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RESEARCH ARTICLE

Influence of seed pelleting on seed quality improvement in bael (*Aegle marmelos* (L.) Corr.): A multipurpose endangered tree

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Abstract

Bael is an endangered medicinal tree with multipurpose utility, propagated through seeds. Hence, attempts were made to improve the vigour of the seed through seed pelleting with eco-friendly organic products. The study investigated the influence of seed pelleting through a series of laboratory experiments (factorial completely randomized design - FCRD) and nursery studies (randomized block design - RBD) with five replications. The seeds were pelleted with botanical leaf powders namely, karisilanganni (*Eclipta prostrate*), avaram (*Cassia auriculata*), arappu (*Albizia amara*) and neem (*Azadirachta indica*); biofertilizers such as Azophos, phosphobacteria and biocontrol agents viz. *Trichoderma viride* and *Pseudomonas fluorescens,* along with unpelleted control seeds. The results revealed that, among the treatments arappu pelleting enhanced germination (76 %) and seedling quality characters such as root length (13.0 cm), shoot length (9.9 cm), dry matter production (318 mg) and vigour index (1740), followed by neem leaf powder and phosphobacteria pelleting compared to the control. The result concluded that seed pelleting with arappu or neem leaf powder at 250 g kg^{-1} of seed or phosphobacteria at 100 g kg^{-1} of seed by using 10 % as gum as an adhesive, enhanced seed germination and seedling vigour under both laboratory and nursery conditions.

Keywords: *Albizia amara*; germination; seed enhancement; seed pelleting; vigour index

Introduction

Bael (*Aegle marmelos*) is an important tree is heavily exploited for various plant parts used to treat a number of neural, bronchial, gastrointestinal, cardiac and urological disorders, as well as for agricultural uses (1). In view of its poor germination and microbiotic (short lived) nature, seed management techniques are employed not only to invigourate the seed but also to modify its physical and biochemical characteristics (2). In addition, these techniques are also used to add necessary substances to individual seeds, so that the seeds receive an invigourating effect upon the absorption of such materials during initial watering, thereby enriching the rhizosphere region of each seed nutritionally, without physiological modification of the seed, but through simple physical alterations.

Seed pelleting is one such physical treatment used to enhance seed vigour. Some of the common benefits of pelleting including uniformity seed size, precision planting, improved production, uniform stands with reduced seed rate, enhanced insect and disease resistance, better performance under stress conditions and supplementary nourishment to seedlings (3-5). The success of the pelleting depends on the filler material used. Seed pelleting has been reported to improve root and shoot growth, thereby increasing yield (6). Hence, an attempt was made with bael seed to increase its planting value through pelleting (Fig. 1).

Materials and Methods

Bael fruits were collected from 8-10 years old trees as bulk from four different locations namely, Ramnagar (11°12′ N,77°12′ E), Perur (10° 58′N,76°54′ E), Saibaba colony (11.21° N, 76.95° E) and Karamadai (11.24° N, 76.96° E) of Coimbatore district, Tamil Nadu (Fig. 2).

The uniformly graded seeds were pelleted individually using botanical leaf powders namely, karisilanganni (*E. prostrata*), avaram (*C. auriculata*), arappu (*A. amara*) and neem (*A. indica*) at 250 g kg^{-1} of seed as filler material and biofertilizers such as, Azophos and phosphobacteria at 100 g kg^{-1} of seed and biocontrol agents viz. *T. viride* and *P. fluorescens* at 25 g kg^{-1} of seed as filler material using 10 % *Acacia* gum used as the common adhesive (Fig. 3).

The pelleted seeds were dried under shade for two days and were evaluated for seed quality characters where speed of germination (using the following formula for each of the seed sources and the mean expressed as whole number (7).

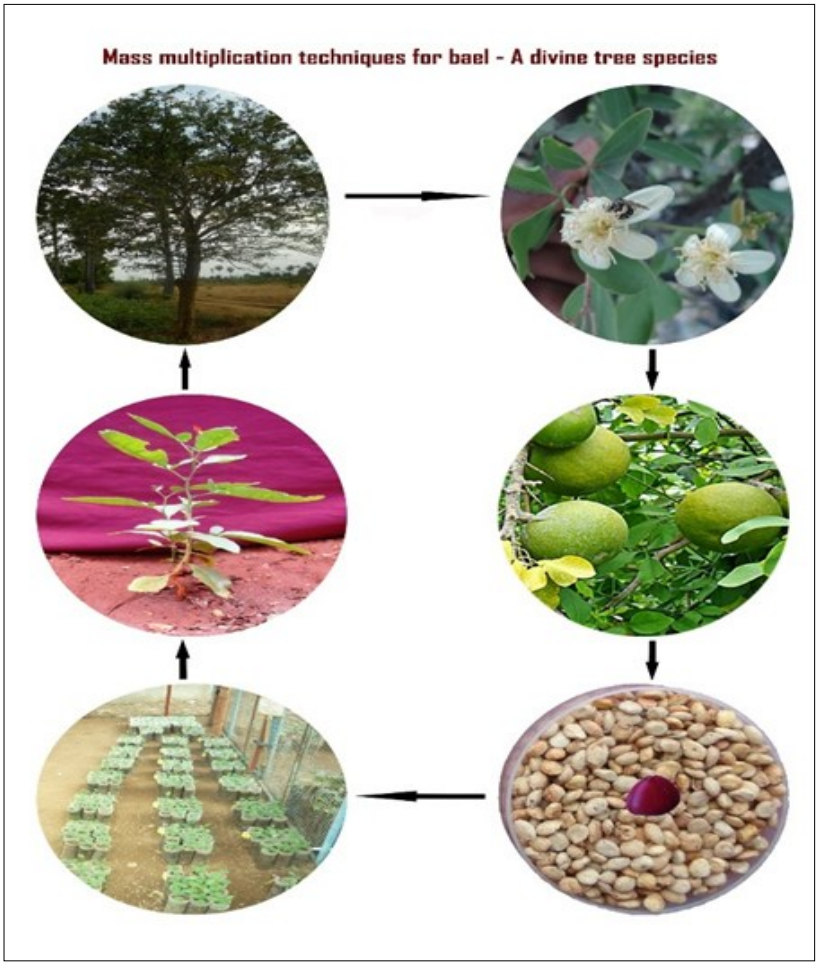

Fig. 1. Mass multiplication techniques for bael -A divine tree species.

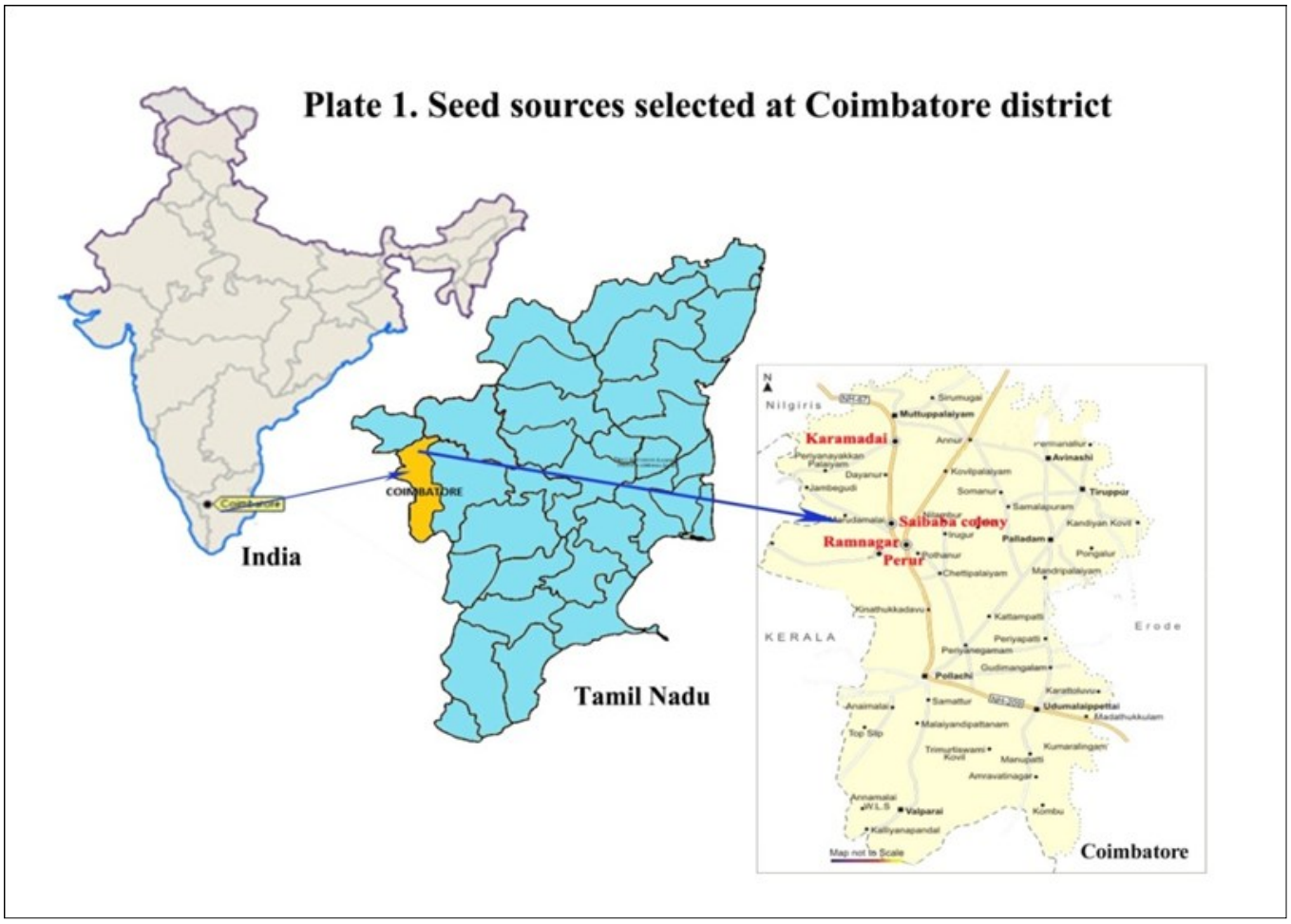

Fig. 2. Seed sources selected at Coimbatore district, Tamil Nadu, India.

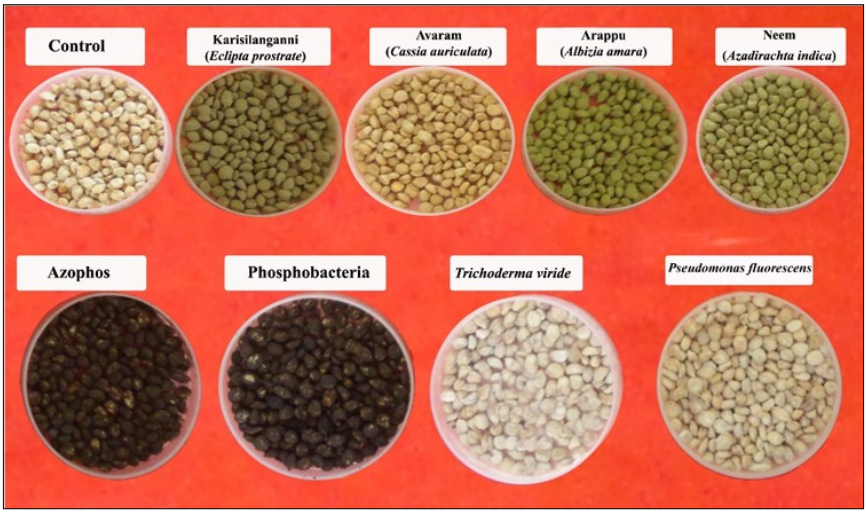

Fig. 3. Seed pellet with different filler materials.

$$\text{Speed of germination} = \frac{X_1}{Y_1} + \frac{X_2 - X_1}{Y_2} + \ldots\ldots\ldots + \frac{X_n - X_{n-1}}{Y_n}$$

Where, X_1- number of seeds germinated at first day; X_2- number of seeds germinated at second day; X_n- number of seeds germinated on n^{th} day; Y_1- number of days from sowing to first count; Y_2- number of days from sowing to second count; Y_n- number of days from sowing to n^{th} count and germination percentage was calculated adopting the following formula.

$$\text{Germination (\%)} = \frac{\text{Number of normal seedlings}}{\text{Total number of seeds placed for germination}} \times 100$$

Root length from the collar region to the tip of primary root were measured using measuring scale and the mean expressed as root length in centimeter (cm), shoot length from the collar region to the tip of the true leaves and the mean expressed as shoot length in centimeter (cm), dry matter production was calculated by ten normal seedlings used for linear measurements of root and shoot length were dried at first in shade and then in a hot air oven maintained at 85 ± 2 °C for 48 hr then cooled in desiccators containing calcium carbonate, weighed and expressed as dry matter production 10 seedling^{-1} in milligram (mg) and vigour index was computed adopting the following formula and the mean expressed as vigour index in whole number (8).

Vigour index = germination (%) × total seedling length (cm) along with control (unpelleted seed).

Nursery performance

The seeds of best treatment along with control seeds were sown in 50 bags of three replications each (comprising of 150 bags per treatment). The polybags were filled with potting mixture containing soil: sand: FYM in 2:1:1 ratio and the seedlings were maintained in the nursery with required management practices. After 30 days of sowing the nursery emergence was observed based on number of seeds put forth as in the nursery and was reported as percentage to the total seed sown in nursery. After three months of sowing, the seedlings were evaluated for survival percentage (surviving seedlings after three months / total number of seeds sown × 100) and seedling quality characters such as root and shoot length, dry matter production and vigour index values were calculated as mentioned earlier.

Statistical analysis

The data obtained from different experiments were analysed for F test of significance, adopting FCRD for laboratory experiments and RBD for nursery studies with five replications (9). Wherever necessary, the percentage values were transformed to angular (Arcsine) values before analysis. The critical differences (CD) were calculated at 5 % probability level.

Results and Discussion

Seed pelleting is a mechanism of applying required substances to seeds in such a way that they influence the seed-soil interface (10). It is the process of enclosing seeds in a small quantity of filler material for singling the seeds—one of the most essential phases of precision planting in modern agriculture—in addition to serving as a natural water-holding medium fortified with nutrients for young seedlings. Thus, seed pelleting provides an effective package of materials that can influence the microenvironment of each seed, eliminating the need to treat the remaining bulk of the soil, as is practiced through broadcasting or soil application. By this means, farmers can save input and reduced the associated costs of applying them. Some of the common benefits of pelleting are uniformity in size, easier planting, uniform stands, reduced seed rate, more resistance to insect and disease, stress tolerance and enhanced nourishment to the seedlings (5, 6).

In pelleting, an adhesive is used to coat the seeds, which are then covered with filler material and rolled for uniformity. The success of pelleting depends on the selection of an appropriate filler material. Researchers have explored a wide range of filler materials, such as leaf powder, biofertilizer and biocontrol agents, inorganic nutrients, vermicompost and combinations of these materials (1, 11-13). In the development of the ecofriendly production techniques for organic farming, the use of organic or biofertilizers and leaf powders are widely recommended. Researchers have pointed out that inoculation of biofertilizers stimulate the growth and enhance the uptake of nitrogen, phosphorus, potassium and other micronutrients, thereby increasing the survival rate of planted seedlings (14-18).

In the present investigation, aimed in enhancing nursery emergence in bael, a slow-growing species, the identification of invigorative filler material for seed pelleting was undertaken. The seeds were pelleted with botanical leaf powders having nutritive and repellent values such as karisilanganni (*E. prostrate*), avaram

(*C. auriculata*), arappu (*A. amara*) and neem (*A. indica*), biofertilizers (azophos, phosphobacteria) and biocontrol agents (*T. viride* and *P. fluorescens)* using a common adhesive (10 % *Acacia* gum) and evaluated for seed and seedling quality parameters, along with unpelleted seeds as control.

The speed of emergence was delayed in all the pelleting treatments due to the physical hardiness associated with the pelleted seeds, as the filler materials enclosed the seeds, compared to control. Similar delayed emergence was also reported by several researchers in different crops (19-21). The results revealed that among the treatments, seeds pelleted with arappu, followed by neem and phosphobacteria enhanced germination and seedling quality parameters compared to the control. The better performance of these treatments compared to control seeds is presented in Table 1.

The other filler materials also improved seed germination, by 10 % with karisilanganni, 8 % with avaram, 12 % with azophos and *T. viride* and 6 % by *P. fluorescens* compared to control, as indicated in Fig. 3. Not only the seed germination but also seedling quality parameters were improved by the pelleting treatments. The highest root length was recorded in arappu (13.0 cm), followed by neem (12.8 cm). Similarly, shoot length was also highest in arappu (9.9 cm), followed by neem (9.7 cm).

The dry matter production recorded by the petting treatments were followed the order: arappu (318 mg), neem (312 mg), phosphobacteria (304 mg), *T. viride* (301 mg), Karisilanganni (293 mg), avaram (278 mg), *P. fluorescens* (274 mg), azophos (274 mg) and control (220 mg). The order of performance for vigour index observed among the pelleting treatments was similar, recording values of 1740, 1539, 1379, 1278, 1234, 1094, 1023, 1006 and 790 respectively (Fig. 4, 5).

This germination improvement by leaf powder-

Table 1. Comparison of best treatments with unpelleted seed

Seed pelleting treatment	Increase over unpelleted seed (%)					
	Speed of germination	Germination (%)	Root length (cm)	Shoot length (cm)	Dry matter production 10 seedlings^{-1} (mg)	Vigour index
Arappu	(-) 0.3	20	59	68	45	120
Neem	(-) 0.4	18	56	64	42	95
Phosphobacteria	(-) 0.7	14	35	46	38	75

Fig. 4. Influence of seed pelleting on seed seedling length in bael.

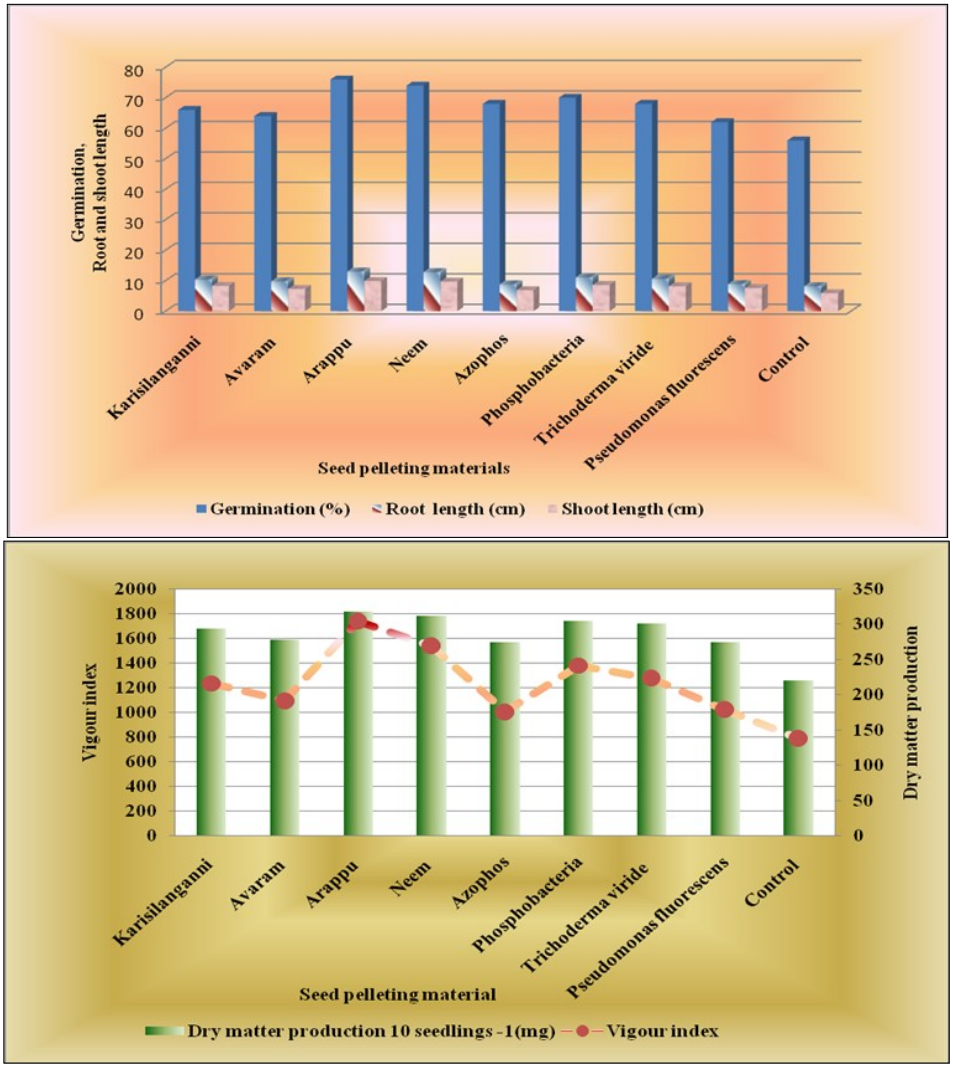

Fig. 5. Influence of pelleting on seed and seedling quality characters (germination percentage (%), root length (cm), seedling length (cm), dry matter production 10 seedlings^{-1} (mg) and vigour index.

karisilanganni, avaram, arappu and neem- might be due to their action as a wick in absorbing, regulating and correcting soil moisture and improving the seed-soil relationship (13). Botanical leaf powders such as arappu are reported to contain gibberellins-like substances, in addition to saponins and micronutrients such as zinc, which may synergistically activate the formation of indole-acetic acid (IAA) (4). In addition to the above, the chlorophyll molecules of arappu, neem, karisilanganni and avaram leaf powders might have acted synergistically with amino acids and humic acid present in the soil rhizosphere, functioning as chelating agents and promoted the growth and development of botanical leaf powder-pelleted seeds into robust seedling at field emergence (3). It was also observed that the energy of the seed, expressed through seedling vigour parameters, indicated that neem leaf powder, followed by *Pongamia pinnata* and *A. amara* leaf powder pelleting served better than control and other filler materials used for pelleting. Seed pelleting with *A. amara* enhanced the seedling quality traits and improved germination under stress conditions such as soil salinity (22).

The present study also highlighted the beneficial influence of user-friendly and environmentally safe leaf pelleting techniques in improving seed vigour. Among them, the performance was best with *A. amara,* as also supported by the previous researchers (23, 24). Pelleting with biofertilizers specific to each crop has been adopted as a routine pre-sowing seed treatment in agricultural crops (25). In silvicultural species, seeds pelleted with phosphobacterium produced vigourous seedling with greater collar diameter at 90 days after sowing in *A. indica* (26). The cause for invigouration through the addition of phosphobacteria may be due to the activation of growth hormones such as IAA and gibberellins, which stimulates root growth by enhancing the uptake of plant nutrients (27, 28). In blackgram, seeds pelleted with pungam leaf powder at 150 g kg^{-1} recorded higher germination percentage, root length, shoot length, dry matter production and vigour index (29).

In bael, the use of various filler materials- neem leaf powder at 200 g kg^{-1} of seed and phosophobacterium, *Azospirllium, Azophos* and *Azotobacter* at 50 g kg^{-1} of seed- revealed that seed pelleting with *Azospirillum* at 50 g kg^{-1} of seed performed better both in laboratory and in nursery conditions and was followed by pelleting with neem leaf powder at 200 g kg^{-1} of seed. Seed pelleted with biofertilizers also improved germination and growth traits up to three months in tamarind seedlings (21). In line with all these findings, the present study also revealed that seed pelleting, irrespective of pelleting material used, was beneficial, as all treatments improved the vigour of seedlings under germination room conditions. Additionally, when pelleted seeds were sown in sand, they exhibited better anchorage and nutrient availability, thereby enhancing seed germination and vigour attributes.

To evaluate the efficacy of the selected treatment at nursery conditions, seeds pelleted with arappu were sown in polypots and

assessed for seed and seedling quality traits. These results showed that seeds pelleted with arappu performed best and could be recommended as a seed management technique to improve seedling production seedlings at nursery level (Table 2).

Table 2. Influence of seed pelleting on seed and seedling quality characters in bael (*Aegle marmelos*) at nursery

Seedling quality characters after 180 days	Arappu	Control	SEd	CD (p = 0.05)
Seedling survival (%)	78 (62.02)	62 (51.94)	**(0.399)**	**(0.856)**
Root length (cm)	20.6	9.6	**0.251**	**0.540**
Shoot length (cm)	19.4	16.5	**0.113**	**0.243**
Dry matter production 10 seedlings^{-1} (mg)	1214	793	**10.180**	**21.837**
Vigour index	3120	1618	**25.628**	**54.974**

Figures in parentheses indicate arc sine transformed values.

Conclusion

Seeds intended for sowing in nurseries or the open fields are pelleted to make the mechanical sowing process faster and more efficient, as well as optimize conditions for better germination. In the present study, seed pelleting with arappu or neem leaf powder at 250 g kg^{-1} of seed or with phosphobacteria at 100 g kg^{-1} of seed by using 10 % *Acacia* gum as adhesive, enhanced seed germination and seedling vigour under both laboratory and nursery conditions.

Authors' contributions

BV carried out the seed pelleting work and drafted the manuscript. CR carried out the frame the manuscript and corrections. MAJB assisted in the experiments and observations recording. SK, KK and VAA were participated in the design of the study, MVKJM performed the statistical analysis. PS conceived of the study and participated in its design and coordination. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interests to declare.

Ethical issues: None

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