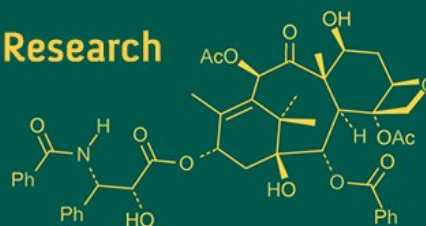
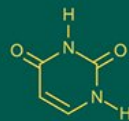
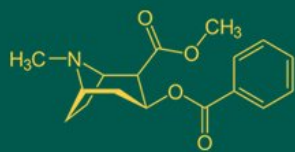


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Studies on the impact of pre-soaking seed treatments on germination and seedling growth parameters of Jackfruit (*Artocarpus heterophyllus* Lam.)

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Abstract

The present investigation was conducted during the year 2025-2026 under shade net conditions at the Horticulture Nursery, Department of Fruit Science, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh. The experiment comprised a total of thirteen treatments and laid out in a Completely Randomized Design (CRD) with three replications. The treatment details were viz. T₀: Control (untreated), T₁: KNO₃ @0.5% for 3 hours, T₂: KNO₃ @1.0% for 3 hours, T₃: KNO₃ @1.5% for 3 hours, T₄: thiourea @0.5% for 1 hour, T₅: thiourea @1.0% for 1 hour, T₆: thiourea @1.5% for 1 hour, T₇: cow urine @2% for 12 hours, T₈: cow urine @3% for 12 hours, T₉: cow urine @5% for 12 hours, T₁₀: vermiwash @2% for 12 hours, T₁₁: vermiwash @3% for 12 hours and T₁₂: vermiwash @5% for 12 hours. The results showed that T₃ had the maximum germination percentage (80.92%). T₃ had maximum height of seedling (5.55, 16.59, 24.39, 32.19, 38.98 and 46.78 cm respectively), diameter of seedling (1.09, 3.02, 3.53, 4.27, 4.91 and 5.83 mm respectively) and number of leaves (1.21, 3.34, 4.71, 6.28, 7.85 and 9.42, respectively) at 15, 30, 45, 60, 75 and 90 days after sowing. Maximum fresh weight of shoot (13.86g), dry weight of shoot (4.52g) and survival percentage (77.94%) was recorded under T₃. The overall results of the investigation concluded that the treatment T₃ was superior in germination and seedling growth parameters as compared to other treatments.

Keywords: Germination, Seedling, Recalcitrant, KNO₃

Introduction

Jackfruit (*Artocarpus heterophyllus* Lam.) is a member of the Moraceae family with 2n = 56 chromosomes and also known for producing the largest fruit among all fruit bearing plants. The botanical genus name *Artocarpus* is derived from the Greek words *artos* meaning "bread" and *carpos* meaning "fruit," reflecting the bread like texture of its edible species (Bailey, 1949)^[4]. The commercial jackfruit cultivars belong to a single species, *A. heterophyllus*. Additionally, significant species of the genus *Artocarpus* include *A. lakoocha* (monkey jack), *A. altilis* or *A. communis* (breadfruit), *A. hirsutus* (wild jack), *A. camansi* (breadnut), *A. odoratissima* (marang) and *A. lingnanensis* (kwaimuk) (Saxena *et al.*, 2011)^[20]. It is originated from the evergreen rain forests of the Western Ghats in India, where it naturally grows in warm and humid conditions (Haq, 2006)^[12]. It requires moist, well-drained soil with a pH between 4.3 to 8.0 and medium soil fertility. The ideal temperature is between 19 to 29°C, the altitude is about 1600 meters above sea level and the yearly rainfall ranges from 1000 to 2400 mm (Prakash *et al.*, 2009)^[16]. It is a multiple fruit (sorosis) and the edible portion is the fleshy perianth (aril/bulbs). It is a climacteric fruit and continuing to ripen after harvest. The optimum stage of harvest maturity in raw jackfruit has been observed to be 90-100 days after the appearance of the spike. The dense, waxy seeds are oval, oblong, or ellipsoid in shape, weigh 2.5-14 g, measure 2-4 × 1-2 cm and have a coriaceous testa, with each syncarp typically containing 100-500 seeds (Gunasena *et al.*, 1996)^[11].

The major producers of jackfruit are India, Vietnam, Malaysia, Myanmar, Indonesia, Bangladesh, Sri Lanka, Brazil, the West Indies, Pakistan and other tropical countries. India, often referred to as the "Motherland of Jackfruit," is one of the world's leading producers (Sidhu, 2012)^[21]. It is frequently described as the "poor man's food" in eastern and southern India. In India, it is extensively found in Kerala, Assam, Odisha, Bihar, Tamil Nadu, Madhya

Pradesh, Chhattisgarh and the northern Indian foothills of the Himalayas (Anon., 2024a) ^[2]. In Chhattisgarh, the major jackfruit producing districts are Raigarh, Mahasamund, Bilaspur, Kanker, Kondagaon and Jashpur (Anon., 2024b) ^[3]. The ripe fruit is a good source of calories, vitamins and minerals, it makes a major nutritional contribution to low income households. The fruits can be consumed raw or processed into pickles and other products. It has two distinct textures when ripe: Khaja, which has a solid perianth and Ghila, which has a watery, pulpy perianth (Rahman *et al.*, 1999) ^[17]. It is an important calorie source for human nutrition with ripe fruit containing 98 kcal, 1.3-1.9 g protein, 0.1-0.3 g total fat, 18.9-25.4 g carbohydrates and 1-1.1 g dietary fiber per 100 g of edible portion (Vinning and Moody, 1997) ^[23]. The majority of nations that grow jackfruit use seed propagation. Its seeds are naturally recalcitrant. Recalcitrant seeds have a tendency to lose their viability when desiccated and have a comparatively high moisture content. Because of their vulnerability to desiccation and chilling, the resistant seeds provide significant storage challenges. Pre- sowing treatments have been shown to improve germination and seedling growth by synchronizing and promoting quick seedling emergence. Seed treatments are essential in jackfruit to increase seed germination and seedling growth (Chin and Roberts, 1980) ^[6].

Chemicals such as KNO₃ and thiourea are used to break the dormancy of seeds or to enhance germination. Potassium nitrate (KNO₃) promotes seed germination in fruit crops by breaking physiological dormancy and enhancing enzyme activity. Thiourea is a nitrogen and sulphur containing compound. In the context of seed germination, thiourea enhances key physiological and biochemical processes such as nitrogen and proline metabolism, enzyme activity, defense responses and water relations. It has been noted that chemical treatment has a major role in breaking dormancy, germination of seeds and plant growth and development (Mithlesh *et al.*, 2025) ^[14]. Organic seed treatments, specifically vermiwash and cow urine, play vital roles in enhancing seed germination and seedling development. Vermiwash obtained from earthworm beds contains a variety of growth regulating substances (Nielson, 1965) ^[15]. Cow urine is rich in physiologically active compounds like growth regulators, iron, urea, uric acid, estrogen's and progesterone. Therefore, it improves seedling growth by enhancing aeration, porosity and water uptake which results in improved seed germination, shoot length and overall enhancement of seedling vigour (Joshi and Adhikari, 2019; Choudhary *et al.*, 2023) ^[13, 7]. This investigation aims to determine most suitable pre-soaking seed treatments to enhance seed germination and ensure standardized practices for jackfruit seedling production.

Materials and Methods

The present investigation was conducted at the Horticulture Nursery, Department of Fruit Science, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh located at a height of 298.15 meters above mean sea level and located at a latitude of 21.25°N and 81.62°E longitude during the year 2025-2026. The investigation was designed using a completely randomized design (CRD) with three replications and including 13 different treatments viz. T₀: control, T₁: KNO₃ @ 0.5% for 3 hrs., T₂: KNO₃ @ 1.0% for 3 hrs., T₃: KNO₃ @ 1.5% for 3 hrs., T₄: thiourea @ 0.5% for 1 hr., T₅: thiourea @ 1.0% for 1 hr., T₆: thiourea @

1.5% for 1 hr., T₇: cow urine @ 2% for 12 hrs., T₈: cow urine @ 3% for 12 hrs., T₉: cow urine @ 5% for 12 hrs., T₁₀: vermiwash @ 2% for 12 hrs., T₁₁: vermiwash @ 3% for 12 hrs. and T₁₂: vermiwash @ 5% for 12 hrs. as represented in table 1. Fresh jackfruit seeds were sown after soaking for different durations of soaking hours of their respective treatments in 8"×6" poly bags with a thickness of 200 gauge filled with growing medium composed with soil, FYM and sand mixture (2:1:1) and irrigated at 1-2 days interval to maintain moisture content.

Results and Discussion

Germination percentage (%)

The data pertaining to germination percentage of the jackfruit seed was presented in Table 2. The maximum germination percentage (80.92%) for jackfruit seeds was observed under the treatment T₃ (KNO₃ @1.5%) statistically *at par* with the treatment T₂ (KNO₃ @1.0%) having value of 77.56%. The treatment T₂ was statistically *at par* with the treatment T₆ (Thiourea @1.5%) showed 74.97%. However, the minimum germination percentage (52.46%) recorded under the treatment T₀ (control).

This advancement in germination percentage could be attributed to KNO₃ role in activates hydrolytic enzymes like α -amylase for effective mobilization of stored food reserves and promotes respiration and embryo growth. Radicle emergence was facilitated by these physiological reactions, leading to higher and more uniform germination. Similar findings were also shown by Gurung *et al.* (2014) ^[10] in passion fruit, Bhavya *et al.* (2017) ^[5] in karonda, Rai *et al.* (2018) ^[18] in Khirmi and Giri *et al.* (2023) ^[9] in papaya, where suitable pre-sowing seed treatments greatly enhanced germination.

Seedling growth parameters

Height of seedling (cm)

The data on height of seedling (cm) as influenced by different pre-soaking seed treatments, recorded at 15, 30, 45, 60, 75 and 90 DAS (days after sowing), are presented in Table 2.

At 15 DAS, the maximum height of seedling (5.55 cm) was recorded under the treatment T₃ (KNO₃ @1.5%), followed by the treatment T₂ (KNO₃ @1.0%) having value of 5.11 cm while the minimum (0 cm) was observed under the treatment T₀ (control). At 30 DAS, the maximum height of seedling (16.59 cm) was recorded under the treatment T₃, followed by the treatment T₂ having value of 15.11 cm while the minimum (10.31 cm) was observed under the treatment T₀. At 45 DAS, the maximum height of seedling (24.39 cm) was recorded under the treatment T₃, statistically *at par* with the treatment T₂ having value of 23.66 cm while the minimum (15.96 cm) was observed under the treatment T₀. At 60 DAS, the maximum height of seedling (32.19 cm) was recorded under the treatment T₃ statistically *at par* with the treatment T₂ having value of 31.21 cm while the minimum (21.61 cm) was observed under the treatment T₀. At 75 DAS, the maximum height of seedling (38.98 cm) was recorded under the treatment T₃ statistically *at par* with the treatment T₂ having value of 37.77 cm while the minimum (27.27 cm) was observed under the treatment T₀. At 90 DAS, the maximum height of seedling (46.78 cm) was recorded under the treatment T₃ statistically *at par* with the treatment T₂ having value of 45.32 cm while the minimum (33.92 cm) was observed under the treatment T₀.

The current results align with those of Rajamanickam *et al.* (2002) ^[19] in aonla, Aatla and Srihari (2013) ^[1] in mango, Bhavya *et al.* (2017) ^[5] in karonda and Mithlesh *et al.* (2025) ^[14] in jackfruit, all of which found that KNO₃ seed treatment greatly increased seedling height and vigor as compared to the control.

Diameter of seedling (mm)

The data pertaining to diameter of seedling (mm) as impact of various pre-soaking seed treatments on jackfruit, observed at 15, 30, 45, 60, 75 and 90 DAS, are demonstrated in Table 2.

At 15 DAS, the maximum diameter of seedling (1.09 mm) was recorded under the treatment T₃ (KNO₃ @1.5%), followed by the treatment T₂ (KNO₃ @1.0%) having value of 1.01 mm while the minimum (0 mm) was observed under the treatment T₀ (control). At 30 DAS, the maximum diameter of seedling (3.02 mm) was recorded under T₃, followed by T₂ having value of 2.91 mm and T₀ observed the minimum value (1.61 mm). At 45 DAS, the maximum diameter of seedling (3.53 mm) was recorded under T₃, followed by T₂ having value of 3.41 mm while the minimum (1.86 mm) was observed under T₀. At 60 DAS, the maximum diameter of seedling (4.27 mm) was recorded under T₃, followed by T₂ having value of 4.02 mm and the minimum (2.26 mm) was observed under T₀. At 75 DAS, the maximum diameter of seedling (4.91 mm) was recorded under T₃, followed by T₂ having value of 4.67 mm while the minimum (2.53 mm) was observed under T₀. At 90 DAS, the maximum diameter of seedling (5.83 mm) was recorded under T₃, followed by T₂ having value of 5.56 mm and the minimum (2.95 mm) was observed under T₀. The recorded increase in diameter of seedling may be attributed to the role of KNO₃ at various vegetative growth stages, as potassium improves enzyme performance, photosynthesis, glucose translocation and water regulation, whereas nitrate acts as both a food and a signaling molecule, stimulating cell division and protein synthesis (Duermeier *et al.*, 2018) ^[8]. Similar results were reported by Aatla and Srihari (2013) ^[1] in mango and Bhavya *et al.* (2017) ^[5] in karonda, who noted increased seedling vigor and stem diameter after seed treatment with KNO₃.

Number of leaves/seedling

The results pertaining to number of leaves/seedling as influenced by various pre-soaking seed treatments on jackfruit, recorded at 15, 30, 45, 60, 75 and 90 DAS, are demonstrated in Table 2.

At 15 DAS, the maximum number of leaves/seedling (1.21) was recorded under the treatment T₃ (KNO₃ @1.5%), followed by the treatment T₂ (KNO₃ @1.0%) having value of 1.07 while the minimum (0) was observed under the treatment T₀ (control). At 30 DAS, the maximum number of leaves/seedling (3.34) was recorded under T₃, followed by T₂ having value of 2.83 and the minimum (1.65) was observed under T₀. At 45 DAS, the maximum number of leaves/seedling (4.71) was recorded under T₃, followed by T₂ having value of 4.25 while the minimum (2.47) was observed under T₀. At 60 DAS, the maximum number of leaves/seedling (6.28) was recorded under T₃, followed by T₂ having value of 5.67 and the minimum (3.29) was observed under T₀. At 75 DAS, the maximum number of leaves/seedling (7.85) was recorded under T₃, followed by T₂ having value of 7.09 while the minimum (4.12) was observed under T₀. At 90 DAS, the

maximum number of leaves/seedling (9.42) was recorded under T₃, followed by T₂ having value of 8.50 while the minimum (4.94) was observed under T₀.

More leaves per seedling are produced as a result of faster leaf initiation and development based through enhanced nutrient mobilization and higher cell division in the shoot apical meristem (Taiz *et al.*, 2015) ^[22]. Similar results were reported by Aatla and Srihari (2013) ^[1] in mango and Bhavya *et al.* (2017) ^[5] in karonda, who noted increased seedling vigor and number of leaves/seedling when seeds were treated with KNO₃.

Fresh weight of shoot (g)

Fresh weight of shoot (g) was recorded at 90 DAS as influenced by various pre-soaking seed treatments and data presented in Table 3. Among the different seed treatments, Maximum fresh weight of shoot (13.86 g) was recorded under the treatment T₃ (KNO₃ @1.5%), followed by the treatment T₂ (KNO₃ @1.0%) having value of 13.01 g while the minimum (7.41) was observed under the treatment T₀.

This results to faster cell division, larger leaf area and increased biomass accumulation. Vigorous shoot growth is promoted by improved seed reserve mobilization and effective photosynthate translocation, which raises shoot fresh weight. Similar findings were reported by Aatla and Srihari (2013) ^[1] in mango and Bhavya *et al.* (2017) ^[5] in karonda, who noted considerably increased shoot growth and seedling vigor after seed treatment with KNO₃.

Dry weight of shoot (g)

Various seed treatments had significant impacts on the dry weight of shoot (g) of jackfruit seedlings, according to the present investigation's observations, which were recorded at 90 DAS and the results are represented in Table 3. The maximum dry weight of shoot was measured under the treatment T₃ (KNO₃ @1.5%) was 4.52 g, followed by the treatment T₂ (KNO₃ @1.0%) having value of 4.33 g. The minimum dry weight (1.34 g) was recorded under the treatment T₀. Enhanced photosynthesis, nitrogen absorption and effective translocation of carbohydrates stimulated by potassium and nitrate may be responsible for the significantly higher shoot dry weight. Similar findings were also shown by Giri *et al.* (2023) ^[9] in papaya and Mithlesh *et al.* (2025) ^[14] in jackfruit, who recorded considerably increased shoot growth and seedling biomass which results as higher dry matter accumulation.

Fresh weight: Dry weight of shoot

The ratio of fresh weight to dry weight of shoot parameter of jackfruit was recorded at 90 DAS presented significant effect among the different pre-soaking seed treatments. The minimum ratio of fresh weight: dry weight of shoot (3.00) was recorded under the treatment T₂ (KNO₃ @1.0%) was statistically *at par* with the treatment T₆ (Thiourea @1.5%) and T₃ (KNO₃ @ 1.5%) having value of 3.01 and 3.13 respectively. The maximum ratio of fresh weight: dry weight of shoot (5.53) was observed under T₀ as presented in Table 3.

The minimum ratio of fresh weight to dry weight of shoot recorded with KNO₃ @ 1.0% may be attributed to the beneficial impact of potassium and nitrate in improving seedling metabolism and dry matter accumulation. These processes enhance the accumulation of structural biomass in shoot tissues which resulting in higher dry matter relative to

fresh weight (Taiz *et al.*, 2015) ^[22]. Similar results have been reported by Aatla and Srihari (2013) ^[1] in mango, Bhavya *et al.* (2017) ^[5] in karonda and Rai *et al.* (2018) ^[18] in Khirni.

Survival percentage (%)

The observations on the survival percentage (%) of jackfruit seedlings under various pre-soaking seed treatments had a substantial impact on the survival percentage at 90 DAS and presented in Table 3. The treatment T₃ (KNO₃ @ 1.5%) had the maximum survival percentage (77.94%), followed by the treatment T₂ (KNO₃ @ 1.0%) had a survival rate of 73.56% in

the present study. T₀ recorded the minimum survival percentage (46.47%).

The higher survival percentage with KNO₃ @ 1.5% for 3 hours can be related to the favorable effects of nitrate and potassium in promoting vigorous root development, effective nutrient uptake and enhanced photosynthetic activity (Taiz *et al.* 2015) ^[22]. Rajamanickam *et al.* (2002) ^[19] found similar results in aonla, Bhavya *et al.* (2017) ^[5] in karonda and Mithlesh *et al.* (2025) ^[14] in jackfruit. Seed treatment with KNO₃ significantly boosted seedling survival percentage.

Table 1: Details of treatments.

S.N.	Treatments	Notations
1	Control	T ₀
2	KNO ₃ @ 0.5% for 3 hrs.	T ₁
3	KNO ₃ @ 1.0% for 3 hrs.	T ₂
4	KNO ₃ @ 1.5% for 3 hrs.	T ₃
5	Thiourea @ 0.5% for 1 hr.	T ₄
6	Thiourea @ 1.0% for 1 hr.	T ₅
7	Thiourea @ 1.5% for 1 hr.	T ₆
8	Cow urine @ 2% for 12 hrs.	T ₇
9	Cow urine @ 3% for 12 hrs.	T ₈
10	Cow urine @ 5% for 12 hrs.	T ₉
11	Vermi wash @ 2% for 12 hrs.	T ₁₀
12	Vermi wash @ 3% for 12 hrs.	T ₁₁
13.	Vermi wash @ 5% for 12 hrs.	T ₁₂

Table 2: Impact of pre-soaking seed treatments on germination percentage (%) and height of seedling (cm) of jackfruit

Notations	Treatments	Germination percentage (%)	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS
T ₀	Control	52.46 ^h	-*	10.31 ^g	15.96 ^f	21.61 ^g	27.27 ⁱ	33.92 ^g
T ₁	KNO ₃ @ 0.5% for 3 hrs.	67.44 ^e	-*	14.02 ^{de}	21.02 ^{cde}	28.03 ^{cde}	35.04 ^{def}	42.33 ^{de}
T ₂	KNO ₃ @ 1.0% for 3 hrs.	77.56 ^{ab}	5.11 ^b	15.11 ^b	23.66 ^{ab}	31.21 ^{ab}	37.77 ^{ab}	45.32 ^{ab}
T ₃	KNO ₃ @ 1.5% for 3 hrs.	80.92 ^a	5.55 ^a	16.59 ^a	24.39 ^a	32.19 ^a	38.98 ^a	46.78 ^a
T ₄	Thiourea @ 0.5% for 1 hr.	66.56 ^e	-*	13.94 ^{de}	20.92 ^{cde}	27.89 ^{cde}	34.86 ^{def}	42.05 ^{de}
T ₅	Thiourea @ 1.0% for 1 hr.	71.96 ^{cd}	4.69 ^d	14.46 ^{cd}	21.70 ^{bc}	28.93 ^{bc}	36.16 ^{cd}	43.39 ^{cd}
T ₆	Thiourea @ 1.5% for 1 hr.	74.97 ^{bc}	4.88 ^c	14.84 ^{bc}	22.56 ^b	29.67 ^b	37.09 ^{bc}	44.51 ^{bc}
T ₇	Cow urine @ 2% for 12 hrs.	60.12 ^g	-*	12.33 ^f	20.07 ^e	25.66 ^f	32.33 ^h	38.96 ^f
T ₈	Cow urine @ 3% for 12 hrs.	61.47 ^{fg}	-*	12.68 ^f	20.63 ^{cde}	26.96 ^{ef}	33.08 ^{gh}	39.08 ^f
T ₉	Cow urine @ 5% for 12 hrs.	65.12 ^{ef}	-*	13.86 ^{de}	21.08 ^{cde}	28.43 ^{bcd}	34.64 ^{ef}	41.83 ^{de}
T ₁₀	Vermi wash @ 2% for 12 hrs.	62.66 ^{fg}	-*	13.60 ^e	20.41 ^{de}	27.21 ^{de}	34.01 ^{fg}	40.81 ^{ef}
T ₁₁	Vermi wash @ 3% for 12 hrs.	64.77 ^{ef}	-*	13.72 ^e	20.57 ^{cde}	27.43 ^{cde}	34.59 ^{ef}	41.57 ^{de}
T ₁₂	Vermi wash @ 5% for 12 hrs.	68.61 ^{de}	3.98 ^e	14.34 ^{cd}	21.50 ^{bcd}	28.67 ^{bcd}	35.84 ^{cde}	43.01 ^{cd}
	SE(m) ±	1.22	0.04	0.19	0.35	0.50	0.44	0.61
	C.D. at 5%	3.57	0.12	0.55	1.03	1.46	1.27	1.77

Note: The superscript letter shows that the treatment means with the same letters are *at par* at 5% level of significance, whereas the means with different letters are significantly different at 5% level of significance. These letters have been affixed based on CD -value comparison of treatment means, DAS - Days After Sowing, -* this denotes to observation was not recorded on particular DAS.

Table 3: Impact of pre-soaking seed treatments on diameter of seedling (mm) of jackfruit.

Notations	Treatments	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS
T ₀	Control	-*	1.61 ⁱ	1.86 ^j	2.26 ^j	2.53 ^g	2.95 ⁱ
T ₁	KNO ₃ @ 0.5% for 3 hrs.	-*	2.51 ^{de}	2.96 ^e	3.27 ^e	3.59 ^d	4.31 ^e
T ₂	KNO ₃ @ 1.0% for 3 hrs.	1.01 ^b	2.91 ^b	3.41 ^b	4.02 ^b	4.67 ^b	5.56 ^b
T ₃	KNO ₃ @ 1.5% for 3 hrs.	1.09 ^a	3.02 ^a	3.53 ^a	4.27 ^a	4.91 ^a	5.83 ^a
T ₄	Thiourea @ 0.5% for 1 hr.	-*	2.43 ^{ef}	2.88 ^{ef}	3.19 ^e	3.54 ^d	4.18 ^{ef}
T ₅	Thiourea @ 1.0% for 1 hr.	0.81 ^d	2.84 ^b	3.34 ^b	3.65 ^{cd}	4.25 ^c	5.11 ^c
T ₆	Thiourea @ 1.5% for 1 hr.	0.93 ^c	2.71 ^c	3.21 ^c	3.53 ^d	4.12 ^c	4.97 ^c
T ₇	Cow urine @ 2% for 12 hrs.	-*	2.08 ^h	2.42 ⁱ	2.66 ⁱ	2.97 ^f	3.39 ^h
T ₈	Cow urine @ 3% for 12 hrs.	-*	2.34 ^{fg}	2.74 ^{gh}	3.04 ^{fg}	3.29 ^e	3.89 ^g
T ₉	Cow urine @ 5% for 12 hrs.	-*	2.39 ^f	2.82 ^{fg}	3.14 ^{ef}	3.44 ^{de}	4.09 ^f
T ₁₀	Vermi wash @ 2% for 12 hrs.	-*	2.25 ^g	2.65 ^h	2.88 ^h	3.04 ^f	3.49 ^h
T ₁₁	Vermi wash @ 3% for 12 hrs.	-*	2.29 ^g	2.69 ^h	2.95 ^{gh}	3.28 ^e	3.78 ^g
T ₁₂	Vermi wash @ 5% for 12 hrs.	0.72 ^e	2.56 ^d	3.08 ^d	3.71 ^c	4.15 ^c	4.74 ^d
	SE(m) ±	0.01	0.03	0.04	0.05	0.06	0.07
	C.D. at 5%	0.02	0.09	0.12	0.13	0.16	0.19

Note: The superscript letter shows that the treatment means with the same letters are *at par* at 5% level of significance, whereas the means with different letters are significantly different at 5% level of significance. These letters have been affixed based on CD -value comparison of treatment means, DAS - Days After Sowing, -* this denotes to observation was not recorded on particular DAS.

Table 4: Impact of pre-soaking seed treatments on number of leaves/seedling of jackfruit.

Notations	Treatments	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS
T ₀	Control	-*	1.65 ⁱ	2.47 ^j	3.29 ^l	4.12 ^k	4.94 ^l
T ₁	KNO ₃ @ 0.5% for 3 hrs.	-*	2.31 ^{ef}	3.46 ^f	4.61 ^f	5.77 ^f	6.92 ^{ef}
T ₂	KNO ₃ @ 1.0% for 3 hrs.	1.07 ^b	2.83 ^b	4.25 ^b	5.67 ^b	7.09 ^b	8.50 ^b
T ₃	KNO ₃ @ 1.5% for 3 hrs.	1.21 ^a	3.34 ^a	4.71 ^a	6.28 ^a	7.85 ^a	9.42 ^a
T ₄	Thiourea @ 0.5% for 1 hr.	-*	2.21 ^{fg}	3.31 ^g	4.41 ^g	5.52 ^g	6.62 ^{fg}
T ₅	Thiourea @ 1.0% for 1 hr.	0.82 ^d	2.53 ^d	3.80 ^d	5.06 ^d	6.33 ^d	7.59 ^d
T ₆	Thiourea @ 1.5% for 1 hr.	0.91 ^c	2.69 ^c	4.04 ^c	5.38 ^c	6.73 ^c	8.07 ^c
T ₇	Cow urine @ 2% for 12 hrs.	-*	1.86 ^h	2.80 ⁱ	3.73 ^k	4.66 ^j	5.59 ^k
T ₈	Cow urine @ 3% for 12 hrs.	-*	1.91 ^h	2.86 ⁱ	3.81 ^{jk}	4.76 ^j	5.71 ^{jk}
T ₉	Cow urine @ 5% for 12 hrs.	-*	2.13 ^g	3.20 ^g	4.26 ^{gh}	5.33 ^{gh}	6.39 ^{gh}
T ₁₀	Vermi wash @ 2% for 12 hrs.	-*	1.98 ^h	2.98 ^h	3.97 ^{ij}	4.96 ⁱ	5.95 ^{ij}
T ₁₁	Vermi wash @ 3% for 12 hrs.	-*	2.15 ^g	3.08 ^h	4.11 ^{hi}	5.14 ^{hi}	6.16 ^{hi}
T ₁₂	Vermi wash @ 5% for 12 hrs.	0.77 ^d	2.41 ^{de}	3.61 ^e	4.81 ^e	6.02 ^e	7.22 ^e
	SE(m) ±	0.01	0.05	0.05	0.06	0.07	0.12
	C.D. at 5%	0.04	0.12	0.13	0.17	0.19	0.34

Note: The superscript letter shows that the treatment means with the same letters are *at par* at 5% level of significance, whereas the means with different letters are significantly different at 5% level of significance. These letters have been affixed based on CD -value comparison of treatment means, DAS - Days After Sowing, -* this denotes to observation was not recorded on particular DAS

Table 5: Impact of pre-soaking seed treatments on fresh weight of shoot (g), dry weight of shoot (g), Fresh: Dry weight ratio of shoot and survival percentage (%) of jackfruit at 90 DAS.

Notations	Treatments	Fresh weight of shoot (g)	Dry weight of shoot (g)	Fresh: Dry weight ratio of shoot	Survival percentage (%)
T ₀	Control	7.41 ^k	1.34 ^l	5.53 ^f	46.47 ^j
T ₁	KNO ₃ @ 0.5% for 3 hrs.	11.16 ^{de}	3.12 ^f	3.58 ^{cd}	63.44 ^{ef}
T ₂	KNO ₃ @ 1.0% for 3 hrs.	13.01 ^b	4.33 ^b	3.00 ^a	73.56 ^b
T ₃	KNO ₃ @ 1.5% for 3 hrs.	13.86 ^a	4.52 ^a	3.13 ^{ab}	77.94 ^a
T ₄	Thiourea @ 0.5% for 1 hr.	10.74 ^{ef}	3.03 ^{fg}	3.54 ^{cd}	62.56 ^{ef}
T ₅	Thiourea @ 1.0% for 1 hr.	12.12 ^c	3.81 ^d	3.18 ^b	68.84 ^{cd}
T ₆	Thiourea @ 1.5% for 1 hr.	12.40 ^c	4.12 ^c	3.01 ^{ab}	71.97 ^{bc}
T ₇	Cow urine @ 2% for 12 hrs.	8.12 ^j	1.92 ^k	4.22 ^{ef}	54.12 ⁱ
T ₈	Cow urine @ 3% for 12 hrs.	8.66 ⁱ	2.12 ^j	4.08 ^e	56.47 ^{hi}
T ₉	Cow urine @ 5% for 12 hrs.	10.34 ^f	2.95 ^g	3.50 ^{cd}	60.13 ^{fh}
T ₁₀	Vermi wash @ 2% for 12 hrs.	9.35 ^h	2.43 ⁱ	3.84 ^d	57.66 ^{ghi}
T ₁₁	Vermi wash @ 3% for 12 hrs.	9.86 ^g	2.74 ^h	3.59 ^{cd}	60.67 ^{fg}
T ₁₂	Vermi wash @ 5% for 12 hrs.	11.60 ^d	3.36 ^e	3.45 ^c	64.61 ^{de}
	SE(m) ±	0.16	0.04	0.06	0.77
	C.D. at 5%	0.48	0.11	0.16	2.24

Note: The superscript letter shows that the treatment means with the same letters are *at par* at 5% level of significance, whereas the means with different letters are significantly different at 5% level of significance. These letters have been affixed based on CD -value comparison of treatment means.

Conclusion

The present experiment revealed that impact of various pre-soaking seed treatments on germination and seedling growth of jackfruit (*Artocarpus heterophyllus* Lam.) under shed net condition. Among the different treatments, T₃ (KNO₃ @1.5%) constantly recorded the maximum values for germination percentage, height of seedling, diameter of seedling, number of leaves/seedling, fresh weight of shoot, dry weight of shoot and survival percentage. The treatment T₃ (KNO₃ @1.5%) closely followed by T₂ (KNO₃ @1.0%) throughout the study for most of the parameters. The superiority of KNO₃ @1.5% for 3 hours may be attributed to increased enzyme activity, seed reserve mobilization, respiration and rapid seedling establishment. Improved uptake of nutrients and photosynthetic efficiency resulted in rapid seedling growth. The control (T₀) observed the minimum values for all parameters. Based on these findings, T₃ (KNO₃ @1.5%) can be recommended as the most effective pre-soaking seed treatment for improving jackfruit germination and seedling growth under shed net conditions

along with T₂ (KNO₃ @1.0%) functioning as a suitable alternative.

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