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Nursery Management for casuarina

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Abstract: Investigations were carried out at Annamalai University Experimental Farm, Tamil Nadu to find out a way to produce super seedlings in Casuarina crop. *Frankia* was inoculated in the nursery through seed treatment and soil application. Different levels of DAP as starter nutrients (0, 500, 1000, 1500 and 2000 g m^{-2}) was applied to supply N and P_2O_5. Frankia and DAP treated seedlings were found healthy and vigorous than the control. The nursery duration was reduced by one month. Seedling height, vigour index, nodulation and biomass production in the nursery and establishment in the main field were higher when *Frankia* inoculation and DAP application @ 1500 g m^{-2} was given to the nursery.

Key words: Frankia, Diammonium phosphate, Seedling vigour, Nodulation, Casuarina.

Introduction

Among the various non-conventional energy sources available, the most used is the fuel wood. Consumption of fuel wood in India have been progressively raising. Casuarina is one among the main sources of fuel wood. It has a high calorific value of 4.950 K Cal kg^{-1}. Casuarina wood splits well, having straight grains and burns even while green, leaving very little ash. Casuarina fuel wood replaces dung cake utilisation. It thrives well in coastal belts, having salinity problems, high water tables and graded lands.

The production of quality seedlings is an important pre-requisite for large scale cultivation of tree crops. An outstanding ability of *Casuarina* sp. is to form symbiotic nitrogen fixing association with *Frankia* that enables these trees to thrive well in adverse nitrogen deficient soils and making them desirable for agroforestry systems (NRC, USA 1984). *Frankia* inoculation had many advantages such as better survival rate of transplanted seedlings (Sougoufara *et al.* 1987). Nutrients like phosphorus and nitrogen affect the nodulation and nitrogen fixation process apart from soil factors and environmental factors such as moisture stress, extremes of temperature, etc. Reddell (1990) reported that phosphorus deficiency is a major limiting factor for growth and nitrogen fixation by *Casuarina* sp. in many tropical soils. Information on management of *Casuarina* nursery for producing quality seedlings is lacking. Hence, the present investigation was carried out to produce quality nursery stock using Frankia biofertilizer and diammonium phosphate fertilizer.

Materials and Methods

Field experiments were conducted during 1997-98 to study the effect of *Frankia* crushed nodule (FCN) suspension inoculation with different levels of di-ammonium phosphate (DAP) application on growth characters of *Casuarina equisetifolia* seedlings at the Experimental Farm, Annamalai University, Annamalai Nagar (Experiment I) and in Farmers field (Experiment II), Tamil Nadu. The soil was low in available nitrogen, moderate in available phosphorus and high in available potassium. The experiment was laid out in split-plot design with three replications. The treatments consisted of four main plot treatments *viz.* no *Frankia* (FCN) inoculation, seed treatment of *Frankia* (FCN), soil application of *Frankia* (FCN) and combination of seed treatment and soil application of *Frankia* (FCN) and five subplot treatments *viz.* no DAP, 500 g DAP 40 m^{-2} 1000 g DAP 40 m^{-2}, 1500 g DAP 40 m^{-2} and 2000 g DAP 40 m^{-2}. The experiment was conducted in raised beds having 1m length x 1m width x 0.25 m height. Each plot was enclosed by bunds to safeguard against the

Table 1. Effect of *Frankia* Crushed Nodule (FCN) and DAP levels on seedling height, vigour index and biomass production of *Casuarina* seedlings.

Treatments	Seedling height (cm)		Vigour index		Root volume (cc plant^{-1})		Shoot DMP (g seedling^{-1})		Root DMP (g seedling^{-1})	
	Exp.I	Exp.II	Exp.I	Exp.II	Exp.I	Exp.II	Exp.I	Exp.II	Exp.I	Exp.II
Frankia inoculation										
No *Frankia* inoculation	32.22	33.14	1532.77	1560.44	5.70	5.60	1.81	1.99	0.38	0.51
Seed treatment of *Frankia*	40.46	36.68	1896.02	1757.28	7.21	6.70	1.86	2.15	0.39	0.54
Soil application of *Frankia*	42.46	39.68	2019.23	1907.01	7.75	7.01	1.90	2.26	0.40	0.53
Seed treatment and soil application of *Frankia*	50.70	45.54	2397.84	2181.96	7.99	7.16	2.22	2.23	0.48	0.63
CD (p=0.05)	0.20	0.16	115.17	50.32	0.19	0.26	0.15	0.10	0.04	0.05
DAP application										
No DAP	36.34	35.59	1720.09	1714.85	6.01	6.04	1.57	1.82	0.29	0.45
DAP @ 500 g cent^{-1}	38.61	36.80	1864.39	1769.91	6.64	6.16	1.78	2.05	0.32	0.52
DAP @ 1000 g cent^{-1}	42.83	39.10	2012.90	1873.09	7.40	6.76	1.91	2.16	0.43	0.55
DAP @ 1500 g cent^{-1}	45.16	41.06	2130.52	1938.53	7.98	7.14	2.24	2.48	0.57	0.64
DAP @ 2000 g cent^{-1}	44.38	40.89	2079.44	1927.95	7.77	6.98	2.23	0.57	0.60	
CD (p=0/05)	0.41	0.81	67.83	62.46	0.22	0.25	0.07	0.15	0.04	0.05

entry of water and to control the movement of nutrients from one plot to another.

FCN was used as source of biofertilizer application (Bond, 1957 and Torrey, 1976). Young, nodules composing of young tissues were collected from casuarina roots and surface sterilized in sodium peroxide (30% v/v) for five minutes. The sterilized nodules were washed three times with sterile distilled water and then crushed into suspension by using pestle and mortar. The suspension was prepared by grinding 10 g of nodule and dissolved in 200 ml of sterile distilled water and filtered with muslin cloth and the resulting FCN suspension was used as per treatment schedule at the rate of 1 g m^{-2} nursery area.

In seed treatments, FCN suspension was mixed with rice gruel and seeds were soaked in this mixture and kept for an hour in shade. Seeds were sown on the beds immediately. Different levels of DAP were applied basaly on beds. After DAP application, FCN suspension was sprinkled uniformly on the beds and immediately covered by sand. The tiny seeds of *Casuarina* @ 2.5 g m^{-2} were broadcasted on the plots in the early morning. Paddy straw was used as mulch material. Seedling growth, nodulation and nitrogenease activity were recorded on 120 days after sowing (DAS). Nitrogenase activity of the fresh intact nodules was assayed by acetylene reduction method (Hardy *et al.* 1968) and activity has been expressed as μ moles C_2H_4 hr^{-1} g^{-1} of nodules weight.

Table 2. Effect of *Frankia* Crushed Nodule (FCN) and DAP levels on nodulation, nodule dry weight and nodule nitrogenase activity of *Casuarina* seedlings

Treatments	Nodule Number		Nodle dry weight (g seedling^{-1})		Nodule nitrogenase activity (µ moles of ethylene produced / hr/g wt. of nodule)		Establishment percentage	
	Exp.I	Exp.II	Exp.I	Exp.II	Exp.I	Exp.II	Exp.I	Exp.II
Frankia inoculation								
No *Frankia*	0.00	2.39	0.00	0.24	0.00	0.29	82.36	84.19
Seed treatment of *Frankia*	3.28	3.68	1.28	1.02	0.80	0.97	85.05	86.29
Soil application of *Frankia*	3.43	3.76	1.26	1.05	0.83	1.00	86.22	87.65
Seed treatment and soil application of *Frankia*	4.33	4.59	1.36	1.34	1.01	1.07	89.12	90.35
CD(p=0.05)	0.38	0.38	0.12	0.09	0.06	0.05	2.40	1.86
DAP application								
No DAP	2.41	3.24	0.46	0.50	0.37	0.57	80.27	81.84
500 g DAP cent^{-1}	2.66	3.39	0.54	0.69	0.61	0.71	84.42	85.55
1000 g DAP cent^{-1}	2.95	3.75	1.16	1.03	0.81	0.96	86.56	87.96
1500 g DAP cent^{-1}	3.38	4.07	1.55	1.34	0.85	1.03	89.52	90.36
2000 g DAP cent^{-1}	3.19	3.58	1.14	1.00	0.65	0.88	87.67	89.43
CD (p=0.05)	0.29	0.30	0.10	0.11	0.09	0.04	3.31	3.13

Results and Discussion

Seedling Height

Frankia inoculation and DAP application had significant influence on seedling height at 120 DAS. Seed treatment and soil application of FCN and DAP application @ 1500 g 40 m^{-2} recorded maximum seedling height of 58.21 cm and 49.52 cm in both the experiments (Table 1). The existence of host specific symbiosis between *Frankia* and *C. equisetifolia* and the contribution of greater amount of N by *Frankia* to the seedling might be the reason for the increased seedling height. The result of the present study is in conformity with the findings of Sanginga *et al.* (1989). The increment in plant height might also be due to increased activity of the actinorhizal symbiosis by the addition of optimum level of externally applied nitrogen and phosphorus through DAP. Similar findings of augmented growth of seedlings in the nursery by the application of DAP was reported by Rangaswamy *et al.* (1990).

FCN and DAP application had significant influence on vigour index (Seedling height x Germination percentage) at 120 DAS (Table 1). Inoculation of FCN through seed treatment and soil application increased the vigour index. Seed treatment and soil application of *Frankia* crushed nodule and DAP application @ 1500 g m^{-2} recorded the maximum vigour index. The increased shoot growth obtained might be the reason for increased vogour index.

Vigour index was significantly increased with increasing dose of DAP application. Higher availability of N and P nutrients through DAP application might be the reason for the increased vigour index of *Casuarina*. Increase in growth and vigour index of seedlings in nursery by application of DAP was reported by Rangaswamy *et al.* (1990).

Root Volume

Seed treatment and soil application of FCN and DAP application @ 1500 g 40 m^{-2} had significant impact on root volume. Maximum root volume of 8.73 and 7.75 cc $plant^{-1}$ was recorded on 120 DAS in both the experiments (Table 1). This might be due to precise host specificity of *Frankia* and *C. equisetifolia* and increased nodulation characteristics. The results corroborate with the findings of Sanginga *et al.* (1989) and Masuka and Makoni (1995).

Dry Matter Production

Frankia inoculation through seed treatment and soil application and DAP application @ 1500 g 40 m^{-1} had significantly influenced both shoot and root dry matter production in *Casuarina* nursery (Table 1). The highest shoot and root dry matter production of 2.52 and 0.59, 2.58 and 0.75 g $seedling^{-1}$ were recorded in experiment I and experiment II, respectively. The increased uptake of nutrients through increased root volume ,increased nodule number, increased plant height and greater accumulation of nutrients might be responsible for higher shoot and root DMP. Similar findings of increase in shoot and root DMP due to *Frankia* inoculation was reported by Anita Sellstedt (1988) and Masuka and Makoni (1995). Increased shoot and root DMP due to nitrogen and phosphorus nutrients was reported by Kohls and Baker (1989), Sanginga *et al.* (1991) and Arnone *et al.* (1994).

Nodulation Characters

Nodule number and nodule dry weight

Frankia inoculation through seed treatment and soil application and DAP @ 1500 g 40 m^{-2}significantly improved nodule number and nodule dry weight (Table 2). Maximum nodule of 5.10 and 5.20 per seedling was recorded in experiment I and experiment II, respectively. Higher nodule dry weight of 2.16 and 1.82 g $seedling^{-1}$ was recorded in both the experiments. This might be due to the fact that FCN had strong relationship with *C. equisetifolia* to form effective symbiosis. Similar findings of increase in nodule number and nodule dry weight was reported by Anita Sellstedt (1988), Reddell *et al.* (1988) and Masuka and Makoni (1995).

The increment in nodule number and nodule dry weight at DAP @ 1500 g 40 m^{-2} level might be due to the fact that the actinorhizal symbiosis was activated with the addition of externally applied nitrogen at optimum level. The reduction in nodule number and nodule dry weight in the treatment DAP application @ 2000 g 40 m^{-2} might be due to inhibitory effect of higher level of nitrogen. The result is in accordance with the findings of Arahou *et al.* (1996).

Nodule Nitrogenase Activity

FCN and DAP application @ 1500 g 40 m^{-2} significantly the influenced nodule nitrogenase activity (Table 2). Least nitrogenase activity was recorded in the treatments where *Frankia* inoculation and DAP application were taken up. Addition of P nutrient might have enhanced nitrogen fixation through more nodulation, dry weight and nitrogenase activity as reported by Sanginga *et al.* (1989).

Establishment Percentage

Frankia inoculation and DAP application had significant influence on establishment percentage of *Casuarina* seedlings in the mainfield (Table 2). Seed treatment and soil application of FCN and DAP @ 1500 g $cent^{-1}$ recorded maximum establishment of 92.7 and 93.7 per cent in experiment I and II, respectively. The increased root volume and nodulation characters and vigorous seedlings might be the reason for more establishment percentage in the main field. Similar findings of better establishment and survival rate was reported by Sougoufara *et al.* (1987).

From the study, it is concluded that *Frankia* inoculation through seed treatment and soil application and application of DAP

@ 1500 g cent^{-1} may be used to obtain vigorous seedlings of *Casuarina* for the better establishment and growth in the mainfield.

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