E-ISSN: 2618-0618
P-ISSN: 2618-060X

NAAS Rating: 5.20
www.agronomyjournals.com
2024; 7(3): 706-708
Received: 06-02-2024
Accepted: 08-03-2024

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Evaluation of pre-sowing treatments on germination and seedling growth of *Carissa carandas* L.

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DOI: https://www.doi.org/10.33545/2618060X.2024.v7.i3i.2805

Abstract
Carissa carandas (karonda) is a hardy, drought-tolerant shrub with high horticultural and medicinal value, but its propagation is limited by poor seed germination due to a hard seed coat. To address this challenge, a study was conducted to evaluate the effect of various pre-sowing treatments on germination and seedling growth. The experiment was carried out in the nursery of the Silviculture and Agroforestry Department, College of Forestry, Sirsi, Uttara Kannada, Karnataka. Seeds of *C. carandas* were collected from the scrub forests of Ballari to ensure genetic diversity and viability. Seven treatments were applied, including control, organic (cow dung and cow urine), physical (hot water and water soaking), and chemical (KNO_3 and GA_3) methods. Among these, GA_3 50 ppm for 1 hour (T_7) recorded the highest germination percentage (40.60%) and the fastest germination (8.00-11.67 days), followed by KNO_3 2% soaking (T_6). Significant improvements in seedling growth parameters such as plant height, number of leaves, collar diameter, shoot and root length, and root-shoot ratio were observed in T_5 (hot water), T_6, and T_7 treatments. These results indicate that GA_3 and KNO_3 are effective pre-sowing treatments for enhancing seed germination and seedling vigor in *Carissa carandas*, offering potential for better propagation and establishment in arid and semi-arid regions.

Keywords: *Carissa carandas*, pre-sowing treatments, germination, seedling growth and seed dormancy

Introduction
Carissa carandas is a species of flowering shrub belonging to the family Apocynaceae. Commonly known as karonda, Bengal currant, Christ's thorn, and carandas plum, it is widely cultivated in Maharashtra, Goa, Rajasthan, Gujarat, Bihar, West Bengal, and Uttar Pradesh. The plant is naturally found in the Western Ghats and the Siwalik Hills of the Himalayas (Singh *et al.*, 2018) [12]. Karonda is a hardy, drought-tolerant plant that thrives in a variety of soil conditions, including saline and sodic soils with pH up to 10 (Sharma & Patel, 2020) [11]. The plant is a woody, evergreen, spiny shrub that grows up to 10-15 feet in height, with small, shiny ovate leaves and white flowers arranged in terminal cymes. Due to its dense foliage and axillary spines, it is widely used as a protective hedge in Gujarat and Punjab (Kumar & Yadav, 2019) [5]. Karonda has significant potential for horticultural plantations in marginal and wastelands due to its xerophytic nature and adaptability (Desai *et al.*, 2021) [3]. Fruits are rich in iron (39.10 mg/100g), pectin, and vitamin C, and are used in the preparation of jelly, jam, syrup, murabba, and chutney (Reddy & Singh, 2017) [10]. The milky white latex from unripe fruits is utilized in chewing gum and rubber production, while the fruit itself has medicinal applications. Unripe fruits act as an astringent, whereas ripe fruits are sweet, cooling, appetizing, and antiscorbutic, helping treat burning sensations, skin diseases, scabies, and anaemia (Gupta *et al.*, 2016) [4].
Despite its multiple uses, karonda has not been commercially exploited on a large scale. The plant exhibits wide genetic variability due to cross-pollination, leading to differences in fruit size, shape, and color. Based on fruit color, three types exist: green, pink, and white, while based on taste, fruits can be sweet or sour (Verma & Sahu, 2018) [12, 14]. One major challenge in karonda cultivation is poor seed germination due to its hard seed coat, making commercial propagation difficult (Patil *et al.*, 2019) [8]. However, the crop has a promising role in agroforestry, as it serves as a secondary host for Santalum album (sandalwood), providing an alternative source of income for farmers until the sandalwood crop matures.

(Rao & Sharma, 2022) [11]. Given the importance of seed germination in establishing healthy plantations, the present study was undertaken to evaluate the effect of different pre-sowing treatments on the germination and seedling growth of *Carissa carandas*.

Materials and Methods

The study was conducted in the nursery of the Silviculture and Agroforestry Department, College of Forestry, Sirsi, Uttara Kannada, Karnataka, India. The seeds of *Carissa carandas* were collected from scrub forests in Ballari, ensuring genetic diversity and viability for the experiment.

Experimental design and Treatments

The experiment was laid out in polythene trays filled with a 2:1:1 mixture of soil, sand, and farmyard manure (FYM). The study followed a Completely Randomized Design (CRD) with seven treatments, each replicated three times. A total of 2,100 seeds were used, with 100 seeds per treatment per replication. The details of the treatments were as follows:

Table 1: Description of pre-sowing treatments applied to *Carissa carandas* seeds

Treatment N	Treatment Description
T_1	Control
T_2	Cow dung slurry treatment (24 hours)
T_3	Cow urine treatment (24 hours)
T_4	Water soaking for 12 hours
T_5	hot water soaking for 10 minutes at 50 °C
T_6	KNO3 2% Soaking (2hr)
T_7	GA3 50ppm for 1hour

Observations and Data Collection

1. Germination Parameters

Germination Percentage (%)

The total number of normal seedlings emerging in each replication was recorded, and the germination percentage was calculated using the formula:

$$\text{Germination Percentage (\%)} = \frac{\text{(Total number of germinated seeds)}}{\text{(Total number of seeds sown)}} \times 100$$

2. Seedling Growth Parameters

- **Plant Height (cm):** The height of randomly selected seedlings was measured at 90 DAS using a measuring scale, and the mean height was expressed in centimeters.
- **Number of Leaves:** The total number of leaves per seedling was counted at 90 DAS, and the mean value was recorded.
- **Collar Diameter (mm):** The diameter at the collar region of seedlings was measured at 90 DAS using a digital vernier caliper and the mean value was expressed in millimeters.
- **Shoot Length (cm):** Randomly selected seedlings were uprooted, and the shoot length (distance from the collar region to the tip of the primary leaf) was measured using a scale. The average length was expressed in centimeters.
- **Root Length (cm):** The same seedlings used for shoot length measurement were assessed for root length (distance from the collar region to the tip of the primary root) using a measuring scale. The mean value was computed and expressed in centimeters.

Root-Shoot Ratio

$$\text{Root} - \text{Shoot Ratio} = \frac{\text{Root Length (cm)}}{\text{Shoot Length (cm)}}$$

All collected data were statistically analyzed to evaluate the effect of different pre-sowing treatments on seed germination and seedling growth parameters.

Results and Discussion

The effect of various pre-sowing treatments on *Carissa carandas* seed germination and seedling growth revealed significant differences among treatments (Table 2). The earliest germination was initiated in T_7-GA_3 50 ppm (1 hr) (8.00 days), followed by T_3-Cow urine and T_6-KNO_3 2% (8.67 days). Similarly, T_7 also exhibited the fastest completion of germination (11.67 days), while the control (T_1) and T_4 recorded the longest time (17.67 days). In terms of germination percentage, T_7 (40.60%) was the most effective, followed by T_6 (36.65%) and T_3 (32.61%), with T_1 showing the lowest (17.83%). The superior performance of GA_3 and KNO_3 is likely due to their roles in breaking seed dormancy and enhancing enzymatic activity during germination. These observations are supported by Patel *et al*. (2017) [7] and Singh *et al*. (2019) [13], who reported improved germination in *Carissa carandas* with GA_3 and KNO_3 treatments. Additionally, the favorable effect of cow urine (T_3) could be attributed to the presence of natural growth promoters and micronutrients, as noted by Chaudhary *et al*. (2016) [2].

Growth parameter analysis at 90 DAS further confirmed the superiority of treated seeds over untreated controls (Table 3). T_5-Hot water soaking (50°C for 10 min) recorded the highest plant height (8.89 cm), number of leaves (13.67), collar diameter (1.78 mm), shoot length (11.71 cm), and root length (8.19 cm), indicating vigorous seedling development. T_6-KNO_3 2% and T_7-GA_3 50 ppm also showed substantial improvements across all growth parameters, while the control treatment consistently showed the lowest values. The improved growth in T_5, T_6, and T_7 can be linked to better germination performance and enhanced physiological activity post-treatment

Table 2: Influence of pre-sowing treatments on germination dynamics and efficiency of *Carissa carandas* seeds

Treatments	Days taken for initiation of germination	Days taken for completion of germination	Germination percent (%)
T_1-Control	12.33	17.67	17.83
T_2-Cow dung slurry treatment (24hrs)	10.00	15.33	30.22
T_3-Cow urine treatment (24 hr.)	8.67	14.67	32.61
T_4-Water soaking for 12 hr	11.33	17.67	24.19
T_5-Hot water soaking for 10 minutes at 50 °C	10.67	15.70	27.77
T_6-KNO_3 2% Soaking (2hr)	8.67	13.67	36.65
T_7-GA_3 50ppm for 1hour	8.00	11.67	40.60
Sem±	0.4179	0.3359	0.3258
CD@5%	1.2674	1.0190	0.9882

Table 3: Effect of pre-sowing treatments on seedling growth attributes of *Carissa carandas* at various stages after sowing

Treatments	Plant Height (cm)			No of Leaves			Collar Diameter (mm)	Shoot Length (cm)	Root Length (cm)	Root-Shoot Ratio
	(30 Das)	(60 Das)	(90 Das)	(30 Das)	(60 Das)	(90 Das)				
T_1-Control	1.50	1.70	3.30	2.33	4.33	5.67	1.18	3.26	1.61	0.50
T_2-Cow dung slurry (24 hrs)	2.12	2.77	4.87	2.67	4.67	8.33	1.39	4.91	2.90	0.60
T_3-Cow urine (24 hrs)	1.70	2.63	4.17	2.67	4.67	7.33	1.33	4.36	2.81	0.64
T_4-Water soaking (12 hrs)	2.09	4.10	5.57	2.67	5.67	7.67	1.33	5.66	3.54	0.62
T_5-Hot water soaking (10 min, 50°C)	3.18	6.24	8.89	3.67	7.67	13.67	1.78	11.71	8.19	0.70
T_6-KNO_3 2% Soaking (2 hrs)	3.18	6.00	7.67	2.67	4.33	12.33	1.21	8.94	6.44	0.72
T_7-GA_3 50ppm (1 hr)	3.22	5.53	7.33	3.33	6.33	11.00	1.15	7.75	6.22	0.80
SEM ±	0.0917	0.1003	0.3426	0.3333	0.454	0.378	0.063	0.338	0.287	0.033
CD @ 5%	0.2783	0.3041	1.0393	1.0111	1.378	1.146	0.192	1.024	0.872	0.100

These findings align with those of Yadav *et al*. (2016) [15], Singh *et al*. (2019) [13], and Bhagat *et al*. (2015) [1], who highlighted the effectiveness of GA_3, KNO_3, and hot water treatments in boosting seedling vigor in arid zone fruit crops. Root-shoot ratio, an important indicator of biomass allocation, was also highest in T_7 (0.80), followed by T_6 (0.72) and T_5 (0.70), indicating better root development and stress adaptability. Similar results were reported by Kumawat *et al*. (2020) [6], affirming GA_3's role in balancing shoot and root growth in arid region plants.

Conclusion

The study concluded that pre-sowing treatments significantly improved the germination and seedling growth of *Carissa carandas*. GA_3 at 50 ppm for 1 hour was the most effective, resulting in the highest germination percentage, early germination, and superior seedling vigour, followed by KNO_3 2% and hot water soaking. These treatments enhanced key parameters like plant height, leaf number, shoot and root length, and root-shoot ratio, while the control recorded the lowest performance. Hence, GA_3, KNO_3, and hot water treatments can be recommended for efficient nursery production of *Carissa carandas*.

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