

**Effect of different priming treatments on seed germination of sago palm (*Cycas revoluta* L.)****Zia Ullah \*, Imran Hassan, Ishfaq Ahmed Hafiz, Nadeem Akhtar Abbasi**

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| <b>Authors' Contribution</b> | Z. Ullah, conducted the survey; I. Hassan helped in green house experiment; I.A. Hafiz and N.A. Abbasi performed the statistical analysis and paper writing   |
| <b>Article History</b>       | Corresponding email address: dr.hamid@bzu.edu.pk Digital Object Identifier (DOI): <a href="https://doi.org/10.33865/wjb.005.01.0237">https://doi.org/10.33865/wjb.005.01.0237</a><br>Received: 03 September 2019, Revised: 17 October 2019, Accepted: 06 December 2019, Published Online: 01 January 2020 |

**ABSTRACT**

King sago palm or sago cycas are the other name of Kangi palm (*Cycas revoluta*) sago palm has been used as an indoor and outdoor landscape plant for centuries. The present study was conducted to estimate the effect of different priming treatments on seed germination of sago palm (*Cycas revoluta* L.) in the research area of Department of Horticulture PMAS, University of Arid Agriculture Rawalpindi, Pakistan. The Experiment consisted of ten treatments; the seeds without pulp were soaked in solution of 500, 750 and 1000 ppm GA<sub>3</sub> and 2%, 3% and 4% solution of KNO<sub>3</sub> for 24 hr at room temperature. In case of hot water treatment, seeds were primed at 80°C, 90°C and 100°C for 30, 20 and 10 minutes respectively. The effect of different concentrations of gibberellic acid (GA<sub>3</sub>), potassium nitrate (KNO<sub>3</sub>) and hot water on various parameters like germination rate, germination percentage, germination value, decayed seed percentage, time of germination, number of leaves and seedling height were studied. Significant results of germination rate (55.56 days), germination value (192.19) were achieved from 500 ppm GA<sub>3</sub>. Maximum germination percentage (73.33%) and number of leaves (2) were observed in KNO<sub>3</sub> at 2% followed by 500 ppm GA<sub>3</sub>. Similarly lowest decayed seed percentage (26.66%) and time of germination (59.41 days) were noted in 2% KNO<sub>3</sub>. The seedling height was optimum (19.33 cm) in 3% KNO<sub>3</sub> followed by 2% KNO<sub>3</sub>. Best germination results were obtained due to permeability of hard seed coat made by low concentrations of priming treatments (KNO<sub>3</sub> @ 3%).

**Keywords:** *Cycas revoluta*, gibberellic acid, potassium nitrate, germination parameters.

**INTRODUCTION:** The sago palm (*Cycas revoluta* L.) is one of the important cycad commonly known as Kanghi palm or Japanese sago or simply sago palm. The cold hardy sago palm has been used as an indoor and outdoor landscape plant for centuries. It is used as a significant or focal point in any landscape design. Despite its importance in ornamental industry, it is facing certain problems regarding its germination due to its hard seed coat. It has been estimated that over 25% of all palm species require over 100 days for germination and they have less than 20% total germination (Tomlinson, 1990). So, there is a serious need of consideration to sort out this major issue. The reasons for this remain obscure, as little research work has been accomplished on seed dormancy in palms. Certain mechanical and chemical scarification, pretreatments were proved to be effective in germination of the hard-seeded species of *Cycas* and some other species (Frett, 1987; Chauhan et al., 2009; Rouhi et al., 2010). Cycad seeds respond to various pretreatment, including scarification, depulping and exposure to some chemical materials like gibberellic acid (GA<sub>3</sub>), potassium nitrate (KNO<sub>3</sub>) and soaking in hot water for specific period of time.

The overall development of plant is regulated by the growth hormones, nutrient and environmental factors. They also vary in their germination requirement (Chauhan et al., 2009). KNO<sub>3</sub> is most widely used chemical for promoting germination. Solutions of 0.1 to 0.2% KNO<sub>3</sub> are common in routine germination testing and are recommended by the Association of Official Seed Analysts and the International Seed Testing Association for germination tests of many species (Copeland and McDonald, 1995).

**OBJECTIVES:** The objectives of the present research was to minimize the time period of seed germination and to enhance percentage of germination by breaking the

external dormancy through different levels of chemicals including GA<sub>3</sub>, KNO<sub>3</sub> and hot water.

**MATERIALS AND METHODS:** This study was conducted in the research field of Department of Horticulture PMAS, Arid Agriculture University Rawalpindi. An experiment was conducted by using Completely Randomized Design (CRD). The seeds of sago palm were collected from 10-15 years old female stocks growing at a commercial garden located in suburb of Islamabad city. Uniform, equal and the same weight and healthy seeds were selected. The seeds had diameter 2.54 to 5.08 cm. Seeds were soaked in fresh water for two weeks to remove pulp from the upper surface of hard seed coat. Seeds without pulp were soaked in solution of 500, 750 and 1000 ppm GA<sub>3</sub> and 2%, 3% and 4% solution of KNO<sub>3</sub> for 24 hr at room temperature. In case of hot water treatment, seeds were primed at 80°C, 90°C and 100°C for 30, 20 and 10 minutes respectively (Table 1). Then seeds were washed with few drops of tween twenty in order to remove surface tension. Seeds were dried at 24°C room temperature. After sterilization, 10 seeds of sago palm were planted in each pot of 14 inch diameter containing sterilized soil media ( Sand, soil, FYM 1:1:1) at 4-8 cm depth and incubated in a greenhouse at daytime temperature of 25±2°C and relative humidity of 60-80% and watered weekly depending on weather conditions. Germination was evaluated at the end of 10 months. Seed emergence was recorded as germination index. The data for germination rate (days), germination percentage (%), germination value, seed decayed percentage (%) and time of germination (days) were recorded during the course of study. After seed germination, observations were recorded for number of leaves and seedling height. The data collected was compiled and analyzed statistically by using computer software germination; observations were recorded for number of leaves (Steel and Torrie, 1980).

**RESULTS AND DISCUSSION:** Analysis of data showed that parameters related to germination significantly affected by hydro and chemical priming treatments (Table 2). Seeds treated with 500 ppm GA<sub>3</sub> showed maximum germination rate (55.56 days) which was statistically significant with control. Hot water treatments observed average germination rate. Minimum germination rate (159.88 days) was

Table 1: Different priming treatments to enhance seed germination of Sago palm.

| Treatment      | Chemical                             | Concentration | Time   |
|----------------|--------------------------------------|---------------|--------|
| T <sub>0</sub> | (Control/ untreated)                 | Tap water     | 24 hrs |
| T <sub>1</sub> | GA <sub>3</sub> (Gibberellic acid)   | 500 ppm       | 24 hrs |
| T <sub>2</sub> | GA <sub>3</sub> (Gibberellic acid)   | 750 ppm       | 24 hrs |
| T <sub>3</sub> | GA <sub>3</sub> (Gibberellic acid)   | 1000 ppm      | 24 hrs |
| T <sub>4</sub> | KNO <sub>3</sub> (Potassium nitrate) | 2 %           | 24 hrs |
| T <sub>5</sub> | KNO <sub>3</sub> (Potassium nitrate) | 3 %           | 24 hrs |
| T <sub>6</sub> | KNO <sub>3</sub> (Potassium nitrate) | 4 %           | 24 hrs |
| T <sub>7</sub> | Hot water                            | 80°C          | 30 min |
| T <sub>8</sub> | Hot water                            | 90°C          | 20 min |
| T <sub>9</sub> | Hot water                            | 100°C         | 10 min |

hr= hours and min= minutes.

Table 2: Effect of different priming treatments on germination parameters of sago palm.

| Treatments                 | Germination rate (days) | Germination percentage (%) | Germination Value    | Decayed seed percentage (%) | Time of germination (days) | No. of leaves      | Seedling height (cm) |
|----------------------------|-------------------------|----------------------------|----------------------|-----------------------------|----------------------------|--------------------|----------------------|
| Control                    | 159.8 <sup>cd</sup>     | 33.33 <sup>e</sup>         | 74.43 <sup>h</sup>   | 66.66 <sup>a</sup>          | 204.58 <sup>a</sup>        | 1.33 <sup>ab</sup> | 12.33 <sup>cd</sup>  |
| GA <sub>3</sub> @ 500 ppm  | 55.5 <sup>abc</sup>     | 70 <sup>ab</sup>           | 192.19 <sup>a</sup>  | 30.0 <sup>de</sup>          | 102.92 <sup>f</sup>        | 1.66 <sup>ab</sup> | 16.33 <sup>abc</sup> |
| GA <sub>3</sub> @ 750 ppm  | 62.5 <sup>ab</sup>      | 63.33 <sup>abc</sup>       | 184.12 <sup>b</sup>  | 36.66 <sup>cde</sup>        | 114.81 <sup>e</sup>        | 1.66 <sup>ab</sup> | 16.66 <sup>ab</sup>  |
| GA <sub>3</sub> @ 1000 ppm | 67.95 <sup>ab</sup>     | 56.66 <sup>bcd</sup>       | 166.57 <sup>c</sup>  | 43.33 <sup>bcd</sup>        | 123.62 <sup>d</sup>        | 1.33 <sup>ab</sup> | 17.0 <sup>ab</sup>   |
| KNO <sub>3</sub> @ 2%      | 62.06 <sup>a</sup>      | 73.33 <sup>a</sup>         | 186.42 <sup>ab</sup> | 26.66 <sup>e</sup>          | 59.41 <sup>h</sup>         | 2.0 <sup>a</sup>   | 18.33 <sup>a</sup>   |
| KNO <sub>3</sub> @ 3%      | 67.23 <sup>a</sup>      | 63.33 <sup>abc</sup>       | 166.92 <sup>c</sup>  | 36.66 <sup>cde</sup>        | 63.81 <sup>h</sup>         | 1.66 <sup>ab</sup> | 19.33 <sup>a</sup>   |
| KNO <sub>3</sub> @ 4%      | 75.38 <sup>ab</sup>     | 53.33 <sup>cd</sup>        | 152.04 <sup>d</sup>  | 46.66 <sup>bc</sup>         | 72.16 <sup>g</sup>         | 1.33 <sup>ab</sup> | 16.66 <sup>ab</sup>  |
| Hot water @ 80° C          | 99.3 <sup>abcd</sup>    | 46.66 <sup>de</sup>        | 119.1 <sup>g</sup>   | 53.33 <sup>ab</sup>         | 161.1 <sup>c</sup>         | 1.0 <sup>b</sup>   | 15.3 <sup>abcd</sup> |
| Hot water 90° C            | 106.38 <sup>d</sup>     | 46.66 <sup>de</sup>        | 127.72 <sup>f</sup>  | 53.33 <sup>ab</sup>         | 180.47 <sup>b</sup>        | 1.0 <sup>b</sup>   | 11.33 <sup>d</sup>   |
| Hot water 100° C           | 111.77 <sup>bcd</sup>   | 43.33 <sup>de</sup>        | 136.49 <sup>e</sup>  | 56.66 <sup>ab</sup>         | 185.2 <sup>b</sup>         | 1.0 <sup>b</sup>   | 13.33 <sup>bcd</sup> |

**Germination rate (days) and germination percentage (%):** The data regarding germination percentage indicated that difference between primed and non-primed seeds was statistically significant. Lower concentrations of potassium nitrate (KNO<sub>3</sub>) @ 2% and gibberellic acid (GA<sub>3</sub>) @ 500 ppm treatments significantly affected the germination percentage 73.33% and 70% respectively as compared to control (33.33%). Significant improvement in seed germination might be due to enhanced breakdown of reserve metabolites present in seed. The lower concentration of KNO<sub>3</sub> has promoting effect on seed germination as compared to its higher concentration. This leads to supposition that higher concentrations exercise decreasing effects on seed germination by causing death of cells and ultimately result in loss of seed viability (Nascimento, 2003; Ramzan et al., 2010).

**Germination value:** Analysis of variance revealed that germination value was affected by various priming treatments (Table 2). Result regarding germination value (192.19) was highest in T<sub>1</sub> (500 ppm GA<sub>3</sub>) followed by 186.42 in T<sub>4</sub> (3% KNO<sub>3</sub>) and 184.12 in T<sub>2</sub> (750 ppm GA<sub>3</sub>). Minimum germination (74.43) was noted in control. The gibberellic acid has positive effect on germination value due to its hormonal regulation capability and retarding effect against abscisic acid present in dormant seeds (Var et al., 2010; Zarchini et al., 2013; Pipinis et al., 2015).

**Decayed seed percentage (%):** Data regarding decayed seed

recorded in unprimed seeds. Gibberellin encourage germination by inducing hydrolytic enzymes that weaken the hurdle tissues such as the endosperm or seed coat, inducing mobilization of food reserves in seed and stimulating expansion of the embryo (Bewley and Black, 1994; Dhoran and Gudadhe, 2012).

percentage have displayed in Table 2. The difference between primed and non-primed seed was significant and primed seed have minimum decayed seed percentage as compared to non-primed seeds. Lowest decayed seed percentage (26.66%) was recorded when 2% KNO<sub>3</sub> was applied followed by 30% when 500 ppm GA<sub>3</sub>) was applied. Whereas maximum decayed (66.66%) of seeds was occurred in untreated seeds. It is reported that scarified treatments have improved germination as compared to non-scarified seeds. Decayed seed percentage might be highest in control due to impermeability of hard seed coat (Fallahabadi et al., 2012).

**Time of germination (days):** Potassium nitrate showed a statistically significant effect on reducing the germination time (Table 2). Minimum time of germination (59.41 days) was recorded in seeds treated with 2% KNO<sub>3</sub> followed by 3% and 4% KNO<sub>3</sub> levels which took 63.81 days and 72.15 days respectively while maximum time duration was taken by control (204.58 days). Reduction in seed germination time was occurred when seeds of *Descurainia sophia* and *Plantago ovate* were primed with 0.3% KNO<sub>3</sub> (Ali et al., 2010; Gashi et al., 2012). Stimulating effect of nitrate for seed germination might be due to dormancy breakage (Hilhorst, 1990). It stimulates oxygen uptake (Hilton and Thomas, 1986) and KNO<sub>3</sub> act as co-factor for phytochrome (Mavi et al., 2006).

**Number of leaves:** Analysis of data showed that number of leaves influenced by different treatments. Hormonal priming

with 2% KNO<sub>3</sub> gave maximum number of leaves per seedling followed by priming with 3% KNO<sub>3</sub>, 4% KNO<sub>3</sub> and in 500 ppm GA<sub>3</sub>, 750 ppm GA<sub>3</sub> and 1000 ppm GA<sub>3</sub> in improving number of leaves per seedling as compared to other physical priming treatments, while results of minimum number of leaves were achieved in non-primed seeds. It was suggested that potassium is an important macronutrient that plays a key role in carbohydrate metabolism and photosynthesis (Marschner, 2011; Kazemi, 2013).

**C Seedling height (cm):** Analysis of variance exposed that there was a significant difference between primed and non-primed seed for seedling height (Table. 2). It was found that maximum seedling height was 19.33 cm influenced by 3% KNO<sub>3</sub> while minimum 11.33 cm observed in 90°C hot water. It is reported that foliar application of K, improved the chlorophyll and fruits-NK content (Sarrwy *et al.*, 2010; Marschner, 2011; Kazemi, 2013).

**C ONCLUSION:** The present study was undertaken to assess the effect of different priming treatments on seed germination of *Cycas revoluta* L. The results of the study clearly indicated that germination rate and germination value were maximum at lower concentration of gibberellic acid (500 ppm GA<sub>3</sub>). While, germination percentage, maximum number of leaves, maximum seedling height, decayed seed percentage and time required for seed germination were observed minimum at lower concentration of potassium nitrate (2% and 3% KNO<sub>3</sub>). Hot water treatments had least effect on seed germination.

**C ONFLICT OF INTEREST:** Authors have no conflict of interest.

**R EFERENCES:** Ali, T., P. Hossein, F. Asghar, Z. Salman and Z. C. M. Ali, 2010. The effect of different treatments on improving seed germination characteristics in medicinal species of *Descurainia sophia* and *Plantago ovata*. African Journal of Biotechnology, 9(39): 6588-6593.

Bewley, J. and M. Black, 1994. Seeds: Physiology of development and germination plenum. Plenum Press New York, USA.

Chauhan, J., Y. Tomar, N. I. Singh and S. Ali, 2009. Effect of growth hormones on seed germination and seedling growth of black gram and horse gram. Journal of American Science, 5(5): 79-84.

Copeland, L. and M. McDonald, 1995. Seed science and technology (3rd eds.). Chapman and Hall.

Dhoran, V. and S. Gudadhe, 2012. Effect of plant growth regulators on seed germination and seedling vigour in *Asparagus Sprengeri* regelin. Research Journal of Biological Sciences 1(7): 6-10.

Fallahabadi, P., D. Hashemabadi, R. Onsinejad, M. Zarchini and B. R. Kaviani, 2012. Improving germination rate of *Cycas revoluta* L. By using different cultivation media and scarification. Annals of Biological Research, 3(7): 3187-3191.

Frett, J. J., 1987. Seed germination of *Cyeas revoluta*. Journal of Environmental Horticulture, 5(3): 105-106.

Gashi, B., K. Abdullai, V. Mata and E. Kongjika, 2012. Effect of gibberellic acid and potassium nitrate on seed germination of the resurrection plants *Ramonda serbica* and *Ramonda nathaliae*. African Journal of Biotechnology, 11(20): 4537-4542.

Hilhorst, H. W., 1990. Dose-response analysis of factors involved in germination and secondary dormancy of seeds of *Sisymbrium officinale*: li. Nitrate. Plant Physiology, 94(3): 1096-1102.

Hilton, J. R. and J. A. Thomas, 1986. Regulation of pregerminative rates of respiration in seeds of various weed species by potassium nitrate. Journal of Experimental Botany, 37(10): 1516-1524.

Kazemi, M., 2013. Effect of foliar application of humic acid and potassium nitrate on cucumber growth bull. Bulletin of Environment, Pharmacology and Life Sciences, 2(11): 03-06.

Marschner, H., 2011. Marschner's mineral nutrition of higher plants. Academic Press.

Mavi, K., S. Ermis and I. Demir, 2006. The effect of priming on tomato rootstock seeds in relation to seedling growth. Asian Journal of Plant Sciences, 5(6): 940-947.

Nascimento, W. M., 2003. Muskmelon seed germination and seedling development in response to seed priming. Scientia Agricola, 60(1): 71-75.

Pipinis, E., E. Miliotis, M. Georgiou and P. J. F. I. Smiris, 2015. Effects of gibberellic acid and cold stratification on seed germination of two sorbus species. 21(1): 107-114.

Ramzan, A., I. Hafiz, T. Ahmad and N. Abbasi, 2010. Effect of priming with potassium nitrate and dehusking on seed germination of gladiolus (*Gladiolus alatus*). Pakistan Journal of Botany, 42(1): 247-258.

Rouhi, H., K. Shakarami and R. Afshari, 2010. Seed treatments to overcome dormancy of waterlily tulip (*Tulipa kaufmanniana* regel). Australian Journal of Crop Science, 4(9): 718.

Sarrwy, S., E. A. Mohamed and H. Hassan, 2010. Effect of foliar sprays with potassium nitrate and mono-potassium phosphate on leaf mineral contents, fruit set, yield and fruit quality of picual olive trees grown under sandy soil conditions. American-Eurasian Journal of Agricultural Environmental Science, 8(4): 420-430.

Steel, R. G. and J. H. Torrie, 1980. Principles and procedures of statistics, a biometrical approach. McGraw-Hill Kogakusha, Ltd.

Tomlinson, P. B., 1990. The structural biology of palms. Oxford University Press.

Var, M., B. Bekci and D. Dinçer, 2010. Effect of stratification treatments on germination of *Sorbus torminalis* L. Crantz (wild service tree) seeds with different origins. African Journal of Biotechnology, 9(34): 5535-5541.

Zarchini, M., D. Hashemabadi, N. Negahdar and S. Zarchini, 2013. Improvement seed germination of wild service tree (*Sorbus aucoparia* L.) by gibberellic acid. Annals of Biological Research, 4(1): 72-74.



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