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RESEARCH PAPER

Effect of *Calophyllum inophyllum* L. seed cake as organic manure on the germination parameters of *Casuarina equisetifolia* L.

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Abstract: Increasing worldwide demand for renewable energy promotes large scale commercial plantations of potential biodiesel trees. Tree Borne Oilseeds (TBOs) are grown in India in order to satisfy the growing demand of biodiesel. One of the major problems for biodiesel producers is the disposal of the seed cake after expelling oil from seeds. The physicochemical characteristics and nutrient composition of the de-oiled seed cakes indicate that it could be converted into valuable organic manure. In this regard, an experiment was conducted at College of Forestry, Sirsi in order to know the impact of de-oiled seed cake of Undi (*Calophyllum inophyllum* L.) on the germination parameters of Whistling pine (*Casuarina equisetifolia* L.). A total of fifteen treatments consisting of various quantities of seed cake, farmyard manure (FYM) and their combination were used. Maximum germination percentage (47.33%), mean daily germination (0.63), peak value (0.82), germination rate (0.92) and germination value (0.52) were recorded in the potting medium containing combination of soil, sand, 200 g FYM and 37 g cake. Seedling vigor index (1546.08) and biomass (0.22 g fresh weight and 0.06 g dry weight) were also maximum in seeds germinated in same potting mixture. The results indicated that application of de-oiled seed cake and FYM had profound and significant impact on seed germination parameters.

Key words: Biodiesel**,** Germination, Seed cake, Vigour

Introduction

The ever growing demand for energy and its consistent impact on the import bill for fossil fuel has necessitated the search for alternative renewable and complementary sources of energy. Biodiesel, an alternative fuel, is gaining worldwide acceptance as a solution to environmental problems, energy security, reducing imports of crude oils and improving agricultural economy. Tree Borne Oilseeds like Neem (*Azadirachta indica* A. Juss.), Karanja (*Pongamia pinnata* L.), Mahua (*Madhuca indica* J. F. Gmel.)*,* Lakshmi taru (*Simarouba glauca* DC.), Undi (*Calophyllum inophyllum* L.), Baheda [*Terminalia bellirica* (Gaertn.) Roxb.] *etc.,* are grown throughout the country in order to satisfy the growing needs of biodiesel. *C. inophyllum* belonging to the family Clusiaceae (Mangosteen family) is an ideal source for making biodiesel since it is non-edible, has high kernel oil (65%), fruits profusely (3,000-10,000 seeds/tree/year), tolerates harsh environmental conditions (acidity, salinity, drought and a wide range of temperature) and requires little maintenance (Azam *et al.,* 2005; Sahoo *et al.*, 2006). One of the major problems for biodiesel producers is the disposal of the seed cake after expelling oil from seeds. After expelling the oil, approximately 60-70 per cent of the seed biomass is left as de-oiled seed cake. Every ton of biodiesel results in 2.5 to 3 tons of seed cake as by-product .The de-oiled seed cakes have been considered as an industrial by-product which contains valuable nutrients useful for plant growth. The physicochemical characteristics and nutrient composition of this residue indicate that it could be converted into valuable organic manure (Chaturvedi *et al.*, 2009). De-oiled seed cakes can be used as a potential, effective, cheaper and non-polluting organic source of nitrogen and other nutrients.

Casuarina equisetifolia L. is an exotic species from Australia that has proved to be a successful multipurpose tree in India. *C. equisetifolia* serves a plethora of uses. A single mature tree of *C. equisetifolia* is capable of producing a large quantity of cones which yields many seeds. The seeds are reported to have poor germination performance; exhibiting a germination percentage ranging between 10-50 per cent, slow germination rates, and they show considerable variability in germination (Goh *et al.,* 1995; Umarani and Vanangamudi, 2002).

Keeping in view the increased demand of *C. equisetifolia* seedlings in agroforestry, plantation and afforestation programmes, an effort was made to study the impact of using *C. inophyllum* seed cake on the germination of *C. equisetifolia* seeds.

Material and methods

The experiment was conducted in a mist chamber at College of Forestry, Sirsi, Karnataka during the year 2016. It consisted of fifteen treatments and was laid out in completely randomized design with three replications. De-oiled seed cake of *C. inophyllum* was collected from Biofuel Park, Hassan (University of Agricultural Sciences, Bangalore) Karnataka. Seed cake being an organic entity is vulnerable to microbial attack and a lot of fungal hyphae were observed on it. Hence, a part of seed cake was sterilized in autoclave for 30 minutes at 120ºC temperature and 15 psi (pounds per square inch) pressure. Seeds of *C. equisetifolia* were obtained from a plantation located in Sirsi. Fifty seeds were sown in trays already containing a mixture of soil (2 parts): sand (1 part) and different quantities of powdered *C. inophyllum* seed cake (both sterilized and

non-sterilized), FYM and their combination. Application of de-oiled seed cake was done on the basis of nitrogen content in it (Table 1). Nitrogen content in sterilized cake was 2.4 per cent while it was 2.7 per cent in non-sterilized cake (as estimated by Kjeldahl method (Piper, 1966). The number of seeds germinated daily was noted upto a period of 75 days. The observations on germination parameters viz. per cent germination, mean daily germination, germination rate, germination value and peak value were calculated. Seedling vigor index was calculated at the end of experimental period. After 75 days, shoot length, root length, seedling fresh weight and seedling dry weight were recorded. For dry weight estimation, the seedlings were dried in oven at 60 ± 1ºC temperature for 48 hours. The data relating to each parameter observed was analyzed statistically using MSTAT-C program as applicable to Completely Randomized Design. The level of significance used in F test was P = 0.05.

Table 1. Treament details

Treatments	Treatments	Quantity of cake applied (g)
T_1	2:1 (Soil : Sand) Control	-
T_2	2:1:1 (Soil : Sand : FYM)	-
T_3	2:1:0.5 (Soil : Sand : FYM)	-
T_4	T_1+ 0.5 g Nitrogen through (Sterilized Cake)	21
T_5	T_1 + 1.0 g N	42
T_6	T_1 + 1.5 g N	63
T_7	T_1 + 2.0 g N	84
T_8	T_1 + 2.5 g N	104
T_9	T_1+ 0.5 g Nitrogen through (Non-Sterilized Cake)	19
T_{10}	T_1 + 1.0 g N	37
T_{11}	T_1 + 1.5 g N	56
T_{12}	T_1 + 2.0 g N	74
T_{13}	T_1 + 2.5 g N	93
T_{14}	T_9 + 100 g FYM	19
T_{15}	T_{10} + 200 g FYM	37

Results and discussion

Application of de-oiled seed cake, in both sterilized and non-sterilized form, FYM and combination of cake and FYM enhanced the germination parameters of the seeds significantly (Table 2). Maximum germination percentage (47.33%), mean daily germination (0.63), peak value (0.82), germination rate (0.92) and germination value (0.52) were recorded in the medium containing combination of soil, sand, 200 g FYM and 37 g cake (treatment T_{15}). All the germination parameters attained least values in control (16%, 0.21, 0.30, 0.37 and 0.06, respectively). Perusal of Table 3 shows that seedlings grown in treatment T_{15} produced maximum shoot length (19.83 cm), root length (13.57 cm) and total seedling length (33.40 cm) while seedlings grown in control had least values for shoot length (4.69 cm), root length (4.92 cm) and total seedling length (9.61 cm). Seedling vigor index (1546.08) and biomass (0.22 g fresh weight and 0.06 g dry weight) were also maximum in seeds germinated in medium having a combination of 200 g FYM and 37 g cake (Table 3). Sterilization of cake did not produce any marked impact on germination of seeds. The performance of both sterilized as well as non-sterilized cakes showed a similar trend i.e. with increasing quantity of seed cake, increased values for germination attributes were recorded.

Significantly better results in treatment T_{15} (comprising of a combination of 200 g FYM and 37 g non-sterilized cake) might be attributed to the fact that combined application of de-oiled seed cake and FYM may have improved the physical, chemical and biological properties of the growing medium. Addition of organic amendments in potting medium alters the pH, bulk density, porosity, increases the water holding capacity and organic carbon content in the medium. Neff and Asner (2001) reported that application of seed cake increased dissolved organic carbon content in soil water of potting mixture and also the nutrient content of soil. The concentration of dissolved organic carbon increases as rate of cake application increases. Addition of seed cake and FYM in potting medium would have

Table 2. Germination parameters of *C. equisetifolia* as influenced by FYM and varying levels of *C. inophyllum* seed cake.

Treatments	Germination %	Mean daily germination	Germination rate	Peak value	Germination value
T_1	16.00	0.21	0.37	0.30	0.06
T_2	28.67	0.38	0.56	0.58	0.22
T_3	20.00	0.26	0.41	0.36	0.09
T_4	17.33	0.23	0.37	0.33	0.08
T_5	33.33	0.44	0.61	0.56	0.25
T_6	34.67	0.46	0.68	0.57	0.26
T_7	38.00	0.51	0.78	0.65	0.33
T_8	38.67	0.52	0.79	0.68	0.35
T_9	26.00	0.36	0.54	0.51	0.18
T_{10}	34.00	0.45	0.63	0.57	0.26
T_{11}	37.33	0.50	0.71	0.65	0.32
T_{12}	40.67	0.54	0.86	0.71	0.38
T_{13}	44.67	0.60	0.89	0.78	0.47
T_{14}	38.00	0.51	0.74	0.66	0.33
T_{15}	47.33	0.63	0.92	0.82	0.52
Mean	32.98	0.44	0.66	0.58	0.27
S.Em±	1.79	0.02	0.05	0.03	0.02
C.D. at 5%	5.21	0.06	0.14	0.1	0.06

attracted lot of microfauna. The microorganisms, while decomposing the cake and FYM might have released certain organic acids, growth promoting substances and other chemicals which may have enhanced the germination parameters of the seeds. Enhanced germination per cent and germination rate in higher level of cake and FYM may be attributed to the fact that cake and FYM act as the sources of nutrients, improve soil physical properties and enhance microbial activity in the soil.

Results of the present study are in agreement with the work done by Arancon *et al.* (2004) who concluded that addition of organic manures enhanced the germination attributes of seeds of green house pepper and it might be ascribed to high porosity, aeration, water holding capacity and presence of humic-like materials and other plant growth influencing substances (such as plant growth hormones) produced by microorganisms during decomposition of organic manures. A similar conclusion was drawn from a study which suggested that highest germination percentage in potting mixture containing soil, sand and FYM had been recorded in *Manilkara hexandra* because of improved soil structure and texture which in turn might have increased the metabolic activities in germinating seeds (Samir *et al.,* 2016). Better seedling length and higher biomass of seedlings was recorded in the potting medium containing combination of 200 g FYM + 37 g de-oiled seed cake. It might be due to early germination of seeds followed by quick biomass allocation. Combination of seed cake and FYM along with soil and sand provided good physical conditions for proper root development and enough nutrients for increased seedling height and biomass.

Conclusion

The best germination and seedling attributes were produced in the medium containing combination of 200 g of FYM and 37 g of seed cake along with soil and sand. It is concluded that use of seed cake of *C. inophyllum* in potting medium provided a good way to boost the germination of *C. equisetifolia*. Hence, application of de-oiled seed cake and FYM can be recommended to enhance the germination parameters of *C. equisetifolia* and provide better quality seedlings for transplanting and final planting out in the field.

Table 3. Influence of *C. inophyllum* seed cake and FYM on seedling length, seedling vigour index and biomass of *C. equisetifolia*

Treatment	Shoot length(cm)	Root length(cm)	Seedling length(cm)	Seedling vigour index	Fresh weight (g)	Dry weight (g)
T_1	4.69	4.92	9.61	152.03	0.040	0.010
T_2	13.24	7.49	20.73	594.39	0.090	0.031
T_3	6.23	5.14	11.36	228.60	0.070	0.021
T_4	7.57	6.92	14.49	250.83	0.090	0.031
T_5	11.36	8.00	19.35	644.48	0.110	0.035
T_6	12.14	8.21	20.34	709.02	0.150	0.041
T_7	16.45	10.14	26.59	1016.37	0.160	0.045
T_8	17.34	11.17	28.51	1163.03	0.170	0.049
T_9	14.11	7.05	21.16	552.35	0.090	0.030
T_{10}	14.23	8.85	23.07	783.32	0.120	0.040
T_{11}	14.43	9.13	23.56	877.09	0.140	0.040
T_{12}	14.94	10.14	25.08	1075.22	0.170	0.050
T_{13}	17.66	11.99	29.65	1324.67	0.200	0.050
T_{14}	15.65	9.37	25.02	950.41	0.150	0.040
T_{15}	19.83	13.57	33.40	1546.08	0.220	0.066
Mean	13.32	8.80	22.13	791.19	0.130	0.039
S.Em±	0.99	0.26	1.05	30.59	0.010	0.004
C.D. at 5%	2.89	0.74	3.06	88.6	0.030	0.011

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