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# Effects of seed size and germination percentage with different treatments in *Holoptelia integrifolia*

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ABSTRACT

*Holoptelia integrifolia* is an important tree of tropical and temperate regions owing to its uses as an afforestation tree as well as a traditional medicinal plant. A study was carried out to know variations in seed size and germination in seeds collected from various locations. Seeds from 13 locations in different parts of Rajasthan. Variation in seed size and germination percentage by using different treatments and plant growth regulators. Detailed results and a futuristic approach are presented in this paper.

**Keywords:** *Holoptelia integrifolia*; Germination percentage; Mean germination time; Germination value; Elm tree; Pre-germination treatments; Seed length; Seed width; Diabetes; Digestive; Seed lots.

## 1. Introduction

*Holoptelia integrifolia* belongs to the family ulmaceae and is found in tropical and temperate regions of the northern hemisphere including the Indian peninsula to Indo-China and Srilanka (Mahmud et. al., 2010). It has different vernacular names in India they are Chirabilva, putigandha in Sanskrit, Papri in Urdu, Karanj, Banchilla, Chilbil, Dhamna, Begana in Hindi, Thavasai, Rasbija, Kaladri, Nilavahi in Kannada, Aval in Malayalam, Vavli, Papara in Marathi, Dauranja, Rajain, Khulen, Arjan in Punjabi, Aya, Ayil, Kanci, Vellaya in Tamil, Thapasi, Nemali, Pedanevilli in Telugu. It is commonly known as the Indian Elm tree.

*Holoptelia integrifolia* is a large deciduous tree found in the greater part of India upto an altitude of 200 feet. Its bark is grey and leaves are elliptical-ovate. Its flowers are greenish yellow. It is a pollen allergen plant in India (Singh & Kumar, 2003). Its fruit is sub-orbicular with membranous wing. Plant flowering time is from January to February, whereas fruiting is from April to May (Wealth of India, 1959).

### 1.1. Traditional uses

It is used traditionally for the treatment of inflammation, gastritis, colic, dyspepsia, intestinal worms, vomiting; wound healing, leprosy, diabetes, hemorrhoids, dysmenorrheal and rheumatism (Warrier et. al., 1995). Its bark and leaves are used as bitter, astringent, thermogenic, anti-inflammatory, digestive, carminative, depurative, laxative, antithelmintic, repulsive, urinary astringent and in rheumatism (Prajapati et. al., 2003).

### 1.2. Study objective

The objective of this study was to evaluate variation in seed size and their link with germination and also to find out the best treatment for optimum germination and other germination parameters so that quality seedlings can be prepared that thrive best in the field.

## 2. Review of literature

For a seed to successfully germinate, it must be exposed to optimal environmental conditions (Craufurd et al., 1996). These conditions typically include adequate water supply, a suitable temperature range, and in some cases,

sufficient light (George and Williams, 1968; Levitt, 1980; Long and Woodward, 1998). The outcome is measured by the final germination percentage achieved and the speed of the germination process. However, other parameters also play significant roles from agronomic, planning, and physiological perspectives (Jones and Sanders, 1987; Esechie, 1994; Kader et al., 1998, 1999, 2005).

The timing differences between the first and last seeds to germinate, the variability in germination rates, and the synchronization of germination events impact various agricultural operations such as fertilization, harvesting, and crop field maturity (Roberts, 1981; Washitani and Saeki, 1986; Kader and Jutzi, 2001). Key indicators of seed vigor and stress resistance include the timing of high (when the majority of seeds germinate) and 'low' (when the minority of seeds germinate) germination events (Kader et al., 1998; Kader and Jutzi, 2002).

Evaluation methods for seed germination and emergence are typically analytical or graphical (Scott et al., 1984). Germination data possess unique characteristics that differentiate them from other types of plant research data. Germination is considered a qualitative developmental response occurring at a specific time for individual seeds, yet seeds within a treatment may respond at different rates (Harper and Benton, 1966; Orchard, 1977; Scott et al., 1984; Kader, 1998). Consequently, relying solely on final germination percentages may not suffice for comparing results, especially when comparing different seed lots that may have similar final germination percentages but differ in the timing of germination (Timson, 1965; Todd and Webster, 1965; Harris and Wilson, 1970; Thompson, 1974). This challenge has led to the development of various germination measurement techniques (Heydecker, 1966; Scott et al., 1984; Carberry and Campbell, 1989).

## 3. Material and Methods

Seeds of *Holoptelia integrifolia* were collected and after proper cleaning and drying they were stored for further analysis. Seed length, width and thickness were recorded for 100 seeds of each seed lot. The seed germination tests were performed in the seed germination Laboratory of Silviculture and Forest Management, ICFRE-Arid Forest Research Institute, Jodhpur. With the help of a seed counter machine seeds per kilogram were calculated. Laboratory test on the germination response of seeds to pre-germination treatments of hot water, $GA_3$ (500 and 1000 ppm) and IBA $GA_3$ (500 and 1000 ppm) compared to untreated seeds (control).

Soak a hundred seeds in hot water for 15 min. Twenty seeds were also soaked in $GA_3$ (500 and 1000 ppm) and IBA $GA_3$ (500 and 1000 ppm) for 6 hours. All the pre-treated and untreated seeds were rinsed thoroughly in distilled water and placed in a germination tray. The experiment was carried out at room temperature in the laboratory. Seeds were considered germinated upon plumule emergence. The number of seeds that germinated was recorded while the percentage of seed germination was calculated. The following procedure was made for different parameter determinations:

### 3.1. Formulas for various calculations

#### 3.1.1. Germination percentage

GP (Germination percentage)= (Total number of seeds germinated/total number of seeds tested) × 100

Final Germination Percentage (FGP %) = Final no. of seeds germinated in a seed lot × 100

The higher the FGP value, the greater the germination of a seed population [Scott et al. (1984)].

### 3.1.2. Mean germination time

MGT (Mean germination time) = total (daily germination) × 1 days/total seed sowing

Mean Germination Time (MGT day) =Σf ·x/Σf

f=Seeds germinated on day x

The lower the MGT, the faster a population of seeds has germinated [Orchard (1977)].

- First Day of Germination FDG day =Day on which the first germination event occurred

Lower FDG values indicate a faster initiation of germination [Kader (1998)].

- Last Day of Germination LDG day =Day on which the last germination event occurred Lower LDG values indicate a faster ending of germination [Kader (1998)].

- Germination Rate Index GRI (%/day) =G1/1 + G2/2 +· · ·+ Gx/x

G1=Germination percentage × 100 on the first day after sowing, G2=Germination percentage × 100 on the second day after sowing.

### 3.1.3. Average Mean germination time

AVG MGT (Average Mean germination time) =Total MGT/Total number of days

### 3.1.4. Germination Value

GV (Germination Value) = (Total MGT/total germination) × (GP%/10)

### 3.1.5. Average Germination Value

AVG GV (Average Germination Value) = Total GV/Total number of days

## 4. Result

Seeds of *Holoptelia integrifolia* were collected from 13 locations in different parts of Rajasthan during 2021-2023. Seeds length and width with thickness were recorded through the vernier caliper. Analysis shows that the mean seed length varies from 6.39 mm to 11.06 mm having the highest 11.06 mm in Kishangarh, Jaipur seed lot of 2021 while the lowest 6.39 mm in Shahbad, Kota in 2023. The average width of the seed was in the range of lowest 4.52 mm in nature park, Churu sample of 2023 while highest 8.72 mm in Kishangarh, Jaipur seed lot of 2021. The lowest mean thickness of the seed was 0.98 mm in the chauth mata ka, Sawai Madhopur sample of 2022 while the highest in 1.58 mm in Navalgarh, Jhunjhunu seed lot of 2023.

Germination percentage was calculated with different treatments viz. control, hot water treatment overnight, $GA_3$ 500 ppm and $GA_3$ 1000 ppm treatment overnight. Control conditions germination percentage ranges from 15 percent in the Tonk seed lot of 2022 to 85 percent in the Churu seed lot of 2023. Under hot water treatment, germination percentage varies from 25 percent in the Tonk seed lot to 80 percent in 3 sites Churu 2023 seed lot, in Navalgarh, Jhunjhunu 2023 seed lot and in Shahbad, Kota seed lot of 2023. Effects of $GA_3$ were studied and it was

found that in $GA_3$ 500 ppm treated seed lot germination percentage was in the range of 20 percent in Deoli, Tonk 2022 seed lot while it was 80 percent in Shahbad, Kota seed lot of 2023. Total MGT was minimum in Deoli, Tonk seed lot of 2022 with a value of 31.55 in control while it was 188.35 in Shahbad, Kota 2023 seed lot in the control treatment. The total GV value was 87.5 in the Herbal Park, Mehrangarh, Jodhpur seed lot of 2022 with $GA_3$ 1000 ppm while it was 3961.62 in the Shahbad seed lot of 2023 with control treatment.

The lowest average MGT was 0.79 in Herbal park, Mehrangarh, Jodhpur with $GA_3$ 1000 ppm while it was highest 9.11 in Shahbad, Kota seed lot of 2023 with $GA_3$ 1000 ppm. The average GV value was minimum in Deoli, Tonk 2022 seed lot with $GA_3$ 500 ppm while it was highest in Shahbad, Kota seed lot of 2023 with control treatment.

## 5. Discussion

Based on data from Tables 1 & 2 it is observed that seed size parameters were different in various locations and it depends on various climatic, edaphic and genetic factors. Germination percentage with different treatments was different in seed lots. $GA_3$ was found effective in breaking dormancy and enhancing germination.

## 6. Conclusion

Based on different seed lots germinations and their effect with different treatments were found to provide a hypothesis to choose better seed lots. However, there was no direct relation between seed size and germination. Factors such as geographical and seasonal variations play an important role in finding seed lots for better germination. *Holoptelia integrifolia* plant has traditional and pharmacological uses. Plants need more research on its uses to discover different aspects of this plant.

## 7. Future Suggestion

Variation in seed size and germination behavior in different seed lots indicates that not only edaphic or climatic variation but genetic makeup can also play a role in germination. It is suggested to study reproductive biology as well as detailed studies on different seed lots from various agro-climatic regions.

**Declarations**

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**Competing Interests Statement**

The authors declare no competing financial, professional, or personal interests.

**Consent for publication**

The authors declare that they consented to the publication of this study.

**Authors' contributions**

All the authors took part in the literature review, analysis, and manuscript writing equally.

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**Table 1.** Effect of Seed Size on Germination in *Holoptelia integrifolia*

| S.No. | Location | GPS | Date of Collection | Seed Analysis | | | Germination Percentage | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Mean Length (mm) | Mean Width (mm) | Mean Thickness (mm) | Control | Hot Water | $GA_3$ 500 PPM | $GA_3$ 1000 PPM |
| 1 | **Chauth Mata ka Barwada, Sawai Madhopur** | N 26˚03.511' | 6-11-2022 | 10.45 | 7.6 | 0.98 | 30 | **45** | 30 | 30 |
| | | E 76˚09.626' | | | | | | | | |
| 2 | **Nature Park, Behind DFO office, Churu** | N 28°29'35.58 | 14-06-2023 | 6.51 | 4.52 | 1.09 | **85** | 80 | 60 | 70 |
| | | E 74°95'87.82 | | | | | | | | |
| 3 | **Deoli Range, Tonk** | N 25˚72.678' | 06-08-2022 | 10.26 | 7.38 | 1.23 | 15 | 25 | 20 | **50** |
| | | E 75˚41.8625' | | | | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | **Gangapur Nursery, Sawai Madhopur** | N 26˚48.0681' | 06-11-2022 | 10.34 | 7.38 | 1.12 | 70 | **75** | 60 | 65 |
| | | E 76˚36.9872' | | | | | | | | |
| 5 | **Herbal Park, Mehrangarh, Jodhpur** | N 26°18'471" | 21-04-2022 | 7.94 | 6.95 | 1.48 | 60 | 60 | **65** | 10 |
| | | E 73°01'099" | | | | | | | | |
| 6 | **Guru nanak smriti vaan, Hindoli, Bundi** | N 25˚37.552' | 06-12-2022 | 9.33 | 6.85 | 1.14 | 30 | 45 | 55 | **75** |
| | | E 75˚28.338' | | | | | | | | |
| 7 | **Samod range, Jaipur** | N25°192'74.59" | 19-07-2022 | 9.29 | 8.09 | 1.21 | **65** | 55 | **65** | 60 |
| | | E75°79'94.772" | | | | | | | | |
| 8 | **Mandawa, Jhunjhunu** | N 28°05'482" | 05-12-2022 | 9.2 | 8.41 | 1.24 | 50 | 45 | **70** | 65 |
| | | E 75° 13'166" | | | | | | | | |
| 9 | **Talvrakash, Kishangarh, Jaipur** | N 27°29'85.27" | 15-04-2021 | 11.06 | 8.72 | 1.45 | 26.67 | 23.33 | **43.33** | 31.67 |
| | | E 75°88'50.82" | | | | | | | | |
| 10 | **Rajasthan Forest Dept. Mohanpura, Jaipur** | N 27˚14.568' | 06-12-2022 | 9.47 | 8.33 | 1.04 | 60 | 60 | 55 | **70** |
| | | E 75˚57.707' | | | | | | | | |
| 11 | **Jhajhar, Nawalgarh, Jhunjhunu** | N 27°80' 15.70" | 16-06-2023 | 7.34 | 5.87 | 1.58 | **80** | **80** | 75 | 50 |
| | | E 75°32'36.73" | | | | | | | | |
| 12 | **Shahbad, KOTA** | N 25° 12'45.24" | 05-03-2023 | 6.39 | 6.22 | 1.1 | 80 | 80 | 80 | **85** |
| | | E 77° 05'41.28" | | | | | | | | |
| 13 | **Guda-gaur, Udaipurwati, Sikar** | N 27° 54'402" | 13-05-2022 | 7.4 | 5.52 | 1.21 | 65 | **70** | 60 | 65 |
| | | E 75° 39'910" | | | | | | | | |

**Table 2.** *Holoptelia integrifolia with* Germination Value and Mean Germination Time

| **S.No.** | **Location** | **GPS** | **Date of Collection** | **Germination in Tray** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | **Treatments** | **GP%** | **Total MGT** | **Total GV** | **Average MGT** | **Average GV** |
| 1 | **Chauth Mata Ka Barwada, Sawai Madhopur** | N 26˚03.511' | 06-11-2022 | Control | 30 | 65.45 | 562.87 | 2.98 | 25.59 |
| | | E 76˚09.626' | | **Hot Water** | **45** | **87.85** | **1021.1** | **3.99** | **46.41** |
| | | | | $GA_3$ 500 PPM | 30 | 63.05 | 766 | 2.87 | 34.82 |
| | | | | $GA_3$ 1000 PPM | 30 | 63.35 | 782.37 | 2.88 | 35.56 |
| 2 | **Nature Park, Behind DFO Office, Churu** | N 28°29'35.58 | 14-06-2023 | **Control** | **85** | **187.3** | **2887.88** | **8.51** | **131.27** |
| | | E 74°95'87.82 | | Hot Water | 80 | 144.65 | 2092.43 | 6.57 | 95.11 |
| | | | | $GA_3$ 500 PPM | 60 | 139.9 | 1965.6 | 6.36 | 89.35 |
| | | | | $GA_3$ 1000 PPM | 70 | 155.75 | 2455.66 | 7.08 | 111.62 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 3 | **Deoli Range, Tonk** | N 25˚72.678'<br>E 75˚41.8625' | 06-08-2022 | Control<br>Hot Water | 15<br>25 | 31.55<br>54.6 | 307.61<br>457.28 | 1.43<br>2.48 | 0.065<br>0.113 |
| | | | | $GA_3$ 500 PPM | 20 | 42.1 | 631.5 | 1.91 | 0.087 |
| | | | | **$GA_3$ 1000 PPM** | **50** | **105.75** | **2006.94** | **4.81** | **0.218** |
| 4 | **Gangapur Nursery, Sawai Madhopur** | N 26˚48.0681' | 06-11-2022 | Control | 70 | 149.2 | 1784.81 | 6.78 | 81.13 |
| | | E 76˚36.9872' | | **Hot Water** | **75** | **151.85** | **3731.17** | **6.9** | **169.6** |
| | | | | $GA_3$ 500 PPM | 60 | 123.95 | 2431.19 | 5.63 | 110.51 |
| | | | | $GA_3$ 1000 PPM | 65 | 136.8 | 2138.48 | 6.22 | 97.2 |
| 5 | **Herbal Park, Mehrangarh, Jodhpur** | N 26°18’471” | 21-04-2022 | Control | 60 | 134 | 1664.79 | 6.09 | 75.67 |
| | | E 73°01’099” | | Hot Water | 60 | 130.4 | 1724.38 | 5.92 | 78.38 |
| | | | | **$GA_3$ 500 PPM** | **65** | **143.75** | **2018.07** | **6.53** | **91.73** |
| | | | | $GA_3$ 1000 PPM | 10 | 17.5 | 87.5 | 0.79 | 3.97 |
| 6 | **Guru Nanak Smriti Vaan, Hindoli, Bund** | N 25˚37.552' | 06-12-2022 | Control | 30 | 62.95 | 871.86 | 2.86 | 39.62 |
| | | E 75˚28.338' | | Hot Water | 45 | 97.95 | 1573.32 | 4.45 | 71.51 |
| | | | | $GA_3$ 500 PPM | 55 | 108.85 | 1539.38 | 4.94 | 69.97 |
| | | | | **$GA_3$ 1000 PPM** | **75** | **150.35** | **3514.43** | **6.83** | **159.74** |
| 7 | **Samod Range, Jaipur** | N25°192’74.59” | 19-07-2022 | **Control** | **65** | **147.45** | **1986.93** | **6.7** | **90.32** |
| | | E75°79’94.772” | | Hot Water | 55 | 119.5 | 2456.06 | 5.43 | 111.64 |
| | | | | **$GA_3$ 500 PPM** | **65** | **144.1** | **2484.22** | **6.55** | **112.92** |
| | | | | $GA_3$ 1000 PPM | 60 | 138.45 | 2194.43 | 6.29 | 99.75 |
| 8 | **Mandawa, Jhunjhunu** | N 28°05’482” | 05-12-2022 | Control | 50 | 105.05 | 1712.69 | 4.78 | 77.85 |
| | | E 75° 13’166” | | Hot Water | 45 | 95.75 | 1495.92 | 4.35 | 68 |
| | | | | **$GA_3$ 500 PPM** | **70** | **146.45** | **1357.10** | **6.66** | **61.69** |
| | | | | $GA_3$ 1000 PPM | 65 | 136.55 | 2619.97 | 6.21 | 119.09 |
| 9 | **Talvrakash, Kishangarh, Jaipur** | N 27°29’85.27” | 15-04-2021 | Control | 26.67 | 45.83 | 147.47 | 2.2915 | 7.37 |
| | | E 75°88’50.82” | | Hot Water | 23.33 | 41.65 | 145.24 | 2.0825 | 7.262 |
| | | | | **$GA_3$ 500 PPM** | **43.33** | **78.33** | **283.24** | **3.9165** | **14.16** |
| | | | | $GA_3$ 1000 PPM | 31.67 | 57.43 | 196.2 | 2.8715 | 9.81 |
| 10 | **Rajasthan Forest Dept. Mohanpura, Jaipur** | N 27˚14.568' | 06-12-2022 | Control | 60 | 110.1 | 1650.45 | 5 | 75.02 |
| | | E 75˚57.707' | | Hot Water | 60 | 116.75 | 1453.84 | 5.31 | 66.08 |
| | | | | $GA_3$ 500 PPM | 55 | 119.35 | 1697.59 | 5.43 | 77.16 |
| | | | | **$GA_3$ 1000 PPM** | **70** | **139.25** | **1710.01** | **6.33** | **77.73** |
| 11 | **Jhajhar, Nawalgarh, Jhunjhunu** | N 27°80' 15.70" | 16-06-2023 | **Control** | **80** | **85.7** | **1031.66** | **5.71** | **68.78** |
| | | E 75°32'36.73" | | **Hot Water** | **80** | **62.3** | **806.09** | **4.15** | **53.74** |
| | | | | $GA_3$ 500 PPM | 75 | 57.55 | 345.79 | 3.84 | 23.05 |
| | | | | $GA_3$ 1000 PPM | 50 | 51.5 | 468.81 | 3.43 | 31.25 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 12 | **Shahbad, KOTA** | N 25° 12'45.24" | 05-03-2023 | Control | 80 | 188.35 | 3961.62 | 8.56 | 180.07 |
| | | E 77° 05'41.28" | | Hot Water | 80 | 184.6 | 1833.63 | 8.39 | 83.34 |
| | | | | $GA_3$ 500 PPM | 80 | 184.8 | 2648.8 | 8.4 | 120.4 |
| | | | | **$GA_3$ 1000 PPM** | **85** | **200.45** | **2997.49** | **9.11** | **136.24** |
| 13 | **Guda-Gaur, Udaipurwati, Sikar** | N 27° 54'402" | 13-05-2022 | Control | 65 | 131.9 | 1587.66 | 6 | 72.17 |
| | | E 75° 39'910" | | **Hot Water** | **70** | **135.7** | **1902.06** | **6.17** | **86.46** |
| | | | | $GA_3$ 500 PPM | 60 | 113.9 | 1523.21 | 5.18 | 69.24 |
| | | | | $GA_3$ 1000 PPM | 65 | 123.7 | 2867.78 | 5.62 | 130.35 |

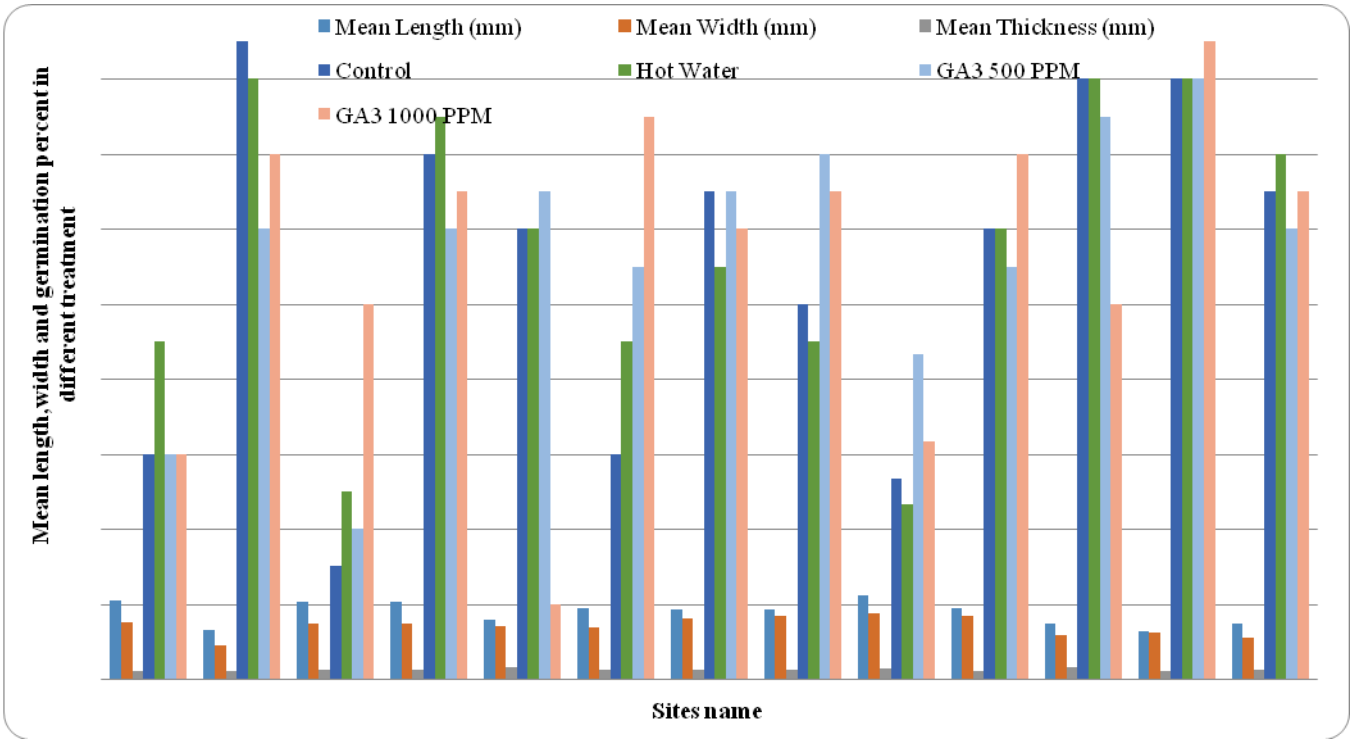


**Figure 1.** Effect of Seed Size on Germination in *Holoptelia integrifolia*

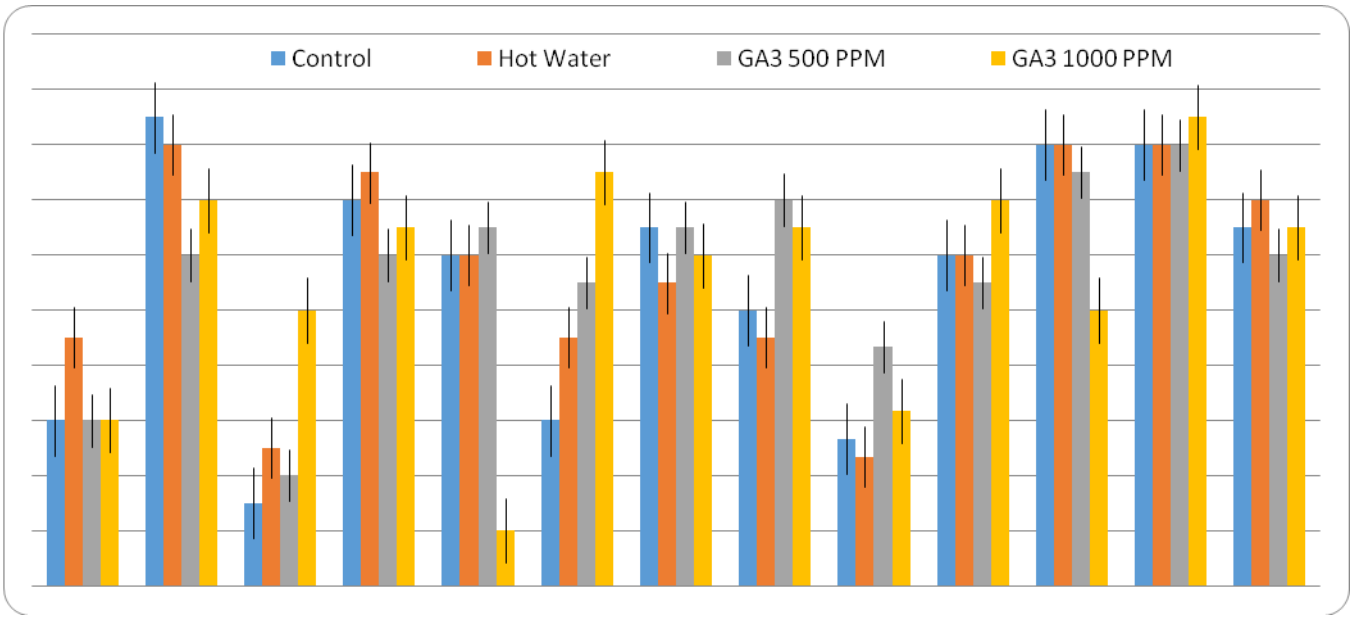


**Figure 2.** Germination percentage of *H. integrifolia* using different pre-treatments

**Figure 3.** *Holoptelia integrifolia* tree with seed


**Figure 4.** Germination of *Holoptelia integrifolia*