all the other variables. With respect to shoot fresh weight, shoot dry weight and total biomass (fresh and dry weight basis), seed raised and vegetatively

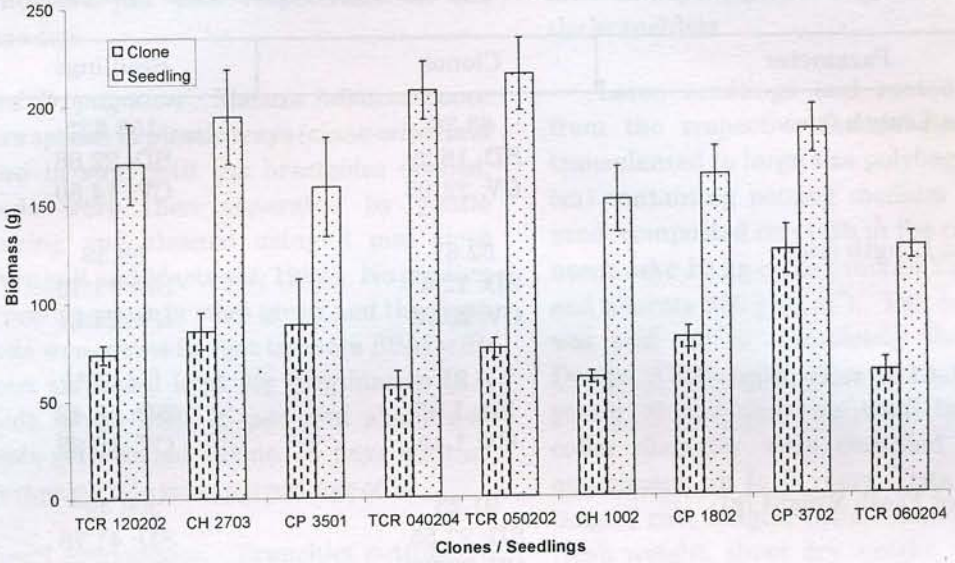
Table 1

Difference in growth response between clones and seedlings of Casuarina equisetifolia.

Parameter	Clones	Seedlings
Shot Length (cm)	68.36 SD: 16.29 CV: 22.93	158.33* SD: 22.68 CV: 14.50
Root Length (cm)	52.67 SD: 12.41 CV: 23.25	55.38 SD: 11.79 CV: 21.21
Collar Diameter (mm)	8.21 SD: 1.06 CV: 1.49	14.57* SD: 13.43 CV: 10.99
Shoot Fresh Weight (g)	91.23 SD: 27.55 CV: 28.39	206.49* SD: 41.78 CV: 21.30
Shoot Dry Weight	46.94 SD: 13.42 CV: 26.37	109.09* SD: 22.04 CV: 20.93
Root Fresh Weight (g)	53.60 SD: 7.05 CV: 21.52	120.12* SD: 15.31 CV: 23.22
Root Dry Weight (g)	31.33 SD: 7.05 CV: 21.51	65.49* SD: 15.29 CV: 23.22
Biomass Index (cm^3)	47.89 SD: 17.51 CV: 38.70	350.30* SD: 108.90 CV: 32.12
Biomass Fresh Weight (g)	144.84 SD: 36.84 CV: 24.97	326.61* SD: 64.07 CV: 19.98
Biomass Dry Weight (g)	78.56 SD: 17.26 CV: 21.33	162.47* SD: 34.03 CV: 19.54

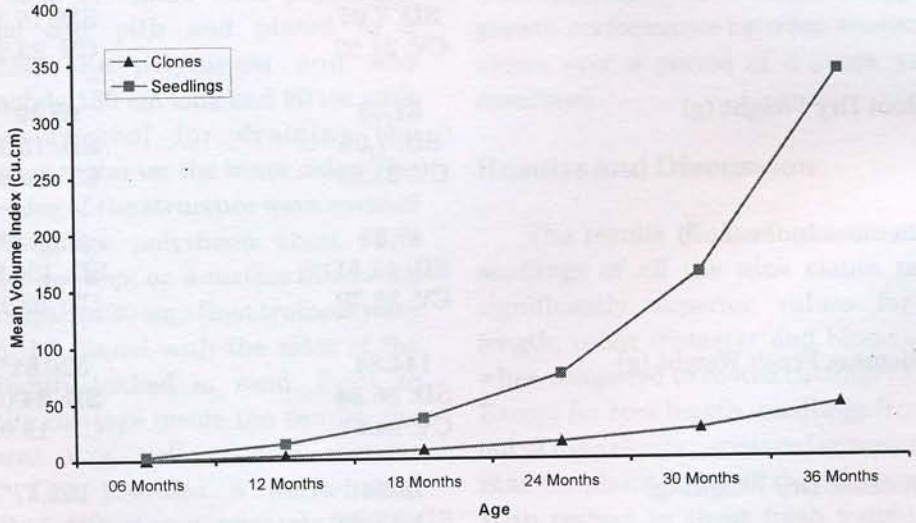
* Significantly different from the corresponding observation as per T-Test ($P \leq 0.05$).

Fig. 1



Difference in biomass production (dry weight basis) between clones and seedlings.

Fig. 2



Difference in growth performance between clones and seedlings over 3 years.

propagated materials were found on par for the clone CP 3501. Seedlings and cuttings from clone CP 3702 did not differ significantly with respect to root fresh weight and root dry weight. No significant difference was noticed between two types of propagules when root length was examined. In around 60 per cent of the cases, coefficient of variation was less in seedlings when compared to the cuttings. The difference in growth response between seedlings and rooted cuttings with reference to total dry matter production and difference in trend in biomass index over 3 years are presented in Fig.1 and 2. Flowering and fruit set were observed in rooted cuttings from 8 months onwards. However, no flowering was noticed in any of the seedlings.

Comparative growth performance between seed raised and vegetatively propagated materials have been detailed by several workers. Reports on this subject is available in *Picea abies* (Kleinschmit, 1978; Gusev, 1989), *Larix* sp., *Pinus sylvestris* (Gusev, 1989), *Pinus radiata* (Arnold, 1990; McGranahan *et al.*, 1999), *Pinus taeda* (Stelzer *et al.*, 1998 ; Frampton *et al.*, 2000), *Cunninghamia lanceolata* (Hu *et al.*, 1999). Little information is available in angiosperms.

The results obtained in the present study indicated the superiority of growth performance of seedlings when compared to the clonal materials in *C. equisetifolia*. Superiority of seedlings over cuttings was noticed by McGranahan *et al.* (1999) in *Pinus radiata*. Arnold (1990) working in the same species reported that seedling production through controlled pollination could have significant advantages over vegetative propagation by cuttings. Better performance of seedlings compared to clones observed in the current study can be attributed to the fact that the clone bank contained selected superior genotypes from various parts of the country. Chances of inferior pollen entering into the clonal garden were also less. Hence the seeds obtained from these clonal materials were the resultant product of random mating between the superior selections. As *C. equisetifolia* is a poor / no coppicer, getting the ideal juvenile coppice shoots for vegetative multiplication does not often materialize as in eucalypts. Therefore, clonal propagation in this species is practiced with relatively juvenile branchlet cuttings obtained from hedge gardens generally maintained at a height of 2 to 3 m. The poor growth of the rooted cuttings when compared to that of seedlings can be attributed to this lack of juvenility factor.

Clone banks maintained to preserve and test a large number of genotypes are of great importance for long-term tree improvement programmes. Clone banks can also be considered as Research Seed Orchard (Zobel and Talbert, 1984) and seeds can be obtained. Though they are not meant to produce massive quantities of seed for operational planting, they will have a definite role to play in case of non-availability of seeds from conventional seed production systems (like seed orchards/ seed production areas). Clone banks thus need a broad genetic base to avoid inbreeding in future generations and to preserve genes and genotypes that might be

useful as the tree improvement programme develops. Being a polygamous species, excluding the monoecious individuals for seed collection will eliminate the problem of selfing in casuarina. Though clonal forestry is not widely practiced in this species for large scale plantation programmes, the blessings of easy rootability and early flowering in rooted cuttings from mature materials can be efficiently exploited in raising clonal seed orchards for quality seed production.

SUMMARY

Difference in growth performance between seed raised and clonally propagated plant materials, derived from nine 6-year old randomly selected female trees, grown in a clone bank of *Casuarina equisetifolia* L. was examined upto 3 years under controlled conditions. Half yearly observations on total height, collar diameter and data on shoot length, root length, collar diameter, shoot fresh weight, shoot dry weight, root fresh weight, root dry weight, biomass index and total biomass (fresh weight and dry weight basis) at the age of 3 were used for the study. The results of this early growth comparison clearly indicated the superiority of seedlings over rooted cuttings. This could be attributed to the fact that seeds were obtained as a result of random mating of the superior *casuarina* selections in the clone bank. Being a polygamous species, possibility of using clone bank as a research seed orchard exists in this species. Flowering and fruit setting were observed in clones from 8 months onwards. However, no flowering was noticed in any of the seedlings. As mature branchlet cuttings from higher up the stem can be rooted which will flower at a very early stage, clonal route will be the most promising option to raise orchards for quick and quality seed production in *C. equisetifolia*.

***Key words*: Clonal Forestry, Juvenility, Maturation State, Rooted Cuttings, Seed Orchard.**

कैजुआरिना इक्विसेटिफोलिया लि. के पौधों और कृन्तकों की प्रारम्भिक बढ़वार की तुलना

कन्नन् सी. एस. वारियर व एम. गणेशन्

सारांश

कैजुअरिना इक्विसेटिफोलिया लि. के बीजों से उगाए और उसके कृन्तक संचयन में उग रहे मादा 6-वर्षीय वृक्षों से यादृच्छया चुने गए वृक्षों की कृन्तकीय रोपण सामग्री से प्रबर्धित पौधों की बढ़वार सक्रियता की जाँच-पड़ताल तीन वर्षों तक नियन्त्रित दशाओं में की जाती रही। कुल ऊंचाई, मूलसंधि पर व्यास के प्रेक्षण और प्ररोह का ताजा भार,प्ररोह का शुष्क भार जड़ का ताजा भार, जड़ का शुष्क भार, जैवपुंज निर्देशांक और तीन वर्ष की उम्र हो जाने पर जैवपुंज (ताजा भार और शुष्क भार) के आंकड़े हर छमाही लिए जाते रहे और उन्हें अध्ययनार्थ उपयोग किया गया। प्रारम्भिक बढ़वार की तुलना के इस अध्ययन के परिणाम स्पष्टत: संकेत देते हैं, जड़े निकलवाई कलमों की तुलना में बीज बोकर उगाए पौधे श्रेष्ठता रहते हैं। इसको इस तथ्य से जोड़ा जा सकता है कि बीज कृन्तकीय संचयन में *कैजुआरिना* के श्रेष्ठ वृक्षों में यादृच्छया संयुग्मन से प्राप्त हुए थे। सर्वलिंगी जाति होने के कारण कृन्तक संचयन को इस वृक्ष जाति का अनुसंधान बीजोद्यान की तरह उपयोग करने की संभावनाए हैं। कृन्तकों पर आठ महीने की उम्र हो जाने पर फूल आ गए, फल भी बन गये। किन्तु बीज बोकर उगाए किसी भी पौंधे पर पुष्पन नहीं हुआ। चूंकि तने से ऊपर वाली प्रौढ़ शाखिकाओं से काटी कलमों में जड़ें निकलवाई जा सकती है। जिन पर प्रारम्भिक अवस्था में पुष्पन हो जाएगा इसलिए के. *इक्सिसेटिफोलिया* का शीघ्र और गुणवत्ता वाला बीजोत्पादन कराने का बीजोद्यान बनाने के लिए कृन्तक मार्ग सबसे ज्यादा उत्साहप्रद रहेगा।

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