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Effect of different plant growth regulators on Rambutan seed germination (*Nephelium lappaceum* var. *lappaceum*)

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Abstract
The present study was conducted to examine the impact of different concentrations of GA_3 and Ethephon on Rambutan seed germination. The experiment followed a Randomized Block Design (RBD) with three replications. The results clearly demonstrated significant differences in the effects of various concentrations of GA_3 and Ethephon on seed germination. The largest percentage of germination (60.82%) was found in seeds treated with Ethephon at a concentration of 10 ppm. Additionally, plants treated with GA_3 showed maximum plant height (24.43 cm) and a higher number of leaves (12.35). On the other hand, Ethephon-treated plants exhibited maximum root length (24.42 cm) a higher number of roots (25.46) and greater stem girth (3.50 mm).

Keywords: Germination, Rambutan, seed treatment, GA_3, ethephon

1. Introduction
Rambutan (*Nephelium lappaceum* var. *lappaceum*) is an evergreen tropical fruit tree belonging to the Sapindaceae family. It shares similarities with lychee and long an and is known for its distinctive appearance, with hairy red and yellow growths covering its ellipsoidal fruits. Rambutan requires a warm, humid tropical climate with regular rainfall for optimal growth. The fruit is highly nutritious, containing vitamins, minerals, and sugars. Despite being an underutilized fruit crop, rambutan presents promising opportunities for increased production and popularity among consumers, driven by its nutritional value and exotic appeal. Research and innovation are vital in exploring appropriate techniques for fostering the growth of rambutan in India's agro climatic conditions. Despite its potential as an exotic fruit, the commercial cultivation of rambutan faced challenges in India due to a lack of practical experience and standardized propagation techniques.
Rambutan seeds have a short viability period (Recalcitrant seeds) and should be sown shortly after being taken from the fruit to ensure a high germination percentage. Therefore, an attempt was made to improve seed germination, *viz*., GA_3 @ 1, 10 and 100 ppm, Ethephon @ 1, 10, 100 ppm and distilled water.

2. Materials and Methods
The current research work's experimental study was conducted at HRS, Dr. YSRHU, VR. Gudem, West Godavari district, Andhra Pradesh. (16.80° North latitude and 81.50° East longitude of 34 M above mean sea level) during., year 2022-2023. The rambutan fruits are generally harvested in the months of July to Sept.
The seeds from fully ripened and healthy Rambutan fruits carefully extracted, washed and dried under shade to ensure their viability for the experiments. The study utilized two different plant growth regulators: Gibberellic acid (GA_3) and Ethephon. Both growth regulators were treated at three different concentration levels (1 ppm, 10 ppm, and 100 ppm), to assess their impact on seed germination and early seedling growth.
This experiment was carried out during second week of August (*i.e*., 11th of August). The seeds were sown in growth regulators for 3 hours. The treated seeds were washed thoroughly with distilled water and sown into the polythene bags. The experiment was conducted in RBD and replicated thrice using 40 seeds in each replication. They were examined daily and the observations were recorded upto next 90 days after sowing.

During the investigation, various observations were recorded to evaluate the germination and growth of the Rambutan seeds. The germination parameters recorded during the experiment were days taken for initiation of germination, number of days taken for 50% of germination and total germination percentage was observed since the date of sowing. The total germination is calculated on percentage basis as below.

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

The growth parameters recorded during the experiment were plant height (cm), number of leaves per seedlings, number of roots per seedlings, root length (cm) and girth of the stem (mm). All metrics were recorded every 30 days intervals for a total of 90 days.

3. Results and Discussions

Table 1 shows that there is a significant variation in germination characteristics. *i.e.*, days taken for initiation of germination, days taken for 50% germination and total germination percentage. Among all the treatments the seeds treated with Ethephon 1 ppm resulted in early germination (7.75 days) which was found to be on par with seeds treated with Ethephon 10 ppm (8.13 days), Where as seeds without any growth regulators recorded maximum days for germination (12.77 days). There is no significant difference was observed in days taken for 50% germination. Among all treatments total germination percentage was recorded maximum in Ethephon 10 ppm (60.82%) and minimum in Control (22.15%). Similar results were reported by Vats and Bakshi (1969) [8] in Kinnow, Sinha *et al*. (1973) [6] in Guava, Barman and Sarma (1985) [1] in *Camellia sinensis*, Prasad *et al*. (1996) [5] in Litchi, Vachhani *et al.* (2014) [7] in Khirnee (*Manilkara hexandra* Roxb).

Table 1: Effect of different Plant growth regulators on germination parameters

S. No	Treatments	Germination		
		Days taken for initiation of germination	Days taken for 50% germination	Germination %
1	GA_3 1 ppm	9.23	-	27.82
2	GA_3 10 ppm	9.90	-	37.80
3	GA_3 100 ppm	9.88	-	32.32
4	Ethephon 1 ppm	7.75	-	38.68
5	Ethephon 10 ppm	8.13	10.13	60.82
6	Ethephon 100 ppm	9.92	12.16	52.09
7	Control	12.77	-	22.15
	CD (P = 0.05)	0.75		3.15
	SE ± (m)	0.24		1.01

The data in table 2 indicated that there is a significant difference between treatments and maximum plant height was recorded in GA_3 10 ppm (24.43 cm) and minimum was recorded in control (20.41 cm). Similar results were reported by Garg and Singh (1996) [5] in Cape gooseberry, Pampanna and Suikeri. 2001 [4] in Sapota and Vachhani *et al.* (2014) [7] in Khirnee (*Manilkara hexandra Roxb*).

Table 2 data showed that there is a substantial difference between treatments and an enormous number of leaves per seedling was recorded in GA_3 10 ppm (12.35) and minimum number of leaves was recorded in control (10.03). Similar results were reported by Garg and Singh (1996) [5] in Cape gooseberry, Pampanna and Suikeri (2001) [4] in Sapota and Vachhani *et al.* (2014) [7] in Khirnee (*Manilkara hexandra Roxb*).

The data representing number of roots per seedling were represented in table 2 where an enormous number of roots per seedling were recorded in Ethephon 10 ppm (25.6) and minimum number of roots per seedling were recorded in control (14.89). Similar results were reported by Sinha *et al.* (1973) [6] in Crab apple, Sinha *et al*. (1973) [6] in Guava and Nikam (1985) [3] in Wood apple and Ber.

The data representing root length was represented in table 2 where an increased root length of the seedlings were recorded in Ethephon 10 ppm (24.42 cm) and decreased root length seedling was recorded in control (12.28 cm). Similar results were reported by Sinha *et al*. (1973) [6] in Guava and Manekar *et al.* (2011) [2] in Aonla.

Table 2: Effect of different plant growth regulators' on Plant height (cm), number of leaves per seedlings, no of roots per seedlings, root length (cm) and girth of the stem (mm)

S. No	Treatments	Plant Height (cm)	No of leaves/ seedlings	No of roots/ seedlings	Root length (cm)	Girth of the stem (mm
1	GA_3 1 ppm	22.71	11.56	15.94	16.43	2.58
2	GA_3 10 ppm	24.43	12.35	24.56	16.28	2.91
3	GA_3 100 ppm	22.73	11.41	21.01	17.95	2.81
4	Ethephon 1 ppm	22.88	10.99	15.42	14.79	3.50
5	Ethephon 10 ppm	23.30	10.54	25.6	24.42	3.42
6	Ethephon 100 ppm	21.00	10.55	16.89	20.23	2.97
7	Control	20.41	10.03	14.89	12.28	2.47
	CD (0.05)	0.86	0.65	0.41	0.62	0.26
	SE ±(m)	0.28	0.21	0.13	0.20	0.08

The data in Table 2 revealed a substantial difference between treatments and an increased girth of the stem of rambutan seedling was recorded in Ethephon 1 ppm (3.50) which is found to be on par with Ethephon 10 ppm (3.42 mm) and decreased girth of the stem was recorded in control (2.47 mm). Similar outcomes were reported by Sinha *et al*. (1973) [6] in Guava and Manekar *et al.* (2011) [2] in Aonla.

The increased germination parameters of Ethephon are due to 1-aminocyclopropane-1-carboxylic acid (ACC), an initial precursor of ethylene production, increases seed germination. Seeds of many species require ethylene binding for dormancy release or germination under ideal or unfavorable factors, ethylene production increases with radicle emergence, which resulted in increased root length and number of roots. The GA_3 also has the ability to trigger mitotic division in some plant leaves, resulting in increased plant height and number of leaves.

4. Conclusion

Based on the outcomes of the investigations, it is possible to conclude that seeds treated with Ethephon resulted on early germination, maximum germination percentage and girth of the stem with optimum vegetative growth of length and number of roots while Gibberellic acid resulted in increased number of leaves, plant height.

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