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# Effect of different concentrations of $GA_3$ and Zn on seed germination and growth of acid lime (*Citrus aurantifolia* Swingle) cv. Phule Sharbati

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**Abstract**
An experiment entitled "Effect of different concentrations of $GA_3$ and Zn on seed germination and growth of acid lime (*Citrus aurantifolia* Swingle) cv. Phule Sharbati." was executed in shade net of Horticultural Research cum Institutional farm under Pt. Kishori Lal, Shukla College of horticulture and Research station, Rajnandgaon in year 2021-2022. The experimental design applied was completely randomized design (CRD) with a total of seven treatments which were replicated three times. T0 (Control), T1 (GA3 @ 500 mg/l), T2 (GA3 @ 1000 mg/l), T3 (GA3 @ 2000 mg/l), T4 (ZnSO4 @ 500 mg/l), T5 (ZnSO4 @ 1000 mg/l) and T6 (ZnSO4 @ 2000 mg/l). The result revealed that treatment T1 (GA3 500 mg/l) was best for germination parameters, Treatment T3 i.e., GA3 2000 mg/l was found to be best for seedling growth parameters.

**Keywords:** Citrus, acid lime, GA3, seed germination, ZnSO4

## Introduction
Citrus is a genus of angiosperm plants which belongs to Rutaceae family. It comprises evergreen plants and trees like lemon and lime, orange, mandarin, clementine, tangerine, grapefruit, pummelo, kumquat. (Velasco and Licciardello, 2014) [13].
As citrus seeds are recalcitrant and vulnerable to desiccation and chilling, they face major storage issues. Seeds do not mature, and keeping them in storage for longer than necessary causes them to lose viability. The seed treatment of citrus species with Gibberellic acid enhanced the germination of seeds, growth and uniformity of seedlings both in commercial and rootstock varieties. Growth regulators are used to counteract certain chemicals inhibitory effects, which cause the germination of acid lime plants to be delayed (Dilip *et al*. 2017) [2].
As one of the essential elements in plants, zinc (Zn) plays a number of roles. Zinc in plants is reported to be involved in membrane integrity, enzyme activation, gene expression and regulation, carbohydrate metabolism, an aerobic root respiration, protein synthesis, structural integrity of ribosome, detoxification of super oxide radicals, phytohormones activity (e.g auxin and gibberellic acid), gene structure (Zn finger motif), and disease resistance (Marschner, 1997) [11]. Applications of GA3 or ZnSO4 seem to have some benefits in terms of shortening the time required for citrus seedling germination and growth. Some plant seeds, such as those from Meshram *et al*. (2015) [12] on acid lime, Khopkar *et al*. (2017) [10] on Pummelo, found that their germination and seedling growth parameters increased by soaking the seeds before sowing directly.

## Material and Methods
The present study was conducted in the year 2021–2022, in the Shade net of Horticultural Cum Instructional Farm, Department of Fruit Science, Pt. K.L.S. College of Horticulture and Research Station, Rajnandgaon (C.G.). The experiment was laid out in Completely Randomized Design.
The fruit seeds were procured from PDKV in Akola, Maharashtra. The fruit seeds were manually pulped to obtain the seeds. The seeds that were separated were cleanly washed for at-least 2-3 times. Then the cleaned seeds were fully dried before being submerged in water to see if they floated. For the experiment, large seeds that sink in water were chosen. Then solutions of 500, 1000 and 2000 mg/l of GA3 and ZnSO4 were made and seeds were soaked for 24 hours.

Seeds were then sown in polythene bags and after 60 DAS following observations were recorded. They were No. of days taken for germination, No. of days taken for 50% germination, Germination percentage, Height of Shoot, Girth of shoot, Number of leaves per plant, length of seedling, root length, survivability percent.

## Result and Discussion

### Germination Parameters

Table 1 shows the No. of days required for germination and it was recorded that the minimum days taken for the germination was under treatment T1 (21.90) days with GA3 500 mg/l. The maximum days taken for the seed to germinate was in treatment T0 (control) with 31.29 days. The reason may be due to the fact that at convenient concentration, GA3 and ZnSO4 act as promoting factor for seed germination and growth, but at high concentrations it becomes an inhibitor. The results are in agreement with Al-Hawezy (2015) [1].

Table 1 shows the significant effect of GA3 on No. of Days required for 50% germination and it was noted that the minimum days required for 50% germination was in treatment T1 under GA3 500 mg/l with (25.62). The maximum days taken were under treatment T0 (Control) with (35.51). Enhancement of seed germination by growth regulators might be due to increase of transcription and translation during protein synthesis. The mobilization of protein and lipid storage bodies upon specific enzymes, which hydrolyze stored molecules and catalyze result into the production of energy and substrates and provide the structural components essential for growth and emergence of the embryo. This result is in agreement with the findings of Feza Ahmad (2010) [3].

The data from table 1 revealed that the highest germination per cent was recorded to be in treatment T1 i.e., GA3 500 mg/l with 92.37%. The lowest germination per cent was recorded in treatment T0 under control with 63.54%. Treatment T1 was also found be at par with treatment T4 and T2 with 91.01% and 89.95% respectively. The possible reason behind the recorded observations may be because at convenient concentration, GA3 and ZnSO4 act as promoting factor for seed germination and growth, but at higher concentrations it becomes an inhibitor. The results are in agreement with Al- Hawezy (2015) [1].

### Seedling growth parameters

Observations related to seedling growth parameters including height and girth of shoot, Number of leaves per plant, length of seedling, root length were recorded and data revealed that Gibberellic aid has shown a substantial effect on seedling growth parameters.

Table 2 shows the data of height of shoot recorded at 60, 90 and 120 DAS. It was found that a maximum height of 3.37, 10.21, and 20.57 cm were recorded under treatment T3 (GA3 @ 2000 mg/l) at 60, 90, and 120 DAS, respectively. Whereas, treatment T3 was found to be at par with treatments T2, T4 (3.32 and 3.35) respectively at 60 DAS. T3 was also found to be at par with treatment T4 (10.19 cm) at 90 DAS and similarly T3 remained at par with treatments T4 and T5 (20.00 and 19.00 cm) at 120 DAS respectively.

The minimum height of the Shoot was recorded to be 2.87, 9.28, 15.12 under treatment T0 (Control) at 60, 90 and 120 DAS respectively.

GAs stimulated a number of genes required for the synthesis of amylases such alpha-amylase, proteases, and B-glucanases that assisted in converting polysaccharides (starch) to monosaccharides, which were an important source of nutrition for embryo cells, resulting in the increase in plant height (AL-Hawezy, 2015) [1].

Additionally, zinc is a key component in the production of auxin, which is essential for controlling cell wall expansion by activating genes involved in cell wall synthesis and modification and Jaiswal *et al.* confirmed that GA3 and ZnSO4 increased plant height (2018).

Gibberellic acid and zinc sulphate concentrations had a substantial impact on shoot girth. Maximum shoot girth (1.22, 2.02 and 2.34 mm) was reported in treatment T3 (GA3 @ 2000 mg/l) at 60, 90, and 120 DAS.

Table 3 shows that the minimum shoot girth (0.80, 1.03 and 2.04 mm) was recorded in treatment T0 (Control/ Distilled water) at 60, 90 and 120 DAS while treatment T3 remained at par with T2 (1.12) at 60 DAS and treatment T2 and T4 (2.0 cm) and (1.90 cm) respectively also were next best after treatment T3 at 90 DAS. Similarly, treatment T3 was also found to be at par with treatment T2 (2.30 cm) and T4 (2.31 cm) at 120 DAS.

The likely cause of the increased shoot girth may be related to GA3's ability to activate seed germination by relieving dormancy in the seed coat and to stimulate gibberellin genes, which alter the modifying proteins of cell walls. These results were confirmed by Joshi *et al.* (2015) [8] on acid lime.

Table 4. Revealed that maximum number of leaves (4.18, 15.32 and 28.22) at 60, 90 and 120 DAS were noted when the seeds were treated with 2000 mg/l of GA3 under T3 treatment. The minimum number of leaves (3.15, 13.15, 20.93) were found under treatment T0 (control). Treatment T2 and T1 (14.87 and 14.86) remained at par with T3 at 90 DAS respectively. However, treatment T4 and T5 at 120 DAS with (27.93 and 27.24) were found to be next best respectively, after treatment T3.

The increase in leaf count may be due to the treatment of seeds with GA3, which has been shown to hasten cell growth and internodal length. These processes are also directly tied to photosynthesis and the build-up of carbohydrates, which accelerated the production of leaves. These outcomes support the conclusions made by Kadam *et al*. (2010) [9].

Table 5. Illustrates that gibberellic acid showed significant effect on length of seedling at 120 DAS. The maximum length was seen in treatment T3 which was GA3 2000 mg/l with (45.98 cm). Treatment T3 was found to be at par with treatment T4 (45.66) and the minimum seedling length was observed in treatment T0 (Control) with 40.06 cm.

The idea that the acid lime seedling's endogenous level of GA3 is inadequate may be the reason of the increase in seedling length. In this instance, external application of GA3 promotes cell multiplication and elongation, which lengthens seedlings and increases growth. These findings are consistent with those of Gurung *et al.* (2014) [4].

Maximum length of root went up-to 30.37 cm under treatment T3 i.e., GA3 2000 mg/l which was found to be superior over rest other treatments. The minimum root length was observed under treatment T0 (control) with 21.14 cm.

The likely cause of greater root length may be because GA3 enhances somatic nutrition absorption, which causes cell elongation and expansion, which further lengthens the primary roots and secondary roots. These results are in support with the report of Hota *et al.* (2018) [6].

Zinc Sulphate concentration has depicted a significant growth

and survival in acid lime seedlings.

Table 5. Shows the utmost survival was seen in treatment T6 under the concentration of ZnSO4 2000 mg/l with 91.66%. The minimum survival percent was under treatment T0 with 75% survivability in acid lime plants.

The difference in the biological and physiological roles that either GA3 or Zn could play in relation to shoot growth and root development may be the cause of the shift in trend of response for the survival percent of translocated seedlings. These results are confirmed by those obtained by Hassabella and Mougheith (1989) [5].

**Table 1:** Impact of different concentrations of GA3 and Zn on germination parameters

| S. No. | Notation | Treatment | No. of days required for germination | No. of days required for 50% germination | Germination Percentage |
|---|---|---|---|---|---|
| 1. | T0 | Control | 31.29 | 35.31 | 63.54 |
| 2. | T1 | GA3 500 mg/l | 21.90 | 25.62 | 92.37 |
| 3. | T2 | GA3 1000 mg/l | 24.92 | 26.60 | 89.95 |
| 4. | T3 | GA3 2000 mg/l | 26.88 | 27.33 | 85.01 |
| 5. | T4 | ZnSO4 500 mg/l | 23.29 | 25.75 | 91.01 |
| 6. | T5 | ZnSO4 1000 mg/l | 24.95 | 26.72 | 88.68 |
| 7. | T6 | ZnSO4 2000 mg/l | 26.95 | 27.36 | 80.02 |
| CD at 5% | | | 1.159 | 0.839 | 2.617 |
| SE(m) ± | | | 0.378 | 0.274 | 0.854 |
| C.V. | | | 2.546 | 1.705 | 1.754 |

**Table 2:** Impact of different concentrations of GA3 and Zn on Height of Shoot (cm) at 60, 90 and 120 DAS.

| S. No. | Notation | Treatment | Height of shoot (cm) | | |
|---|---|---|---|---|---|
| | | | 60 DAS | 90 DAS | 120 DAS |
| 1 | T0 | Control | 2.87 | 9.28 | 15.12 |
| 2 | T1 | GA3 500 mg/l | 3.20 | 9.27 | 15.18 |
| 3 | T2 | GA3 1000 mg/l | 3.32 | 9.39 | 18.85 |
| 4 | T3 | GA3 2000 mg/l | 3.37 | 10.21 | 20.57 |
| 5 | T4 | ZnSO4 500 mg/l | 3.35 | 10.19 | 20.00 |
| 6 | T5 | ZnSO4 1000 mg/l | 3.23 | 9.58 | 19.00 |
| 7 | T6 | ZnSO4 2000 mg/l | 3.00 | 8.72 | 18.99 |
| C.D at 5% | | | 0.23 | 0.52 | 2.07 |
| S.Em ± | | | 0.08 | 0.17 | 0.68 |
| C.V. (%) | | | 4.12 | 3.09 | 6.41 |

**Table 3:** Impact of different concentrations of GA3 and Zn on Girth of Shoot (mm) at 60, 90 and 120 DAS

| S. No. | Notation | Treatment | Girth of Shoot(mm) | | |
|---|---|---|---|---|---|
| | | | 60 DAS | 90 DAS | 120 DAS |
| 1 | T0 | Control | 0.82 | 1.03 | 2.04 |
| 2 | T1 | GA3 500 mg/l | 1.03 | 1.75 | 2.18 |
| 3 | T2 | GA3 1000 mg/l | 1.12 | 2.00 | 2.30 |
| 4 | T3 | GA3 2000 mg/l | 1.22 | 2.02 | 2.34 |
| 5 | T4 | ZnSO4 500 mg/l | 1.08 | 1.92 | 2.31 |
| 6 | T5 | ZnSO4 1000 mg/l | 1.06 | 1.83 | 2.08 |
| 7 | T6 | ZnSO4 2000 mg/l | 1.04 | 1.75 | 2.14 |
| C.D at 5% | | | 0.06 | 0.15 | 0.18 |
| S.Em ± | | | 0.02 | 0.05 | 0.06 |
| C.V. (%) | | | 3.07 | 4.84 | 4.58 |

**Table 4:** Impact of different concentrations of GA3 and Zn on Number of leaves at 60, 90 and 120 DAS.

| S. No. | Notation | Treatment | Number of leaves | | |
|---|---|---|---|---|---|
| | | | 60 DAS | 90 DAS | 120 DAS |
| 1 | T0 | Control | 3.15 | 13.15 | 20.93 |
| 2 | T1 | GA3 500 mg/l | 3.67 | 14.86 | 25.44 |
| 3 | T2 | GA3 1000 mg/l | 3.75 | 14.87 | 25.59 |
| 4 | T3 | GA3 2000 mg/l | 4.18 | 15.32 | 28.22 |
| 5 | T4 | ZnSO4 500 mg/l | 4.07 | 14.83 | 27.93 |
| 6 | T5 | ZnSO4 1000 mg/l | 3.90 | 14.37 | 27.24 |
| 7 | T6 | ZnSO4 2000 mg/l | 3.75 | 14.69 | 26.36 |
| C.D at 5% | | | 0.07 | 0.67 | 1.58 |
| S.Em ± | | | 0.02 | 0.22 | 0.51 |
| C.V. (%) | | | 1.00 | 2.59 | 3.43 |

**Table 5:** Impact of different concentrations of GA3 and Zn on length of seedling (cm), root length and survival percentage at 120 DAS

| S. No. | Notation | Treatment | Length of seedling at 120 DAS | Root length at 120 DAS | Survival percentage at 120 DAS |
|---|---|---|---|---|---|
| 1. | T0 | Control | 40.06 | 21.14 | 75.00 |
| 2. | T1 | GA3 500 mg/l | 42.13 | 22.81 | 77.78 |
| 3. | T2 | GA3 1000 mg/l | 43.37 | 25.38 | 86.11 |
| 4. | T3 | GA3 2000 mg/l | 45.98 | 30.37 | 83.33 |
| 5. | T4 | ZnSO4 500 mg/l | 45.66 | 27.84 | 83.21 |
| 6. | T5 | ZnSO4 1000 mg/l | 44.28 | 27.00 | 80.55 |
| 7. | T6 | ZnSO4 2000 mg/l | 44.06 | 25.35 | 91.66 |
| CD at 5% | | | 1.15 | NS | NS |
| SE(m) ± | | | 0.37 | 1.94 | 5.114 |
| C.V | | | 1.00 | 13.05 | 7.59 |

## Conclusion

On the basis of present investigation on "Effect of different concentrations of $GA_3$ and Zn on seed germination and growth of acid lime (*Citrus aurantifolia* Swingle) cv. Phule Sharbati." the following conclusions can be made:

- It can be concluded that in case of germination parameters *viz*., days taken for germination, days taken for 50% germination and germination percentage (%). T1 was found to be best for all the three germination parameters and significantly took less time for germination, least span of time for 50% germination and for maximum germination percentage (%).
- In case of seedling growth parameters, it was recorded that T3 was significantly superior and gave the best results over rest of the treatments and the parameters included height of shoot (cm), girth of shoot (mm), No. of leaves per plant, length of seedling (cm), Root length (cm), Fresh weight (g), Dry weight (g), Vigour index- Ⅰ and Vigour index-II(g).

In the observation referred survival percentage (%) treatment T7 gave the maximum survivability out of all the treatments and proved to be superior than others.

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