Studies on growth attributes of *Casuarina* species in Cauvery delta zone of Tamil Nadu

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ABSTRACT

Casuarina is one of the potential fast growing tree crops that grows largely in six districts of Cauvery delta zone (CDZ) of Tamil Nadu. In the present study, growth attribute pattern of *Casuarina* species was assessed in CDZ of Tamil Nadu. In CDZ, the growth attributes like tree height and diameter (6, 12, 18, 24, 30, 36 and 42 months after planting) with respect to varieties (*Casuarina* and its hybrid), spacing and districts were taken for the experiment. Split-split plot design was applied for analyzing the growth data for comparison of different parameters. Significant impact of factors like variety and spacing was found on the growth attributes of *Casuarina* hybrid 36 months after planting (MAP). Hence if farmers wanted to make harvesting at this stage, the 1.5 m spacing with *Casuarina* hybrid variety would be beneficial to them. The results concluded that 36-42 MAP was the right time for harvesting to get maximum benefits. Significant interaction of district vs variety vs spacing was found till 36 MAP for diameter and height. Significantly higher above ground biomass was recorded by *Casuarina* hybrid under spacing 1.5 m in Villupuram district (44.55 kg) which was followed by *Casuarina* hybrid under in Cuddalore district under the same spacing (40.55 kg).

Keywords: *Casuarina*; variety; spacing; growth parameters

INTRODUCTION

An understanding of tree growth characteristics is beneficial for the management of trees in both forest and urban settings. This knowledge can aid in maintaining proper forest stocking in pruning and limb manipulation, in making aesthetic choices and in selecting appropriate growth measurements to monitor individual tree growth and forest health. *Casuarina* is a fast growing and light demanding tree species. It is very sensitive to excess soil moisture, fire and frost. It comes very well under well drained sandy soils; grows poorly in heavy soils and does not tolerate clay. In general it does not coppice. The tree attains height up to 40 m with diameter of 60 cm (180 cm girth) often buttressed at the base. It is short-lived; its natural span of life seldom exceeds 50 years. In less favorable localities, it turns misshapen and hollow beyond 25 years of age.

The present study was carried out to elucidate information on spacing, biometric characters like diameter and height and other characteristics responsible for increasing the biomass production in two species of *Casuarina* viz *Casuarina* and *Casuarina* hybrid, based on the data collected from the districts of Cauvery delta zone of Tamil Nadu under split-split plot design.

METHODOLOGY

The landholding data of *Casuarina* plantation in the six districts of Cauvery delta zone districts were collected from the district cropping programme chart. Majority of the plantations were established by TNPL through contract farming and captive plantation programmes. In order to get the growth attributes of *Casuarina* species, the list of *Casuarina* cultivating farmers was collected from Tamil Nadu News Print Limited (TNPL) industry. The details collected were farmers' name, landholding, year of plantation, village name, block name, district name and harvesting time.

The crop area was bifurcated into different homogenous blocks like based on spacing S_1 (1 m x 1

m) and spacing S_2 (1.5 m x 1.5 m); based on variety, *Casuarina* V_1 and *Casuarina* hybrid V_2; based on the location, Cauvery delta zone different districts like T_1 (Cuddalore), T_2 (Villupuram), T_3 (Tanjaore), T_4 (Trichy), T_5 (Pudukottai) and T_6 (Nagapattinam). Data were collected from randomly chosen plants of different ages of *Casuarina* plantation 6, 12, 18, 24, 30, 36 and 42 months after planting. Five per cent of sampling intensity was used to identify the sample location, farmers' names, variety, spacing and age of the plantation.

The marked trees of each sampling area were used for measuring basal diameter. The basal diameter was measured at 15 cm above ground during the initial stages like 6 and 12 MAP. After one year it was recorded as diameter at breast height (dbh) 1.37 m using digital calipers and was expressed in cm. The diameter of the trees was recorded and the corresponding mean height was calculated. For the height, five trees were randomly selected from sampling area and were marked for further investigations. The total height of each tree was initially measured using manually prepared tree scale using digital clinometers (Chaturvedi and Khanna 1982).

Based on the famers list from six districts of Cauvery delta zone, 42 months old (months after planting) for *Casuarina* (V_1) and *Casuarina* hybrid (V_2) under different spacings 1 (S_1) and 1.5 m (S_2) for biometric measurement were selected for destructive sampling of randomly marked five trees in each plantation at this age for further investigations.

The five marked trees of *Casuarina* (V_1) and *Casuarina* hybrid (V_2) under different spacings 1 (S_1) and 1.5 m (S_2) of each district were felled at 15 cm above ground level using a saw at 42 months old (MAP).

After recording the total height, basal diameter and diameter at breast height (dbh) of the felled trees, the above ground portions were separated into wood, bark and branches. Fresh weight of all the above ground tree components was recorded immediately after felling using appropriate digital weigh scale. The biomass fractionation was carried out in *Casuarina* (V_1) and *Casuarina* hybrid (V_2) under different spacings 1 (S_1) and 1.5 m (S_2) of the six districts.

The diameter may be influenced by various factors like varieties, spacing, districts etc. To test this, ANOVA tool was adopted and all the assumptions for the application of ANOVA were verified.

Split-split plot design was adopted for analyzing the data for the comparison of different aspects. At first, 6 districts of Cauvery delta zone T_1, T_2, T_3, T_4, T_5 and T_6 were treated as main plot treatments, varieties of casuarina were taken as sub-plot treatments [*Casuarina* (V_1) and *Casuarina* hybrid (V_2)] and different spacings of *Casuarina* were treated as sub-sub-plot treatments [S_1 (1 m x 1 m) and spacing S_2 (1.5 m x 1.5 m)]. Biometric observation on diameter was taken for the analysis from *Casuarina* plantations 30, 36 and 42 MAP.

RESULTS and DISCUSSION

Effect on diameter

From the analysis it was observed that there were significant differences among the districts (T), varieties (V) and spacings (S) (Table 1, Fig 1). Among the districts, Villupuram was significantly superior and it recorded the highest value of 8.20 cm in diameter at breast height. It was on par with Cuddalore (8.15 cm). The spacing S_2 had the highest value of 7.99 cm. *Casuarina* hybrid performed better with the highest value of 7.67 cm and it was significantly superior to *Casuarina* (7.13 cm). Among the first order interaction effects, all interactions were significant. In second order, interaction was also significant and the maximum diameter was recorded by *Casuarina* hybrid under spacing 1.5 m in Villupuram district (8.70 cm) followed by *Casuarina* hybrid under spacing 1.5 m in Cuddalore district (8.65 cm). Nicodemus et al (2011) also reported that *Casuarina* with a spacing of 1.5 m x 1.5 m could result in the best growth of 3.58 cm diameter in the first year.

Effect on height

Biometric observations on height were taken from *Casuarina* plantations 30, 36 and 42 MAP. In null hypotheses, all the main effects and interaction effects were not significant.

Nicodemus et al (2011) reported that *Casuarina equisetifolia* and *C junghuhniana* in the irrigated farmland conditions of Chellancheri with a spacing of 1.5 m x 1.5 m resulted in the best growth among the three locations recording a mean value of 5.08 m for height. Mbuvi et al (2010) and Velmurugan and Shanmugam (2011) also recorded maximum height in *Casuarina* at 1.5 m x 1.5 m.

Table 1. *Casuarina* diameter (cm) at 36 MAP with ANOVA table for Cauvery delta zone

Source	df	SS	MS	Fcal	Prob
Total	95	75.2491	0.7920	230.6793	Total
Treatment	23	75.0062	3.2611	949.7302	0.000**
Replication	3	0.0059	0.0019	0.5796	-
Error	69	0.2369	0.0034	1.0000	-
T	5	30.9446	6.1889	2,433.1304	0.000*
Error 1	15	0.0381	0.0025	1.0000	-
C	1	7.0308	7.0308	2,024.0716	0.000**
TC	5	2.0256	0.4051	116.6329	0.000**
Error 2	18	0.0625	0.0034	1.0000	-
S	1	33.5830	33.5830	8,873.3075	0.000**
TS	5	0.3095	0.0619	16.3563	0.000**
CS	1	0.8030	0.8030	212.1699	0.000**
TCS	5	0.3095	0.0619	16.3563	0.000**
S	1	33.5830	33.5830	8,873.3075	0.000**
Error 3	36	0.1362	0.0037	1.0000	-

CV (treatment): 0.79%

District (T)	36 MAP						District mean
	C1			C2			
	S1	S2	Mean	S1	S2	Mean	S1
Cuddalore	7.10	8.35	7.72	7.65	8.65	8.15	7.93
Villupuram	7.00	8.40	7.70	7.70	8.70	8.20	7.95
Tanjaore	6.80	8.00	7.40	7.30	8.30	7.80	7.60
Trichy	5.80	6.90	6.35	7.00	8.00	7.50	6.92
Pudukottai	5.55	7.00	6.27	6.00	7.00	6.50	6.38
Nagapattinam	6.45	8.25	7.35	7.40	8.40	7.90	7.62
Mean	6.45	7.81	7.13	7.17	8.17	7.67	7.40
S Mean	6.81	7.99	7.40	-	-	-	-

	T	C	S	T x C	T x S	C x T	C x S	T x C x S
SE(d)	0.01783	0.01203	0.01256	0.02743	0.02813	0.02947	0.01739	0.04260
$CD_{0.05}$	0.03801	0.02528	0.02547	0.05797	0.05821	0.06191	0.03588	0.08788

Impact on above ground biomass growth

At 42 MAP there were significant differences among the districts, varieties and spacing (Table 2). Among the districts, Villupuram was significantly superior and recorded the highest value of 37.30 kg per tree above ground biomass. It was observed that *Casuarina* hybrid performed well with the highest value of 31.96 kg per tree and was significantly superior to *Casuarina* (29.31 kg/tree). Better performance was seen with respect to spacing S_2 (1.5 m) with the value of 34.14 kg per tree. Among the first order interaction effects, it was inferred that the interactions with districts, *Casuarina* variety and spacing were significant. The second order interaction was also significant. Significantly higher above ground biomass was recorded by *Casuarina* hybrid under spacing 1.5 m in Villupuram district (44.55 kg) followed by *Casuarina* hybrid under spacing 1.5 m in Cuddalore district (40.55 kg) (Table 2) Similar findings were witnessed by Baranidharan (2012) in *Casuarina* varieties under different spacings in Bhavanisagar area.

CONCLUSION

Casuarina is one of the potential fast growing tree crops that grow largely in Cauvery delta zone of Tamil Nadu. *Casuarina* hybrid under spacing 1.5 m in Villupuram district was found to be high. Significant

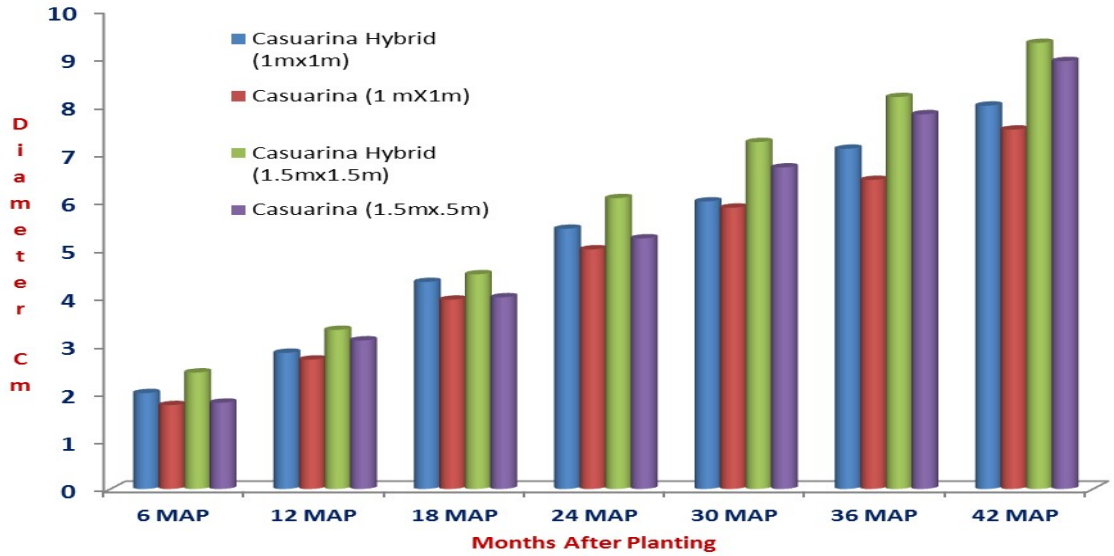

Fig 1. Mean diameter of *Casuarina* and *Casuarina* hybrid in CDZ

Table 2. *Casuarina* above ground biomass at 42 MAP with ANOVA in Cauvery delta zone

Source	df	SS	MS	Fcal	Prob
Total	95	3,926.796	41.334698	86,514.48	Total
Treatment	23	3,926.760533	170.728719	3,57,339.1796	0.000 **
Replication	3	0.002833	0.000944	1.9767	-
Error	69	0.032967	0.000478	1.0000	-
T	5	2,091.034333	418.20	14,87,692.4311	0.000 **
Error 1	15	0.004217	0.000281	1.0000	-
C	1	168.964267	168.964267	2,96,717.7364	0.000 **
TC	5	75.663133	15.132627	26,574.3688	0.000 **
Error 2	18	0.010250	0.000569	1.0000	-
Spacing	1	1,178.801667	1,178.801667	22,93,884.3254	0.000 **
TS	5	404.787733	404.787733	1,57,539.0098	0.000 **
CS	1	0.504600	0.504600	981.9243	0.000 **
TCS	5	7.004800	1.400960	1.400960	0.000 **
Error 3	36	0.018500	0.000514	1.0000	-

CV (treatment): 0.07%

District	42 MAP						District mean
	C1			C2			
	S1	S2	Mean	S1	S2	Mean	S1
Cuddalore	27.10	36.00	31.55	31.31	40.55	35.93	33.74
Villupuram	30.80	38.90	34.85	34.98	44.55	39.76	37.30
Tanjaore	27.40	32.10	29.75	29.85	34.15	32.00	30.87
Trichy	24.10	30.00	27.05	26.60	30.43	28.51	27.78
Pudukottai	21.90	23.30	22.60	22.00	22.54	22.27	22.43
Nagapattinam	23.10	37.02	30.06	26.45	40.15	33.30	31.68
Mean	25.73	32.86	29.31	28.53	35.39	31.96	30.63
S Mean	27.13	34.14	30.63	-	-	-	-

	T	C	S	T x C	T x S	C x S	T x C x S
SEd	0.00590	0.00487	0.00463	0.01031	0.00999	0.06672	0.01413
$CD_{0.05}$	0.01260	0.01020	0.00939	0.02177	0.02050	0.01388	0.02903

impact of the factors like variety and spacing was found on the growth of the *Casuarina* at 36 months after planting. Hence if the farmers wanted to make harvesting at this stage, 1.5 m spacing with *Casuarina* hybrid variety would be beneficial to them. Significantly higher above ground biomass was recorded by *Casuarina* hybrid under spacing 1.5 m in Villupuram district (44.55 kg) followed by *Casuarina* hybrid under spacing 1.5 m in Cuddalore district (40.55 kg). The interaction effects were not significant in 42 months after planting (MAP) which shows that the growth of the plant attained almost stagnation with respect to height and diameter. Hence 36-42 MAP was the right time for harvesting and to get maximum benefits. At the same time to attain higher above ground biomass and weight at 42 MAP, *Casuarina* hybrid variety must be chosen and the plantation done with 1.5 m spacing.

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