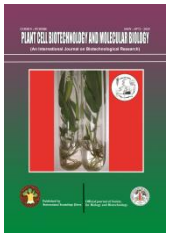

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Effect of Different Seed Treatment on Germination of Fishtail Palm (*Caryota urens*) under Naturally Ventilated Poly-house Conditions

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Authors' contributions

This work was carried out in collaboration among all authors. Author RJM conceived and designed the analysis, collected the data, contributed data or analysis tools, performed the analysis and wrote the paper. Author VDR edited the manuscript. Author BHP wrote the paper. All authors read and approved the final manuscript.

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ABSTRACT

An investigation was conducted to study the effect of different seed treatments comprising of mechanical scarification, chemical and plant growth regulator on germination of Fishtail palm (*Caryota urens*) seeds under naturally ventilated poly-house at sheth D. M. Polytechnic in Horticulture College, Anand Agricultural University, Vadodara during 2021 to 2023. There were total 12 treatments under study which was replicated trice and statistically analysed by completely randomized design at 90 days after sowing. The results revealed that treatment T_{12} *i.e.* seeds treated with GA_3 1000 ppm for one day recorded significantly lesser days to initiation of germination

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(46.33 days) along with higher germination percentage (86.67 % and 85.00 %), germination rate index (5.90 %/day and 5.70 %/day) and germination index (255 and 243.67), coefficient of velocity of germination (6.18 and 6.02), timpson's germination index (1275 and 1218), modified timpson germination index (42.50 and 40.61) and survival percentage (88.33 and 86.67) at 90 days after sowing during first and second year respectively. While, seed without any treatment kept in open condition treatment T_1 showed poor performance in germination percentage as well as survival percentage. Thus, Fishtail palm (*Caryota urens*) seeds soaked in solution of 1000 ppm GA_3 along with sowing them in polybags and kept under NVPH condition provides better germination and survival.

Keywords: Fishtail palm; seed germination; seed treatment; palm seed germination; palm seedling.

1. INTRODUCTION

Fish tail palm also known as Kithul botanically known as *Caryota urens* L. is a monocotyledon multipurpose tree species belonging to family Arecacea. This species is mainly distributed in Indian Subcontinent and Southeast Asia where they grow in fields and rainforest clearings. Solitary fishtail palm is a multipurpose tree, cultivated both for its products and as an ornamental specimen. The trunk yields starch (sago), which is edible. Palms are felled to extract the central 'pith', and the sweet-tasting pulp is sundried, powdered and stored and can be used for the preparation of bread. Sap is tapped from the inflorescence, then fermented into an alcoholic drink (palm wine or toddy) or boiled down to make syrup or sugar (jiggery). The stem apex (palm heart or palm cabbage) can be chewed raw or cooked. The leaves produce strong fibers (kitul fiber) that are made into ropes, brushes and baskets.

Slow germination in many species of palms has been attributed to a thick, impervious endocarp and sarcotesta [1,2,3]. Seed scarification using concentrated sulfuric acid has improved germination speed in a few species, but has negative effects on Fishtail palm seeds [4]. The long duration (about 4 months) taken for seed germination is considered as one of the major issues in the propagation of this species [5].

Therefore, an experiment was conducted to explore possibilities of improving the seed germination through mechanical, physical and chemical treatments and to develop a cost effective and rapid seed germination method.

2. MATERIALS AND METHODS

The experiment was conducted during 2022 and 2023 at Sheth D. M. Polytechnic in Horticulture College Research Farm, Anand Agricultural University, Model farm, Vadodara to study the effect of different seed treatment on germination of fishtail palm. Each treatment of the 12 treatments used involved 60 seeds replicated on 3 batches with completely randomized design. A mature inflorescence which consisted of ripened, partially ripened and matured fruits, was carefully brought down to the ground with the help of a rope controlled by a climber, from a tree of fish tail palm from Horticulture Nursery at B. A. College of Agriculture, AAU, Anand. The collected inflorescences were kept inside a poly bag for 3 days to facilitate ripening of un-ripened fruits. Then the fruits were removed from the inflorescence and collected to a poly bag. Seeds were extracted by pressing the poly bag manually followed by separation of fleshy skin (exo-carp). Extracted seeds were dried under shade for a day. Before every treatment, seeds were soaked in the water, floating seeds were eliminated to remove seeds having damage, porous space and immature growth. Seed having similar morphological characters of seed length 14.5 ± 0.5 mm, seed width 11.0 ± 0.5 mm, seed thickness 7.5 ± 0.5 mm and seed weight 1 ± 0.02 g were selected and 20 seeds distributed for each replication.

There were ten set of treatments *viz.,* seed rubbed with sand paper (T_3), Seed soaking in hot water for 5 min and immediate soak in cold water for 15 min for 2 times (2 days) (T_4), seed soaking in water for 5 days (T_5), Seed soaking in 50 % cow urine for 5 days (T_6), Seed soaking in 100 % cow urine for 5 days (T_7), Seed kept in moist coco peat container wrapped with plastic on top for 5 days (T_8), seed soaked in Profenol 50 % (15 min) for 2 times (2days) (T_9), Seed soaked in GA_3 1000 ppm for 1 day (T_{10}), seed soaking in Bio NP 10 ml/1 liter water (Azotobactor+PSB) for 2 days (T_{11}) and Seed soaked in HNO_3 50% for 5 mins (T_{12}). Seeds after the treatments were washed with tap water and sown in the polybags having 20 x 10 cm in size filled with the media comprising of garden soil, sand and vermicompost of 1:1:1 ratio. Another two sets of three replication each were prepared and directly

sown in the polybags and kept in open condition (T_1) as a control and another set along with all other treatments were kept under Naturally Ventilated Poly-house Condition (T_2) for taking observations. Seeds were observed every day up to 90 Days. Numbers of the germinated seeds in each treatment were recorded in 3 day intervals. Germination testing time, capacity and speed of germination were computed as follows.

2.1 Initiation of Germination and Germination Percentage

First day of initiation of germination was calculated from the day seeds were planted and represented in tabular formation. Lower the values indicate a faster initiation of germination in particular treatment [6]. Germiantion percentage was calculated on the basis of formula given in Rules for Seed Analysis [7].

GP = (N/A) x 100

The higher the GP value represents the greater the germination of a seed population [8].

Germination rate index was calculated by following formula

GRI = (G1/1) + (G2/2) +...+ (G30/30)

Where, G1=Germination percentage on first day of sowing

G2=Germination percentage on second day of sowing …

The Germination rate index (GRI) reflects the percentage of germination on each day of the germination period. Higher GRI values indicate higher and faster germination [9].

2.2 Germination Index

Germination index (GI) was calculated on the basis on formula proposed by Goodchild and Walker [10].

GI=(30 x T1) + (29 x T2) +· · · + (1 x T30)

Where, 1. T1, T2, .. T30 is number of seed germinated on 1st day, 2nd day … 30th day.

2. And 30, 29 … 1 were the weights given to the number of germinated seed on the first to last observation respectively.

In the GI, maximum weight is given to the seeds germinated on the first day and less to those germinated later on. The lowest weight would be for seeds germinated on the 10th day. Therefore, the GI emphasizes on both the percentage of germination and its speed. A higher GI value denotes a higher percentage and rate of germination [11].

2.3 Coefficient of Velocity of Germination

Coefficient of velocity of germination (CVG) was calculated with the formula proposed by Labouriau [12].

CVG=N1 + N2 +…+Nx/100 × N1T1 + N2T2 + … +NxTx

Where, N=No. of seeds germinated each day and

T = No of days from seeding corresponding to N

The CVG gives an indication of the rapidity of germination. It increases when the number of germinated seeds increases and the time required for germination decreases. Theoretically, the highest CVG possible is 100. This would occur if all seeds germinated on the first day [13].

2.4 Modified Timpson Germination Index

Timson's Germination Index (TGI) [14] is computed as follows,

$$\Sigma k=\sum i=1kGi$$

Where, Gi is the cumulative germination percentage in time interval i and k is the total number of time intervals.

With reference to above formula modification was proposed by Khan and Ungar [15], where Timson's index (Σk) is divided by the total time period of germination (Tk)

$$\Sigma kmod=\Sigma k/Tk$$

Two year data for all the observations were collected separately and statistical analysis for individual year was done by the statistical method proposed by Panse and Sukhatme [16].

3. RESULT AND DISCUSSION

Data presented in Table 1 clearly showed significant influence of seed treatment on

Table 1. Effect of seed treatment on days to initiation of germination (days), germination percentage (%), germination rate index (%/days) and Germination Index of fishtail palm under Naturally Ventilated Poly-House at 90 DAP

Treatments		Initiation of germination (Days)		Germination Perentage (%)		Germination rate index (%/day)		Germination index	
		2022	2023	2022	2023	2022	2023	2022	2023
T_1	Control (Open condition)	68.33	72.33	21.67	18.33	1.15	0.92	49.00	38.33
T_2	NVPH + Control	62.33	56.00	38.33	38.33	2.08	2.15	89.33	91.67
T_3	NVPH + sand paper	54.67	51.67	48.33	45.00	2.75	2.50	121.33	105.67
T_4	NVPH + hot water	54.33	55.33	50.00	50.00	2.77	2.66	115.33	104.00
T_5	NVPH + water	56.00	57.00	51.67	50.00	2.82	2.72	121.33	116.33
T_6	NVPH + 50 % cow urine	61.33	56.67	50.00	50.00	2.74	2.74	117.67	116.67
T_7	NVPH + 100 % cow urine	61.00	62.33	50.00	48.33	2.48	2.46	101.00	102.67
T_8	NVPH + Coco peat container	65.00	66.33	48.33	45.00	2.38	2.19	95.67	84.00
T_9	NVPH + Profenol 50 %	65.67	67.00	50.00	51.67	2.43	2.54	95.00	100.00
T_{10}	NVPH + GA_3 1000 ppm	48.33	47.00	86.67	85.00	5.90	5.70	255.00	243.67
T_{11}	NVPH + Bio NP	47.00	55.33	60.00	61.67	3.48	3.63	152.67	158.00
T_{12}	NVPH + HNO_3 50%	46.33	50.33	68.33	68.33	4.43	4.47	194.67	197.67
CD (P=0.05)		5.67	6.07	9.21	7.69	0.46	0.39	21.41	20.37

Table 2. Effect of seed treatment on Coefficient of velocity of germination, Timson's Germination Index, Modified Timpson Germination Index and Survival Percentage of fishtail palm under Naturally Ventilated Poly-House at 90 DAP

Treatments		Coefficient of velocity of germination (%/Day)		Timson's Germination Index		Modified Timpson germination index (%)		Survival Percentage (%)	
		2022	2023	2022	2023	2022	2023	2022	2023
T_1	Control	5.13	4.94	245	192	8.17	6.39	21.67	23.33
T_2	NVPH + Control	5.18	5.25	447	458	14.89	15.28	43.33	45.00
T_3	NVPH + sand paper	5.42	5.23	607	528	20.22	17.61	53.33	48.33
T_4	NVPH + hot water	5.16	4.87	577	520	19.22	17.33	58.33	58.33
T_5	NVPH + water	5.20	5.17	607	582	20.22	19.39	58.33	53.33
T_6	NVPH + 50 % cow urine	5.19	5.18	588	583	19.61	19.44	53.33	58.33
T_7	NVPH + 100 % cow urine	4.80	4.92	505	513	16.83	17.11	56.67	53.33
T_8	NVPH + Coco peat container	4.74	4.60	478	420	15.94	14.00	58.33	60.00
T_9	NVPH + Profenol 50 %	4.65	4.69	475	500	15.83	16.67	51.67	48.33
T_{10}	NVPH + GA_3 1000 ppm	6.18	6.02	1275	1218	42.50	40.61	88.33	86.67
T_{11}	NVPH + Bio NP	5.49	5.52	763	790	25.44	26.33	73.33	68.33
T_{12}	NVPH + HNO_3 50%	5.99	6.07	973	988	32.44	32.94	83.33	76.67
CD (P=0.05)		0.48	0.50	107	102	5.67	6.07	5.44	9.21

initiation of germination (days), Germination percentage (%) Germination rate index (%/day) and germination index at 90 days after sowing. During first year, seeds treated with HNO_3 50 % for 5 minutes recorded significantly lesser days to initiation of germination (46.33 days) while second year, treatment T_{10} *i.e.* seeds treated with GA_3 1000 ppm for one day recorded significantly lower days to initiation of germination (47.00 days). Moreover, seeds treated with GA_3 1000 ppm for one day recorded significantly higher germination percentage (86.67% and 85.00%), Germination rate index (5.90%/day and 5.70%/day) and germination index (255 and 243.67) at 90 days after sowing during first and second years respectively. It was evident from the data depicted in Table 2 that germination treatment significantly influence Coefficient of velocity of germination, Timson's germination index, Modified Timpson germination index and survival percentage at the 90 days after sowing. Seeds treated with GA_3 1000 ppm for one day recorded significantly higher Coefficient of velocity of germination (6.18 and 6.02), Timson's germination index (1275 and 1218), Modified Timpson germination index (42.50% and 40.61%) and survival percentage (88.33% and 86.67%) at the 90 days after sowing during first and second years respectively. Fishtail palm seeds without any treatment kept in open condition recorded significantly poor performance in all the germination parameters as compared to treatments kept under naturally ventilated poly-house along with lowest germination (21.67% and 18.33%) and survival percentage (21.67% and 23.33%) after 90 days after sowing during first and second years respectively.

GRI calculations merely show the percentage of germination per day for that treatment, so the higher the percentage and the shorter the duration, the higher the GRI. It has less information regarding the 'high' and 'low' germination days rather than it spreads the percentage evenly across the time spread. In case of CVG not focuses on the final germination percentage, but it emphasis on the time required for reaching it. While GI appears to be the most comprehensive observation tool combining both germination percentage and speed of germination (spread, duration and 'high or low' events) [17]. It also magnifies the variation among seed lots ultimately makes easier to compare numerical measurement and provide more insight to the germination behaviour. Amongst various treatments under study GA_3 shown better results comparing over other treatments for germination and survival of seeds in fishtail palm might be due to its role and plant growth regulator and enhancing the seed elongation and amylase hydrolysis process which is activated by giberellic acid which allows radicle to push through the seed coat and ultimately breaking seed dormancy. The longer the seed is soaked with GA_3, the more GA_3 accumulates in the seed cell. Moreover, the increased germination percentage in GA_3 treated seeds might be attributed to fact that the GA_3 helps in breaking the seed dormancy which results in early and enhanced seed germination due to the diffusion of endogenous auxin and gibberellins like substances [18,19]. GA_3 might have helped in weakening of the tissues surrounding the embryo or the stimulation of embryonic elongation or both. Rout et al. [20] observed that increase in germination percentage with GA_3 might be due to involvement of GA_3 in the activation of cytological enzymes along with increase in cell wall plasticity and better water absorption. Provision of GA_3 as a growth regulator substance can stimulate cell division. The application of 1000 ppm GA_3 increased germination to palm kernels is thought be optimal in stimulating cell growth and ensuring that the kernels germinates fast. The results are in accordance with Setiawan et al. [21] in oil palm Kadir et al. [22] and Moussa et al. [1]. All the treated seeds recorded better germination percentage compared to control. With respect to germination percentage, seeds treated with Bio NP responded well among all the treatments after GA_3 and HNO_3 treatment respectively.

4. CONCLUSION

From the experiment it was evident that fishtail palm seed has very low germination percentage and slow rate of germination. It is must to provide a proper seed treatment get higher germination percentage along with uniform and quick germination of seed. The experiment does prove that seeds of fishtail palm treated with 1000 ppm GA_3 for one day resulted in lower initiation of germination along with higher germination speed, germination percentage and survival percentage. It was also clear that growing seeds under naturally ventilated poly house condition also help to improve germination. Nurseryman or farmer growing fishtail palm seeds are recommended to seed soaked in 1000 ppm GA_3 solution for one day and place them under naturally ventilated poly house condition in polybags for better germination and early growth.

5. FUTURE SCOPE

GA_3 gave promising results for breaking seed dormancy in fishtail palm and more research can be conducted to see the effect of different concentration along with duration to get the best results in improving initiation of germination. Moreover along with combination of other treatments can be tried to get better results in future.

CONSENT

As per international standards or university standards, respondents' written consent has been collected and preserved by the author(s).

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (Chat GPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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