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**PLANT PHYSIOLOGY**

# Combination of Halo Priming Accompanied with Hormonal Priming on Papaya Seed Development

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**ABSTRACT**

The study was carried out to find out the effect of halo and hormonal priming on papaya seeds. The experiment was laid down in Completely Randomized Design (CRD) and was replicated thrice with nine different treatments namely T1 (sodium chloride 600 PPM for 10 hours and gibberellic acid 50 PPM for 4 hours), T2 (sodium chloride 600 PPM for 10 hours and gibberellic acid 100 PPM for 4 hours), T3 (sodium chloride 900 PPM for 10 hours and gibberellic acid 50 PPM), T4 (sodium chloride 900 PPM for 10 hours and gibberellic acid 100 PPM for 4 hours), T5 (sodium chloride 600 PPM for 10 hours and benzyl adenine 50 PPM for 4 hours), T6 (sodium chloride 600 PPM for 10 hours and benzyl adenine 100 PPM for 4 hours), T7 (sodium chloride 900 PPM for 10 hours and benzyl adenine 50 PPM for 4 hours), T8 (sodium chloride 900 PPM for 10 hours and benzyl adenine 100 PPM for 4 hours) and T9 (control: distilled water for 10 hours). Various attributes were observed for the study. From the entire experiment the results showed that priming with Sodium chloride 600 PPM for 10 hours and gibberellic acid 50 PPM for 4 hours (T1) was the best seed priming technique as it gave the maximum final germination percentage and which performed better than other treatments.

**HIGHLIGHTS**

- Best results were obtained for the treatment of T1 i.e.; Sodium chloride 600 PPM for 10 hours and gibberellic acid 50 PPM for 4 hours.

**Keywords:** Halo-priming, hormonal priming, growth hormone, gibberellic acid, benzyl adenine, sodium chloride, seed germination

Seed germination in papaya is slow, erratic and is also incomplete (Chako and Singh 1966). The seed is enclosed within a gelatinous sarcotesta (aril, or outer seed coat which is formed from the outer integument. The sarcotesta can delay germination, and also dormancy is observed in seeds from which the aril has been removed. The theory of seed priming was proposed by Heydecker *et al*. 1973. Seed priming is a process of regulating the germination process by managing the temperature and seed moisture content. Seed priming is an effective technology to enhance rapid and uniform emergence and to achieve high vigour, leading to better stand establishment and yield (Harris *et al*. 2007). Various seed priming techniques have been developed till date. Halo priming is a pre-sowing soaking of seeds in salt solutions, which enhances germination and seedling emergence uniformly under adverse environmental conditions and normal condition. NaCl, KCl, $KNO_3$, and $CaCl_2$ are used generally. Hormonal priming on the other hand is soaking of seed in hormone solution. GA3, Salicylic acid, Ascorbic acid, Cytokinins etc. can be used for this. Hence, considering the importance of priming, the present study was undertaken on Halo and Hormonal priming of papaya seed.

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## MATERIALS AND METHODS

### Study area

The experiment has been executed on the effect of halo priming followed by hormonal priming in Papaya seed germination in the Department of Horticulture, Institute of Agricultural Science, University of Calcutta. This study has been done in the month of June 2022.

### Seed collection

For this experiment purpose, fully ripened Papaya (*Carica papaya* L.) were collected from the Sealdah Market, Kolkata. Thereafter seeds were extracted out carefully from the fruit.

### Tillage practices

The soil was collected from two different places i.e. Baruipur Agricultural Farm and Institute of Agricultural Science and mixed properly with coco peat & leaf mold.

### Treatment and experimental design

The experiment comprised of nine different treatments such as: T1-Sodium chloride 600 PPM and gibberellic acid 50 PPM, T2-Sodium chloride 600 PPM and gibberellic acid 100 PPM, T3-Sodium chloride 900 PPM and gibberellic acid 50 PPM, T4-Sodium chloride 900 PPM and gibberellic acid 100 PPM, T5-Sodium chloride 600 PPM and benzyl adenine 50 PPM,T6-Sodium chloride 600 PPM and benzyl adenine 100 PPM, T7-Sodium chloride 900 PPM and benzyl adenine 50 PPM, T8-Sodium chloride 900 PPM and benzyl adenine 100 PPM, T9 - Distilled water. The experiment was laid down in Completely Randomized Design (Gomez and Gomez 1984; Sheoran *et al*. 1998) method with these nine treatments and three replications with 10 seeds in each pot. The pots were filled with 50% coco peat, 25% soil, 25% leaf mold in each of them. The seeds of papaya were soaked in sodium chloride (in different concentrations) for 10 hours and then were taken out of water on filter paper to dry out under room temperature and again the treated seeds were soaked in growth hormone for 4 hours i.e.; Gibberellic acid & Benzyl adenine (in different concentrations). Thereafter seeds were sown in pots containing the potting mixture at 10-15 m deep in soil. Further data were recorded on the basis of specific incidents such as germination percentage of seed (Nichols and Heydecker 1968), number of leaves (Tian *et al*. 2014), length of leaves (Dhal *et al*. 2022)., increase in length of roots (Mondal *et al*., 2018)., increase in number of rootlets (Aryal 2020), increase total length of seedling (Kumari *et al*. 2017)., chlorophyll content (Ranganna *et al*. 2003). Every day the pots had to expose out in the sun for 6 to 7 hrs. Irrigations were done on daily basis in the evening until all the seeds germinated and then in an interval of 2 days. Other cultural practices like weeding and plant protection measures were done uniformly in every pot.

## RESULTS AND DISCUSSION

### Germination percentage

It is revealed from experimental result presented in Table 1 that the highest percentages was recorded as 83.33% in T9 (control: distilled water for 10 hours) whereas the lowest germination percentage was 26.67% in T6 (sodium chrolide, 600 PPM for 10 hours and benzyl adenine 100 PPM for 4 hours), T7 (sodium chloride, 900 PPM for 10 hours and benzyl adenine 50 PPM for 4 hours) and T8 (sodium chloride, 900 PPM for 10 hours and benzyl adenine 100 PPM for 4 hours) and this total observation was done on 30 DAS.

**Table 1:** Germination percentage of the papaya seedlings as influenced by halo priming followed by hormonal priming

| Treatments | 30 DAS | 35 DAS |
|---|---|---|
| T1 | 80.00 | 83.33 |
| T2 | 56.67 | 66.67 |
| T3 | 70.00 | 66.67 |
| T4 | 60.00 | 63.33 |
| T5 | 36.67 | 26.67 |
| T6 | 26.67 | 26.67 |
| T7 | 26.67 | 23.33 |
| T8 | 26.67 | 13.33 |
| T9 | 83.33 | 86.67 |
| **CD** | 19.111 | 18.222 |
| **SEm±** | 6.383 | 6.086 |

Further, it is observed on 35 DAS the highest germination percentage was recorded as 86.67% in T9 (Control: distilled water for 10 hours) which was closely followed by T1 (sodium chloride 600 PPM for 10 hours and gibberellic acid 50 PPM for

4 hours) showing of 83.33% and lowest germination percentage was recorded as 13.33% in T8 (sodium chloride, 900 PPM for 10 hours and benzyl adenine 100 PPM for 6 hours).

### Number of leaves

It has been revealed from experimental results presented in Table 2 that the collected highest mean number of leaves of 30 DAS was 4.50 which was observed in the treatment of T1 (sodium chloride, 600 PPM for 10 hours and gibberellic acid, 50 PPM for 4 hours) and T9 (control: distilled water for 10 hours) whereas lowest mean number of leaves was 3.67 observed in the treatment of T5 (sodium chloride 600 PPM for 10 hours and benzyl adenine, 50 PPM for 4 hours) and T7 (sodium chloride, 900 PPM for 10 hours and benzyl adenine ,50 PPM for 4 hours) and these above data was recorded on 30 days. Next observations was done on 35 days where highest mean number of leaves of 5.67 was shared by the treatment T8 (sodium chloride, 900 PPM for 10 hours) and T9 (control: distilled water for 10 hours), this was followed by T5 (sodium chloride 600 PPM for 10 hours and benzyl adenine, 50 PPM for 4 hours) and T7 (sodium chloride, 900 PPM for 10 hours and benzyl adenine 50 PPM for 4 hours) showing 5.33 and 5.00 no. of leaves respectively. The lowest mean number of leaves was 4.33 which was observed on the treatment of T6 (sodium chloride 600 PPM for 10 hours and benzyl adenine 100 PPM for 4 hours).

**Table 2:** Number of leaves of the papaya seedlings as influenced by halo priming followed by hormonal priming

| Treatments | 30 DAS | 35 DAS |
|---|---|---|
| T1 | 4.50 | 4.67 |
| T2 | 4.17 | 4.67 |
| T3 | 4.00 | 4.67 |
| T4 | 4.17 | 4.83 |
| T5 | 3.67 | 5.33 |
| T6 | 4.00 | 4.33 |
| T7 | 3.67 | 5.00 |
| T8 | 4.33 | 5.67 |
| T9 | 4.50 | 5.67 |
| **CD** | NS | NS |
| **SEm±** | 0.299 | 0.614 |

### Length of leaves

In Table 3, the first reading was taken on 30 DAS in which highest leaf length was 1.43 cm in the treatment of T2 (sodium chloride, 600 PPM for 10 hours and gibberellic acid, 100 PPM for 4 hours) and T6 (sodium chloride, 600 PPM for 10 hours and benzyl adenine, 100 PPM for 4 hours) and lowest leaf length was 1.17 cm observed in the treatment of T4 (sodium chloride 900 PPM for 10 hours and gibberellic acid 100 PPM for 6 hours) and T7 (sodium chloride 900 PPM for 10 hours and benzyl adenine 50 PPM for 4 hours). The second reading was followed on 35 DAS and where the highest leaf length was 1.63 cm in the treatment of T8 (sodium chloride 900 PPM for 10 hours and benzyl adenine 100 PPM for 4 hours) and T7 (sodium chloride 900 PPM for 10 hours and benzyl adenine 50 PPM for 4 hours). Other treatments maintained significant acceptable length of leaves, however the lowest length of leaf was 1.10 cm in the treatment of T5 (sodium chloride 600 PPM for 10 hours and benzyl adenine 50 PPM for 4 hours).

**Table 3:** Length of leaves of the papaya seedlings as influenced by halo priming followed by hormonal priming

| Treatments | 30 DAS | 35 DAS |
|---|---|---|
| T1 | 1.40 | 1.40 |
| T2 | 1.43 | 1.37 |
| T3 | 1.40 | 1.47 |
| T4 | 1.17 | 1.53 |
| T5 | 1.20 | 1.10 |
| T6 | 1.43 | 1.33 |
| T7 | 1.17 | 1.63 |
| T8 | 1.20 | 1.63 |
| T9 | 1.40 | 1.53 |
| **CD** | NS | 0.503 |
| **SEm±** | 0.118 | 0.168 |

### Length of roots

It is being observed from experimental results shown in Table 4, that highest root length of 4.27 cm was observed in T9 (control: distilled water for 10 hours) followed by T1 (sodium chloride 600 PPM for 10 hours and gibberellic acid 50 PPM for 4 hours) of 4.02 cm whereas the lowest root length of 1.43 cm was observed in T5 (sodium chloride 600 PPM for 10 hours and benzyl adenine 100 PPM for

6 hours) on 30 DAS. For the next observation on 35 DAS the highest root length of 4.80 cm was observed in T6 (sodium chloride 600 PPM for 10 hours and benzyl adenine 100 PPM for 4hours) which was very closely succeeded by T5 (sodium chloride 600 PPM for 10 hours and benzyl adenine 50 PPM for 4 hours) showing a root length of 4.77 and 4.42 cm then the lowest root length of 2.73 cm was observed in T8 (sodium chloride 900 PPM for 10 hours and benzyl adenine 100 PPM for 4 hours). Then on the last reading of 40 DAS the maximum root length, 4.83 cm was observed in T5 (sodium chloride 600 PPM for 10 hours and benzyl adenine 50 PPM for 4 hours). Also the treatments T6 (sodium chloride 600 PPM for 10 hours and benzyl adenine 100 PPM for 4 hours), T3 (sodium chloride 900 PPM for 10 hours and gibberellic acid 50 PPM for 4 hours), T9 (control: distilled water for 10 hours), T4 (sodium chloride 900 PPM for 10 hours and gibberellic acid 100 PPM for 6 hours), T7 (sodium chloride 900 PPM for 10 hours and benzyl adenine 50 PPM for 4 hours) and T1 (sodium chloride 600 PPM for 10 hours and gibberellic acid 50 PPM for 4 hours) showed the mean length of root above 4 cm. Lastly the lowest root length of 3.33 cm was observed in T8 (sodium chloride 900 PPM for 10 hours and benzyl adenine 100 PPM for 4 hours) on 40 DAS.

**Table 4:** Length of roots of the papaya seedlings as influenced by halo priming followed by hormonal priming

| Treatments | 30 DAS | 35 DAS | 40 DAS |
|---|---|---|---|
| T1 | 4.02 | 4.42 | 4.02 |
| T2 | 3.53 | 3.63 | 3.93 |
| T3 | 3.88 | 4.07 | 4.38 |
| T4 | 3.75 | 3.87 | 4.15 |
| T5 | 1.43 | 4.77 | 4.83 |
| T6 | 3.50 | 4.80 | 4.77 |
| T7 | 3.03 | 3.53 | 4.03 |
| T8 | 1.80 | 2.73 | 3.33 |
| T9 | 4.27 | 3.73 | 4.33 |
| **CD** | 0.183 | 1.212 | NS |
| **SEm±** | 0.395 | 0.405 | 0.481 |

## Number of rootlets

Variations in rootlet numbers were observed in case of different replications in different pots. It is noticeable from Table 5 that the highest number of rootlets of 14 was observed in T9 (control : distilled water for 10 hours) whereas, lowest number of rootlets, 6.33 was recorded in T5 (sodium chloride 600 PPM for 10 hours and benzyl adenine 50 PPM for 4 hours) on 30 DAS. Next observation was done on 35 DAS which shows the highest number of rootlets of 17 in T3 (sodium chloride 900 PPM for 10 hours and gibberellic acid 100 PPM for 4 hours) followed by 14.67 in T5 (sodium chloride 600 PPM for 10 hours and benzyl adenine 50 PPM for 4 hours) and the lowest number rootlets, 6 was observed in T8 (sodium chloride 900 PPM for 10 hours and benzyl adenine 100 PM for 4 hours). In last observation on 40 DAS the maximum number of rootlets of 19 was observed in T3 (sodium chloride 900 PPM for 10 hours and gibberellic acid 50 PPM for 4 hours) succeeded by T4 (sodium chloride 900 PPM for 10 hours and gibberellic acid 100 PPM for 6 hours) with 18.83 and lowest number of rootlets of 7.67, were observed in T8 (sodium chloride 900 PPM for 10 hours and benzyl adenine 100 PPM for 4 hours).

**Table 5:** Number of rootlets of the papaya seedlings as influenced by halo priming followed by hormonal priming

| Treatment | 30 DAS | 35 DAS | 40 DAS |
|---|---|---|---|
| T1 | 10.00 | 13.33 | 13.67 |
| T2 | 9.17 | 13.67 | 13.33 |
| T3 | 12.50 | 17.00 | 19.00 |
| T4 | 12.67 | 13.17 | 18.83 |
| T5 | 6.33 | 14.67 | 13.33 |
| T6 | 10.00 | 13.33 | 14.00 |
| T7 | 10.00 | 11.33 | 12.00 |
| T8 | 9.33 | 6.00 | 7.67 |
| T9 | 14.00 | 13.67 | 13.33 |
| **CD** | 3.497 | 3.314 | 3.768 |
| **SEm±** | 1.168 | 1.107 | 1.258 |

## Total length of seedling

Table 6 shows the highest seedling length of 12.13 cm was observed in T9 (control for 10 hours) and the lowest seedling length was 3.63 cm which was observed in T5 (sodium chloride 600 PPM for 10 hours and benzyl adenine 50 PPM for 4 hours) on 30 DAS. Then on 35 DAS, the highest total length of seedling, 14.20 cm was observed in T9 (control: distilled water for 10 hours) and the lowest length

of seedling, 9.70 cm was observed in T8 (sodium chloride 900 PPM for 10 hours and benzyl adenine 4 hours). Lastly on 40 DAS the highest length of seedling of 17.32 cm was observed in T9 (control for 10 hours). But the seedlings under other treatments showed good response and documented a standard total length of the plants throughout the study period.

**Table 6:** Total length of the papaya seedlings as influenced by halo priming followed by hormonal priming

| Treatments | 30 DAS | 35 DAS | 40 DAS |
|---|---|---|---|
| T1 | 11.52 | 11.87 | 12.61 |
| T2 | 10.28 | 12.37 | 12.70 |
| T3 | 12.10 | 12.43 | 12.93 |
| T4 | 11.12 | 11.67 | 13.32 |
| T5 | 3.63 | 12.33 | 13.70 |
| T6 | 10.77 | 12.33 | 13.07 |
| T7 | 11.27 | 11.83 | 12.87 |
| T8 | 10.90 | 9.70 | 11.23 |
| T9 | 12.13 | 14.20 | 17.32 |
| **CD** | 1.823 | NS | 2.855 |
| **SEm±** | 0.609 | 0.934 | 0.953 |

## Chlorophyll content

Table 7 shows the highest content of chlorophyll a, for 30 DAS was 0.025 mg/ml, observed in T9 (control for 10 hours) while the lowest content of chlorophyll a, 0.002 mg/ml observed in T5 (sodium chloride 600 PPM for 10 hours and benzyl adenine 50 PPM for 4 hours), T6 (sodium chloride 600 PPM for 10 hours and benzyl adenine 100 PPM for 4 hours) and T7 (sodium chloride 900 PPM for 10 hours and benzyl adenine 50 PPM for 4 hours) on 30 DAS. For chlorophyll b, 0.013 mg/ml observed in T9 (control: distilled water for 10 hours) while the lowest content of chlorophyll b, 0.00 mg/ml was observed in T7 (sodium chloride 900 PPM for 10 hours and benzyl adenine 50 PPM for 4 hours). And then for total chlorophyll, 0.038 mg/ml observed in T9 (control for 10 hours) and the lowest content of total chlorophyll of 0.002 mg/ml was seen in T7 (sodium chloride 900 PPM for 10 hours and benzyl adenine 50 PPM for 4 hours). An increasing trend for chlorophyll was seen in the next interval, the highest content of chlorophyll a at 35 DAS of 0.013 mg/ml observed in T9 (control: distilled water for 10 hours) while the lowest content of 0.002 mg/ml was observed in T5 (sodium chloride 600 PPM for 10 hours and benzyl adenine 50 PPM for 4 hours) and T6 (sodium chloride 600 PPM for 10 hours and benzyl adenine 100 PPM for 4 hours). Chlorophyll b content at the same interval was 0.012 mg/ml in T6 (sodium chloride 600 PPM for 10 hours and benzyl adenine 100 PPM for 4 hours) and lowest value of b 0.001 mg/ml was observed in T5 (sodium chloride 600 PPM for 10 hours and benzyl adenine 50 PPM for 4 hours) and T8 (sodium chloride 900 PPM for 10 hours and benzyl adenine 4 hours) respectively. In case of total chlorophyll content it was 0.023 mg/ml observed in T9 (control: distilled water for 10 hours).

**Table 7:** Chlorophyll content (mg/ml) of the papaya seedlings as influenced by halo priming followed by hormonal priming

| Treatments | 30 DAS | | | 35 DAS | | |
|---|---|---|---|---|---|---|
| | Ch a | Ch b | T Ch | Ch a | Ch b | T Ch |
| T1 | 0.016 | 0.005 | 0.016 | 0.008 | 0.005 | 0.013 |
| T2 | 0.004 | 0.002 | 0.005 | 0.003 | 0.002 | 0.005 |
| T3 | 0.003 | 0.001 | 0.004 | 0.005 | 0.003 | 0.008 |
| T4 | 0.004 | 0.003 | 0.007 | 0.004 | 0.003 | 0.007 |
| T5 | 0.002 | 0.001 | 0.003 | 0.002 | 0.001 | 0.004 |
| T6 | 0.002 | 0.001 | 0.003 | 0.002 | 0.012 | 0.014 |
| T7 | 0.002 | 0.000 | 0.002 | 0.005 | 0.003 | 0.007 |
| T8 | 0.010 | 0.004 | 0.008 | 0.003 | 0.001 | 0.004 |
| T9 | 0.025 | 0.013 | 0.038 | 0.013 | 0.010 | 0.023 |
| **CD** | 0.012 | 0.005 | 0.015 | 0.004 | NS | NS |
| **SEm±** | 0.004 | 0.002 | 0.005 | 0.001 | 0.004 | 0.005 |

Seed priming came out to be successful and effective strategy for improving the germination of papaya seeds. Significantly higher germination percentage, observed in halo primed followed by hormonal primed seeds as compared to non-primed seeds indicated a positive effect of seed priming in synchronizing the seed germination process (Table 1). A higher germination percentage, 86.67% was recorded in seeds that were soaked in distilled water for 10 hours similar work has been done by Khajjak *et al*. (2022). In this experiment it was reported that, the maximum germination percentage was given by seed primed with distilled water for 10 hours. Tian *et al*. (2014) also reported that the optimum germination performance was observed after halo priming and hormonal priming. Combination of halo priming accompanied with hormonal

priming on the papaya seed development showed remarkable benefit on the number of leaves and length of leaves (Table 2 and 3) etc. At week 4 to week 5, the treatment showed significant difference in the plant parameters in view. The maximum number of leaves was 5.67 observed in treatment T8 (sodium chloride 900 PPM for 10 hours and benzyl adenine 50 PPM for 4 hours). This may be due to coco peat that assists to increase leave number in plant, similar work has done by Ketter *et al*. (2014). The highest length of leaves, 1.53 cm was recorded in treatment T7 (sodium chloride 900 PPM for 10 hours and benzyl adenine 50 PPM for 4 hours) and T8 (sodium chloride 900 PPM for 10 hours and benzyl adenine 50 PPM for 4 hours) on 35 DAS whereas the lowest length of leaves, 1.10 cm was recorded in treatment of T4 (sodium chloride 900 PPM for 10 hours and gibberellic acid 100 PPM for 4 hours) on 35 DAS. Ghobadi *et al*. (2012) and Tian *et al*. (2014) work also reported that wheat seeds were treated with hormonal priming (gibberellic acid) and osmo priming solution, increase the number of leaves and length of leaves. Papaya seedlings showed appreciable effect of halo priming followed by hormonal priming on the length of root, number of rootlets, and total length of seedling (Table 4, 5, and 6). The number of rootlets per seedling was increased with increasing in days. Overall highest length of root was 4.83 cm in the treatment of T5 (sodium chloride 600 PPM for 10 hours and benzyl adenine 50 PPM for 4 hours) on 40 DAS. Overall highest number of rootlets, 19.00 was recorded in T3 (sodium chloride 900 PPM for 10 hours and gibberellic 50 PPM for 4 hours) on 40 DAS. Similar experiment has been done by Rehman *et al*. (2021) that signifies the role of seed priming in root development and crop production. Furthermore, it may also be due to 50% coco peat, 25% soil and 25% leaf mold which have a high-water absorption capacity and also promotes root aeration as it retains a good amount of air even in wet condition. It has limited anti-fungal properties which helps in keeping pests away.

## CONCLUSION

From this study, it is concluded that the present investigation of different concentration of priming treatments showed significant effect on seed germination and seed vigor parameters. The seed performances of papaya for all recorded parameters were remarkably better after priming. However, from the entire experiment, it was obtained that the best priming treatments for seeds of papaya were T1 (sodium chloride 600 PPM for 10 hours and gibberellic acid 50 PPM for 4 hours) as it gave the maximum final germination percentage and performed better than other treatments.

## REFERENCES


Aryal, K., Shrestha, A. and Subedi, R. 2020. Effect of various seed priming methods on germination characteristics of Black Gram. *J. Protein Res Bioinform.*, **2**: 009.

Chacko, E.K. and Singh, R.N. 1966. The effect of gibberellic acid on the germination of papaya seeds and subsequent seedling growth. *Tropical Agric.*, **43**(4).

Dhal, P., Sahu, G., Dhal, A., Mohanty, S. and Dash, S.K. 2022. Priming of vegetable seeds: A review. *The Pharma Innovation J.*, **11**(2): 519-525.

Ghobadi, M., Abnavi, M.S., Honarmand, S.J., Ghobadi, M.E. and Mohammadi, G.R. 2012. Effect of hormonal priming (GA3) and osmopriming on behavior of seed germination in wheat *(Triticum aestivum* L.). *J. Agril. Sci. (Toronto).*, **4**(9): 244-250.

Gomez, K.A. and Gomez, A.A. 1984. *Statistical procedures for agricultural research*. (2nd Ed.) Wiley-Inter Science Publication, New York, USA.

Harris, D., Rashid, A., Miraj, G., Arif, M. and Shah, H. 2007. 'On-farm' seed priming with zinc sulphate solution—A cost-effective way to increase the maize yields of resource-poor farmers. *Field Crops Res.*, **102**(2): 119-127.

Heydecker, W., Higgins, J. and Gulliver, R.L. 1973. Accelerated germination by osmotic seed treatment. *Nature*, **246**(5427): 42-44.

Ketter, N.C., Kariuki, W., Wesonga, J.M., Elings, A. and Hoogerwerf, F. 2014. Vegetative growth of rose flower in cocopeat and soil in Naivasha, Kenya. In *XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC2014).*, **11**(04): 95-102.

Khajjak, A.H., Noor-Un-Nisa, M.E.M.O.N., Wahocho, N. A., Sharif, N., Minao, T.F., Siddique, I.M. and Irshad, U. 2022. Effect of seed priming on germination and seedling growth of papaya (*Carica papaya* L.). *Plant Cell Biotechnology and Molecular Biology,* pp. 1-12.

Kumari, N., Rai, P.K., Bara, B.M., Singh, I. and Rai, K. 2017. Effect of halo priming and hormonal priming on seed germination and seedling vigour in maize (*Zea mays* L.) seeds. *J. Pharmacogn. Phytochem.*, **6**: 27-30.

Mondal, S., Kumar, M. and Bose, B. 2018. Effect of hydro priming and osmo priming with magnesium nitrate in the early vegetative growth phase of rice variety Swarna. *J. Pharmacogn Phytochem.*, **7**(5): 1343-1346.

Nichols, M.A. and Heydecker, W. 1968. Two approaches to study of germination data. *Proceedings of the International Seed Testing Association*, **33**: 531-540.

Rangana, S. 2003. Handbook of Analysis and Quality Control for Fruit and Vegetables Products 2nd ed., Tata McGraw Hill, pp. 12-16.

Rehman, A., Nadeem, F. and Farooq, M. 2021. Role of Seed Priming in Root Development and Crop Production. *The Root Systems in Sustainable Agricultural Intensification*, pp. 221-243.

Sheoran, O.P., Tonk, D.S., Kaushik, L.S., Hasija, R.C. and Pannu, R.S. 1998. Statistical Software Package for Agricultural Research Worker. Recent Advances in information theory, Statistics and Computer Applications by D.S. Hooda and R.C. Hasija, Department of Mathematics Statistics, CCS HAU, Hisar, pp. 139-143.

Tian, Y., Guan, B., Zhou, D., Yu, J., Li, G. and Lou, Y. 2014. Responses of seed germination, seedling growth, and seed yield traits to seed pretreatment in maize (*Zea mays* L.). *The Scientific World J.*, pp. 1-8.