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Influence of de-oiled seed cakes on seedling performance of East Indian Rosewood (*Dalbergia latifoila* Roxb.)

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Abstract

Most of the tree species can be propagated through seeds; however, the seedlings require sufficient root growth and nutrient availability to attain proper size at the time of planting. The application of de-oiled seed cakes in addition to soil and sand is a common practice to improve or maintain the nutrient status of the nursery soil. The de-oiled cakes were added to mixture of soil and sand in different proportions M_1 (1:2), M_2 (2:1) and M_3 (1:1) in poly bags in such a way that the quantity of each de-oiled seed cake (neem cake, castor cake, cotton seed cake) and FYM, (nitrogen content applied per bag was 100 kg Nha^{-1}). The highest germination (28.93%), seedling height (16.33 cm), collar diameter (0.36 cm), root length (4.73 cm), number of root nodules (23.33) and leaflets per plant (47.16), root shoot ratio (0.29), fresh weight (11.30 g), biomass (5.63 g) were observed in the potting medium containing neem cake with soil and sand mixture (T_2M_2). The highest available N, P and K (286.49, 72.90 and 395.66 kg ha^{-1}, respectively) also was recorded in T_2M_2. Our study suggests that de-oiled seed cakes along with soil, sand can be used as a potential, effective, cheaper and nonpolluting organic source of nitrogen and other growth promoting substances. Further studies are required to confirm the performance of the seedlings under field conditions.

Keywords: *De-oiled seed cakes, Dalbergia latifolia, biomass production, nutrient content, polybag media*

Introduction

Multiple use of forestry has been emerged as a long-awaited answer to the developing world's ever-increasing timber, fuel and fodder. According to Spears (1978), unless, the tree planting is greatly accelerated, by the turn of the century, some 250 million people will be without fuel wood for their minimum cooking and heating needs and will be forced to burn dried animal dung and agricultural crop residues, thereby further decreasing the food crop yields. The quality planting stock production is of paramount importance in any tree planting programme. Most tree species can be propagated through seeds; however, the seedlings require sufficient root growth and nutrient availability to attain proper size at the time of planting. East Indian Rosewood (*Dalbergia latifolia* Roxb.) belonging to family *Fabaceae* and subfamily *Papilinoideae* is one of the most priced timbers of the world and is ranked among the finest woods for furniture, cabinet work, decorative objects, musical instruments, religious artifacts, etc. Under natural conditions; Rosewood can be reproduced by seed, root suckers or coppice. Although reproduction through seeds is the cheapest and easiest method, but the germination and seedling growth is found to be slow (Chacko *et al.,* 2002). Coupled with slow growing nature of seedlings poses serious problem in nursery.

Nowadays, the increased use of chemical fertilizers which cause negative influence on soil environment has declined the crop production. These unattended harmful effects and the energy intensive processes involved in the production of inorganic fertilizers have resulted in several research initiatives for developing organic fertilizer alternatives (Chaturvedi *et al.,* 2013). Moreover, the scarcity and expensive nature of chemical fertilizers coupled with the negative impact on environment has led to the use of the organic fertilizers. Vidyasagran *et al*., 2014a; Vidyasagran *et al*., 2014b; Vidyasagran *et al*., 2014c) observed that the change in nutrient content in potting media can influence the quality seedling production. De-oiled seed cake, a byproduct of oil seed after oil extraction, has the potential of being used as fuel and feed stock for animals. However, the nutrient composition of de-oiled seed cake also suggests that it could be used in the formulation of de-oiled cakes based fertilizers (Chaturvedi *et al.,* 2009). The de-oiled seed cakes being used as fertilizers viz. *Jatropha,* Neem, Salvadora, *Maduca* or *Pongamia* not only improve the organic content of soil but also act as effective insecticides and fungicides (Chaturvedi *et al.,* 2008a; Chaturvedi *et al.,* 2008b). The recommendations of National Commission on Agriculture (1976) states "The full utilization of oil cakes or meal of all the oilseeds in general is an imperative necessity, because if the cakes are not disposed, it will discourage the further off take of oilseeds for cruising and in turn to the very

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cultivation of oilseeds. Utilization of cakes as manures and repellants may be developed and popularized". The proper utilization of available tree cakes in terms of even the present availability would not only help in sustained production of fuel wood but would also bring about considerable environmental improvement in terms of tree cover on vast stretches of marginal lands. Hence, the present investigation was formulated to find out the influence of potting media including de-oiled seed cakes as well as common soil and sand mixture on seedling growth of *Dalbergia latifolia*.

Materials and Method

The present investigation was carried out at Polyhouse Nursery, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Gujarat located at longitude 75º-90' N and latitude 20º-95 'E at an altitude of 10 m above Mean Sea Level during March to September 2011. The area experiences an average annual rainfall of 1431 mm and the lowest temperatures are recorded in December or January (10 °C to 23.8 °C). The potting and germination media were prepared with de-oiled seed cakes and sand soil mix in different proportions. The quantity of de-oiled seed cakes and Farm Yard Manure (FYM) to be added to the sand and soil mixture was determined in such a way that the N content was 100 kg N ha^{-1}. Initial nutrient content of de-oiled seed cakes and FYM and actual quantity of cakes applied per polybag is given in Table 1. The quantity of de-oiled seed cakes and FYM, sand soil proportion used as potting media is given in Table 2. The castor, neem and cotton seed cakes and FYM with different combinations of sand and soil mixtures constituted the treatments. The respective potting media were filled in polybags of 25 × 12 cm size (gauge 250). Seeds of *D. latifolia* were obtained from Navsari Agricultural University and pretreated by mechanical removal of wing and soaking in water for 24 hours. Twenty five seeds in three replications were sown in different potting media and daily germination counts were recorded up to one month. The germinated seedlings of 5-8 cm height were transplanted to polybags containing different potting media. The plants were irrigated once in three days during first month and once in two days during rest of the period. Fungicide (Tilt, 0.02 %) was applied to polybags to control soil born diseases as and when needed.

At the end of 150th day after sowing (DAS), three seedlings were destructively sampled from each treatment. The height, collar girth, number of leaflets and root length were recorded immediately after plucking the seedlings. Fresh weight of the seedlings was recorded in the field and then oven dried at 70 °C to get constant weight (dry weight). The number of root nodules per root system of the seedlings was also counted.

In order to assess the available nutrients in the media both initially and towards end of the study, the soil samples in three replications were air-dried at room temperature. The soil was fine ground and prepared samples by passing through 2 mm sieve. Available nitrogen was estimated by Kjeldhal's method (Piper, 1960), P as suggested by Olsen's method (1954) and available K by Flame photometer (Jackson, 1973).

Table 1: Nutrient content of de-oiled cakes applied to *Dalbergia sissoo* seedlings

S. No.	De-oiled seedcake	Nutrient content			Quantity/Polybag (g) [= 100 kg Nha^{-1}]
		N	P	K	
1.	Castor	4.25	1.85	1.40	4.25
2.	Neem	5.20	1.08	1.45	3.45
3.	Cotton	4.60	1.90	1.62	3.90
4.	FarmYard Manure	0.50	0.30	0.50	36.0

Table 2: The potting media containing de-oiled seed cakes and soil and sand in different proportion

T_1M_1	T_2M_1	T_3M_1	T_4M_1	T_5M_1
T_1M_2	T_2M_2	T_3M_2	T_4M_2	T_5M_2
T_1M_3	T_3M_3	T_3M_3	T_4M_3	T_5M_3

Note: T_1- Castor seed cake - 4.25 g/polybag , T_2-Neem cake-3.34 g/polybag, T_3-Cotton seed cake-3.90 g/polybag, T_4-FYM-36.0 g/ polybag, T_5-Without seed cake, M_1- Soil: Sand (1: 2), M_2- Soil: Sand (2: 1) & M_3-Soil: Sand (1: 1).

Statistical analysis

The experiment was laid out in CRD with three replications per treatment. In order to assess the variation in germination and growth parameters due to potting media. One way analysis of variance was carried out. The treatment means were compared with least significant difference (lsd) wherever necessary.

Results

In general, the application of the de-oiled seed cakes enhanced the growth and biomass production of the *D.*

latifolia seedlings. Application of neem seed cake to 2:1 soil sand mixture recorded the highest growth and biomass production. Analysis of variance revealed significant variations in germination percentage, height, root length, root nodules and leaflets per plant, fresh weight, dry weight and root: shoot ratio of plant due to application of potting media at one percent level. With regards to germination, the highest value (28.93%) was recorded in T_2M_2 (Neem cake with 2:1 soil and sand) which was at par with T_1M_2 (28.30%), castor seed cake with 2:1 soil and sand) and T_3M_2 (27.83%), Figure 1. The lowest germination (22.96%) was observed in T_5M_3 (soil and sand in the ratio 1:1 devoid of any seed cakes or FYM).

length (4.73 cm) was noted in T_2M_2, which was followed by T_1M_2 (4.26 cm) whereas lowest value (2.73 cm) was recorded in T_5M_3.

The highest number of root nodules per plant (23.33) was observed in T_2M_2 i.e. followed by T_1M_2 (21.33). The lowest number of root nodules per plant (8.66) was recorded in T_5M_3 at 150 DAS. Similarly the highest number of leaflets per plant (47.17) was noted in of T_2M_2 followed by T_1M_2 (45.00). The lowest number of leaflets per plant (29.66) was recorded in T_5M_3 at 150 DAS. The highest root: shoot ratio (0: 0.29) was noted in T_2M_2, which was at par with T_1M_2 and T_2M_1. The lowest root: shoot ratio (0:

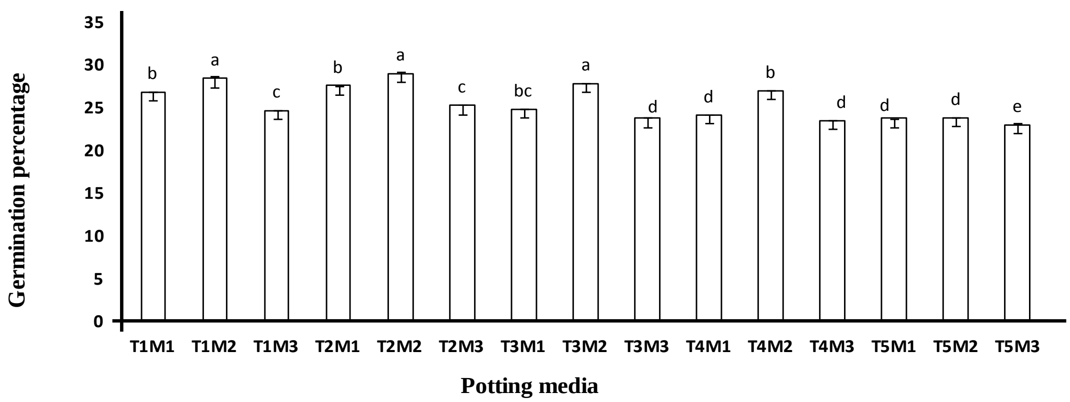

Figure 1: Germination percentage of *D. latifolia* seeds as influenced by the potting media

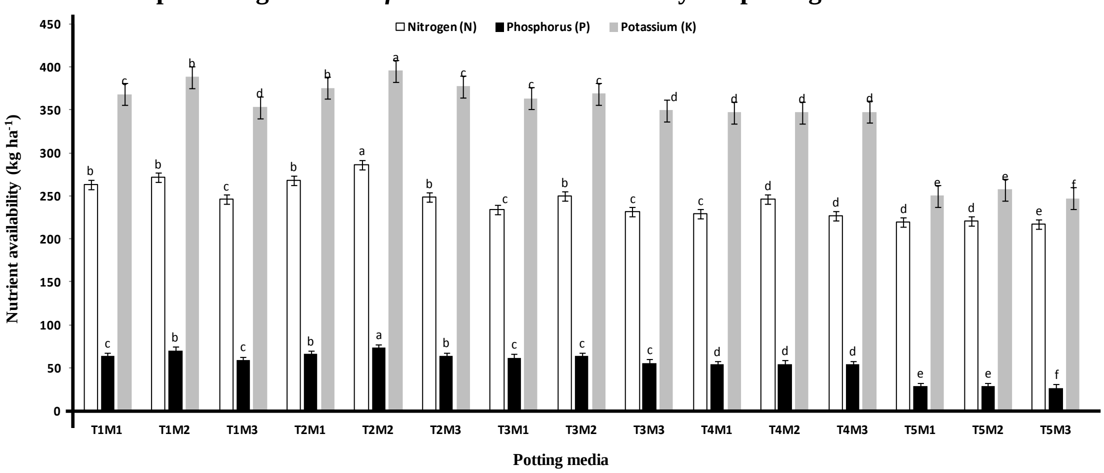

Figure 2: The soil nutrient availability of *Dalbergia latifoila* as influenced by de-oiled cake and soil media mixture

The differences in potting media significantly affected seedling height (p = 0.01). Maximum (16.33 cm) seedling height at 150 DAS was recorded in T_2M_2, which was at par with T_1M_2 (Table 3). The highest (0.36 cm) collar diameter was observed in potting media T_2M_2 at 150 DAS followed by T_1M_2. The lowest (0.31 cm) collar diameter was recorded in T_5M_3 at 150 DAS. Similarly, the highest root

0.20) was recorded in seedlings grown in T_5M_3.

Among different treatments, the highest fresh weight (11.30 g) was noted in combination of T_2M_2 followed by T_1M_2 (10.63 g). The lowest value (5.60 g) was recorded in T_5M_3. While, the highest biomass (dry weight) (5.63 g) was observed in T_2M_2 followed by T_1M_2 (5.06 g). The lowest biomass of plant (2.22 g) was recorded in treatment

Table 3: The growth and biomass production attributes of *Dalbergia latifoila* as influenced by de-oiled cake and soil and sand mixture

Potting media	Height	Collar diameter	Root length	Root nodules/ plant	Leaflets/ plant	Root-Shoot ratio	Fresh weight	Dry weight
	(cm)						(g)	
T_1M_1	14.79 d (0.01)	0.34 (0.01)	3.86de (0.03)	19.34 c (0.07)	42.16 b (0.09)	0.26b (0.01)	8.96c (0.08)	4.55b (0.24)
T_1M_2	16.28a (0.03)	0.33 (0.01)	4.27b (0.02)	21.33b (0.05)	45.00 b (0.29)	0.28b (0.01)	10.63b (0.05)	5.06a (0.01)
T_1M_3	14.28e (0.02)	0.34 (0.01)	3.74e (0.01)	17.66d (0.01)	38.33d (0.07)	0.26b (0.01)	8.62 (0.13)	4.33b (0.02)
T_2M_1	15.54b (0.13)	0.33 (0.02)	4.01c (0.04)	21.00b (0.10)	43.16b (0.05)	0.28b (0.01)	10.27b (0.01)	4.80b (0.01)
T_2M_2	16.33a (0.05)	0.36 (0.01)	4.74a (0.04)	23.33a (0.10)	47.17a (0.05)	0.30a (0.01)	9.83b (0.04)	5.66a (0.04)
T_2M_3	15.05c (0.14)	0.34 (0.00)	3.55g (0.08)	19.33c (0.12)	42.01b (0.02)	0.26b (0.01)	9.16b (0.11)	4.56b (0.03)
T_3M_1	14.63d (0.38)	0.36 (0.01)	3.53g (0.03)	18.34d (0.01)	41.52b (0.15)	0.26b (0.02)	8.86c (0.02)	4.30c (0.18)
T_3M_2	15.09c (0.08)	0.36 (0.02)	3.81d (0.02)	20.33c (0.05)	42.66b (0.03)	0.26b (0.01)	11.31a (0.06)	4.74b (0.06)
T_3M_3	14.33e (0.05)	0.32 (0.01)	3.43h (0.02)	16.66d (0.20)	38.16d (0.01)	0.24c (0.01)	7.80d (0.09)	4.15c (0.04)
T_4M_1	14.27e (0.13)	0.34 (0.05)	3.36h (0.04)	16.67d (0.10)	40.16c (0.06)	0.25c (0.01)	8.44c (0.03)	4.06c (0.02)
T_4M_2	14.07 (0.04)	0.34 (0.01)	3.65f (0.05)	18.43c (0.30)	42.67b (0.04)	0.25c (0.01)	8.46c (0.01)	4.70 (0.19)
T_4M_3	12.66f (0.07)	0.35 (0.04)	3.11i (0.05)	16.00d (0.33)	39.20c (0.03)	0.20d (0.01)	7.26d (0.05)	3.80c (0.07)
T_5M_1	10.90g (0.20)	0.32 (0.01)	2.72j (0.12)	9.30e (0.02)	29.00e (0.05)	0.22d (0.02)	5.73e (0.15)	2.85d (0.03)
T_5M_2	11.54 (0.06)h	0.32 (0.01)	2.83j (0.05)	9.66e (0.02)	30.83e (0.01)e	0.24c (0.02)	6.27d (0.11)	3.20d (0.08)
T_5M_3	10.29g (0.05)	0.31 (0.00)	2.73j (0.04)	8.66e (0.03)	29.66e (0.11)	0.22d (0.01)	5.64e (0.04)	2.22e (0.22)

Note: Values with similar alphabets with in a column are not significantly different

combination T_5M_3.

Regarding the nutrient availability of the soil, the highest available nitrogen (286.49 kg ha^{-1}) was observed in T_2M_2 (neem cake with 2:1 soil and sand mixture), followed by T_1M_2 (271.20 kg ha^{-1}) and the lowest (216.83 kg ha^{-1}) was recorded in T_5M_3. Similarly, the highest available phosphorus (72.90 kg ha^{-1}) was noted in combination of T_2M_2 (Neem cake with 2:1 soil and sand mixture), followed by T_1M_2 (70.06 kg ha^{-1}). The lowest available phosphorus (26.56 kg ha^{-1}) was recorded in treatment combination T_5M_3 (Figure 2). The highest available potassium (395.66 kg ha^{-1}) was noted in combination of T_2M_2 (neem cake with 2:1 soil and sand mixture), followed by T_1M_2 (388.23 kg ha^{-1}) and the lowest available potassium (247.10 kg ha^{-1}) was recorded in T_5M_3 at 150 DAS.

Discussion

The de-oiled seed cakes of neem, castor cotton and FYM maintained source of soil nutrients, soil aeration and control microbial activity and temperature. The nutrients N, P and K present in seed cakes decomposed only slowly to release nutrients for a longer period and accelerated growth and biomass production in many species of plants (Singh and Pokhriyal, 1997). The leguminous plants like *D. latifoila* were more adapted to biological nitrogen through nitrogen fixing system of root nodules rather than absorbing the external nitrogen applied in soil (Postgate, 1978). Jha and Rathor (1984) had reported that the de-oiled seed cakes being used as organic fertilizers have dissolution of minerals and increased rate in soil detoxification on harmful substances. Moreover, the leaching of plant nutrients also reduced in the presence of organic substances in the soil. These functions of organic fertilizers may be directly or indirectly responsible for creating proper growth condition (Kaul and Sharma, 1981).

In the present investigation, the highest germination and seedling performance were observed in potting medium containing neem cake and 2:1 soil and sand mixture (T_2M_2). The highest germination (28.93%), seedling height (16.33 cm), collar diameter (0.36 cm), root length (4.73 cm), number of root nodules (23.33) and leaflets per seedling (47.16), root: shoot ratio (0.29), fresh weight (11.30 g), dry biomass (5.63 g plant^{-1}) were recorded in T_2M_2. The available N, P and K (286.49, 72.90 and 395.66 kg ha^{-1}, respectively), was also found significantly higher in the T_2M_2. Our results are in conformity with findings of Singh (1984) who found the seedlings treated with neem cake produced maximum growth and biomass production. The increase in growth and biomass production might also be due to the beneficial effect of different levels of de-oiled seed cakes which acted as an organic nitrogen manure but nitrification inhibitor (nitrogen regulator) and helped in efficient use of nitrogenous fertilizers (Rawat, 1995). Singh *et al.* (1986) observed that the incorporation of de-oiled seed cakes resulted in improvement in soil texture, aeration, increase in soil temperature and microbial activity, which might have lead to increase growth and biomass production. However, Postgate (1978) proposed that the leguminous plants growing in nitrogen rich soil do not admit rhizobia and nitrogen assimilation under such conditions is performed by glutamate dehydrogenase which represses the glutamate synthesis thus disturbing the natural mechanism of nitrogen assimilation. Nitrogen assimilation glutamate dehydrogenase is less energy requiring, the efficiency of nitrogen assimilation through this process may be slow. The nutrients are released slowly, making them available for plants for long period. Leaching of plant nutrients reduced considerably in the presence of organic substance in the soil. These functions of organic fertilizers may be directly or indirectly responsible for proper growth conditions (Kual *et al*., 1981).

The present findings are also supported by Singh *et al.* (1986) in *Dalbergia sissoo*, Azmi (1990) in *Leucaena leucocephala*, Naidu and Swamy (1994) in *Terminalia bellerica*, Gupta *et al.* (1988) in *Pinus caribeia* and Kumar *et al.* (1993) in *Dalbergia sissoo*. Singh and Gurumurt (1984) also reported that neem cake was much superior to other de-oiled seed cakes because of the fact that neem cake has more chemical stability and low mobility in plants might have resulted in longtime supply of nutrients. Similar results were also reported by Bhatnagar and Gupta (1977) in *Tectona grandis* and *Acacia nilotica*. The earlier studies conducted on the de-oiled seed cakes by Singh *et al*. (1986) also indicated that the presence of nutrients (N, P and K) slow down the nitrification, which produced available nutrient for long duration in plant growth and biomass production. This seedling growth promoting medias was later on found to be similar to de-oiled cake substance. Neem cake was found superior over all other treatments. The availability of N, P and K also was higher in T_2M_2.

Conclusion

The present investigation concluded that among various de-oiled cakes added to soil and sand mixture, combination of neem seed cake and soil and sand in the ratio 2: 1was the most effective in enhancing the seedling growth and biomass production of *D. latifolia*. The available N, P and K were also highest in this medium. Hence, this medium can be used as a potential, effective, cheaper and nonpolluting organic source of nitrogen and than other conventional medium. However, further investigations are needed to confirm the enhanced growth performance under field conditions.

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