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Influence of Salicylic Acid and Gibberelic Acid on Germination and Growth of Bitter Gourd, *Momordica charantia* L.

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Aim: Uniform and rapid germination and growth is a major barrier to successful crop production of bitter gourd, a major summer vegetable of Bangladesh. Seed priming with different signaling molecules can efficiently confer this problem. Therefore, the present study was conducted to explore the potentiality of different signaling molecules such as salicylic acid (SA) and gibberelic acid (GA_3) to increase germination and growth of bitter gourd.
Place and Duration of the Study: The study was conducted in the Department of Seed Science and Technology, Bangladesh Agricultural University, from September-October, 2022.
Methodology: The bitter gourd seeds were soaked in 1mM, 2mM and 3mM GA_3, and 3mM, 6mM and 9mM SA solutions for 1 hour. The untreated seeds were used as control. Seeds were germinated in petri dishes and data on germination was collected. Then seedlings were transplanted to pot after 7 days to record growth parameters at 15^{th} day of establishment.
Results: The experiment's findings indicated that lower concentrations of SA and GA_3 had a beneficial effect, however greater levels significantly reduced the bitter gourd's ability to germinate

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and develop in comparison to the control. Findings of the study showed priming concentrations of 3mM SA, 6mM SA, and 1mM GA_3, markedly improved the germination percentage, shoot and root length, seedling vigour, and fresh and dry weight of the shoot and root, RWC of bitter gourd.
Conclusion: Pretreatment with SA and GA_3 was observed to be relatively more efficient in increasing germination of bitter gourd compared with control. Overall, this study suggests that bitter gourd seed priming 3mM SA, 6mM SA, and 1mM GA_3 can improve germination and growth.

Keywords: Salicyclic acid; gibberelic acid; germination; growth; bitter gourd.

1. INTRODUCTION

A balanced diet for humans depends heavily on vegetables, which also provide farmers with a source of revenue. *Momordica charantia*, a cucurbitaceous vegetable known for its bitter taste and therapeutic properties, is one of the most consumed cucurbitaceous vegetables in Bangladesh. It is widely grown around the nation, primarily in the summer. Its immature fruit, which also functions as a blood purifier and is very helpful to diabetics, is a great source of nutritional fiber, minerals, and vitamins (C and A) [1]. It also possesses anti-carcinogenic qualities and can be employed as a cytostatic drug against several cancer types [2]. Additionally, it is employed in conventional therapy to treat conditions like perlipidemia, digestive issues, menstrual irregularities, and a number of microbiological diseases [2].

An essential component of production, quality, and ultimately the profitability of vegetable farmers is uniform and quick germination. Even though bitter gourd seeds have a high germinability, rapid and uniform emergence is usually problematic because of the thick seed coat that causes the seed to slowly consume water and produce delayed germination [3]. Priming is one of the strategies that have been used to address this issue. Increasing crop performance through seed priming is an easy, inexpensive and efficient technique. It is referred to as a physiological technique that hydrates and dry seeds without radicle protrusion into water or the solution of additional priming chemicals to enhance the pre-germinative metabolic process [4-6]. It has been demonstrated that several horticultural and agricultural crop profit from it in terms of seed germination, seedling establishment and ultimately productivity [7-11]. Thus, it has been suggested for a long time as a possible means of enhancing crop performance [12]. Additionally, primed seeds exhibit improved uniformity in the emergence of seedlings and a higher rate of germination, both of which aid in the regular establishment of crops and subsequently the production. Better plant water status management and an improved ability for nutrient uptake are linked to the primed plants' rapid development [13,14].

Plant hormones, which have tiny molecules and are present in minuscule amounts in cells, are essential for controlling the growth processes of plants [13]. Salicylic acid (SA; o-hydroxy benzoic acid) is one of the crucial plant growth regulators (PGRs) that contributes significantly to the development and growth of plants. For instance, SA priming of cereal seeds has been shown to positively affect plant growth and development in maize [15] and also in rice [16-20]. Therefore, SA has the potential to enhance yield components as well as biological, physiological and morphological indices in plants [13]. Gibberellins (Gas), another significant phytohormone that is a member of the tetracyclic diterpenoid carboxylic acid group, can stimulate plant growth and development by encouraging seed germination and releasing dormancy [8,21]. They have an impact on growth and development throughout the entire plant life cycle as tiny plant growth molecules. A number of studies to have better germination and growth of bitter gourd has been done to see the efficiency of these growth regulators but the ideal concentration is yet to be determined. Therefore, the goal of this study is to investigate the ideal SA and GA3 concentration for boosting bitter gourd seed germination uniformity and seedling growth.

2. MATERIALS AND METHODS

The experiment was accomplished using local bitter gourd variety riya at the Department of Seed Science and Technology in Bangladesh Agricultural University. Initially, uniform-sized seeds were sterilized for 5 minutes with 1% sodium hypochlorite, then washed repeatedly with double-distilled water. Firstly, for priming, the seeds were soaked in 1mM, 2mM and 3mM GA_3, and 3mM, 6mM and 9mM SA in separate screwcapped bottles. For control, untreated seeds were used. Ten bitter gourd seeds were then placed on petri dishes (150*20 diameter) with three layers of Whatman filter papers moistened with 20 ml distilled water and stored in standard laboratory conditions (room temperature was 25±1^{0}C and relative humidity was 95%). Three independent duplicates of the experiment were run in a completely randomized block design. 7 days old seedlings were transplanted in hydroponic solution in pots and grown for further collection of data.

Table 1. The following treatments were maintained

Treatment	Concentration of priming agent
T1	Control
T2	3mM SA
T3	6mM SA
T4	9mM SA
T5	1mM GA_3
T6	2mM GA_3
T7	3mM GA_3

2.1 Determination of Germination and Growth Parameters

Germination percentage, vigor index, root length, shoot length, fresh and dry weight of root and shoot, relative water content of leaf were considered as germination and growth parameters and determined in control as well as plants under treatment.

2.2 Germination Percentage

The number of sprouted seeds were counted daily commencing from the 1st day to 7th day. After 7th day, final count was done and Germination Percentage (GP) of final day was calculated by the following formula stated in [22]:

Percent germination (PG) = (Total no. of seeds germinated)/ (Total no. of seeds taken for germination) x100 (1)

2.3 Shoot and Root Length

Shoot and root length of all sprouting's from each replication were measured on the 15th day. Shoot length was measured from shoot base to the tip of the longest leaf and root length was measured from root base to the root tip.

2.4 Fresh and Dry Weight of Shoot and Root

Fresh weight (g) of root and shoot were measured just after harvesting. The dry weight (g) of root and shoot were determined by drying the sample in an oven at 80±2°C for three days' till attaining a constant weight.

2.5 Relative Water Content (RWC)

The procedures of Mostofa and Fujita were used to determine the relative water content (RWC) [23]. After 14 days of planting, leaf samples were collected, and fresh weights (FW) of the leaves were taken. After the leaves had been submerged in water for one or two hours, their turgid weights were measured. Following the removal of excess water from the turgid leaves, the turgid weight (TW) was immediately recorded. To determine the leaves' dry weight, they were subsequently oven-dried for 48 hours at 70 degrees Celsius (DW). The RWC was examined using the following equation:

$$RWC\ (\%) = (FW - DW)/(TW - DW) \times 100\ldots \quad (2)$$

2.6 Statistical Analysis

Utilizing the statistical program Minitab 17.0, a one-way ANOVA was performed on the data gathered for each parameter (Minitab Inc., State College, PA, USA). Pair-wise comparisons revealed statistical differences between the means of various treatments (P 0.05).

3. RESULTS

3.1 Effect of Priming on Germination and Seedling Growth of Bitter Gourd

3.1.1 Germination percentage

The effects of SA priming and GA_3 priming on germination of bitter gourd seedlings are presented in Table 2. Seed priming with SA and GA_3 increased germination percentage considerably. Priming with 3 and 6mM SA showed 100% germination and with 9mM 87.51%. Also priming with 1 and 2mM SA showed 100% germination and with 3mM 87.5%. All the concentrations showed increased germination percentage compared with control which only accounted for 62.33%. Germination percentage improved between 40-60% with both priming agents compared with control.

3.1.2 Seedling growth and vigour index

To evaluate the consequences of SA and GA_3 priming on the growth of bitter gourd seedlings and to find out the effect of these agents on seedling vigor, the shoot and root length was monitored (Table 2).

Priming concentrations had both positive and negative effects on shoot and root length of bitter gourd seedlings. The priming with 1 mM GA_3 showed the highest shoot length and the shoot length was recorded as 24.3cm. Again, priming with 2 and 3mM GA_3 increased the shoot length significantly by 40% and 7%, respectively, in comparison with control plants. Moreover, seed priming with 3 and 6 mM SA enhanced shoot length by 14% and 13% but priming concentration 9mM SA decreased shoot length by 17% compared to control. Likewise, root length showed significant variation with different priming treatments. Priming with 6 mM SA had the highest root length which accounted for 16.35cm and priming with 3 mM SA had the second highest root length which was 15.5cm. All other treatments had decreased value compared with control. Priming with every agent, significantly increased SVI both for SA and GA_3 primed conditions compared with control. Among the treatments, the highest SVI was recorded for priming with 1mM GA_3 and the lowest result was found for 9 mM SA.

3.1.3 Fresh and dry weight

A considerable variation in fresh and dry weight was observed as a result of priming of bitter gourd seeds (Fig. 1). The highest shoot and root fresh weight was observed with priming concentration of 6mM SA which was 2.45g and 0.49g, respectively. Priming with 3mM SA and 1 mM GA_3 increased shoot fresh weight by 18% and 8%, respectively where a decrease in fresh weight of shoot was observed for other treatment compared with control. Similarly priming with 3 and 6mM SA increased root fresh weight by 63% and 86%, and priming with 1mM GA_3 increased by 31% compared with control.

In case of dry weight the highest shoot and root weight was observed with priming concentration of 6mM SA, which was 0.29g and 0.13g, respectively. Priming with 3mM SA and 1 mM GA_3 increased dry weight of shoot by 22% and 9%, respectively where a decrease in shoot dry weight was observed for other treatment compared with control. Moreover root dry weight showed an similar pattern as of increase 84% and 5% with 3mM SA and 1 mM GA_3 priming compared with control. Other concentrations of priming decreased in root dry weight compared with control.

3.1.4 Relative water content (RWC)

A considerable variation of relative water content was observed as a result of priming seeds (Fig. 2). All the concentrations except 9mM SA relative water content increased between 2-11% whereas in 9mM SA RWC decreased by 0.9% compared to control. The highest RWC was observed in pretreatment with 1mM GA_3.

Table 2. Effect of concentrations of plant growth regulators i.e salicylic acid and gibberelic acid on germination and seedling properties of bitter gourd

Treatment	Germination Percentage (%)	Shoot Length (cm)	Root Length (cm)	Vigour Index
T1	62.33c	15.27e	13.44c	1789.48
T2	100a	17.5c	15.5b	3300c
T3	100a	17.3c	16.33a	3365.33c
T4	87.50b	12.57f	10.53f	2021.76e
T5	100a	24.3a	12.3d	4660a
T6	100a	21.44b	11.27e	4273.67b
T7	87.5b	16.4d	9.27g	2858.63d
Level of Significance	*	*	*	*

*In a column, values having similar letter(s) do not differ significantly at 5% level of probability by LSD0.05 test. * indicates significant at 5% level of significance*

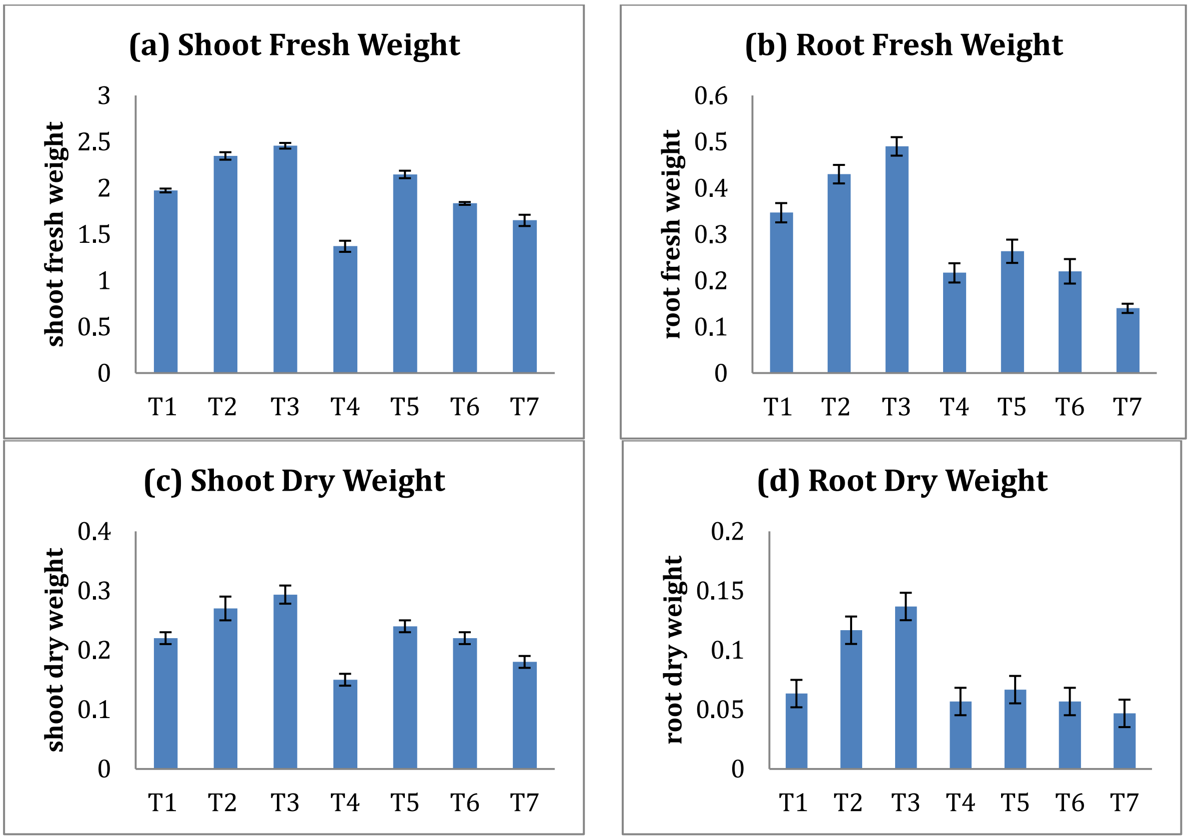

Fig. 1. Effect of concentrations of plant growth regulators i.e salicylic acid and gibberelic acid on (a) shoot fresh weigh (b) root fresh weight, (c) shoot dry weight, (d) root dry weight of bitter gourd. Vertical bars are SEM (n=3)

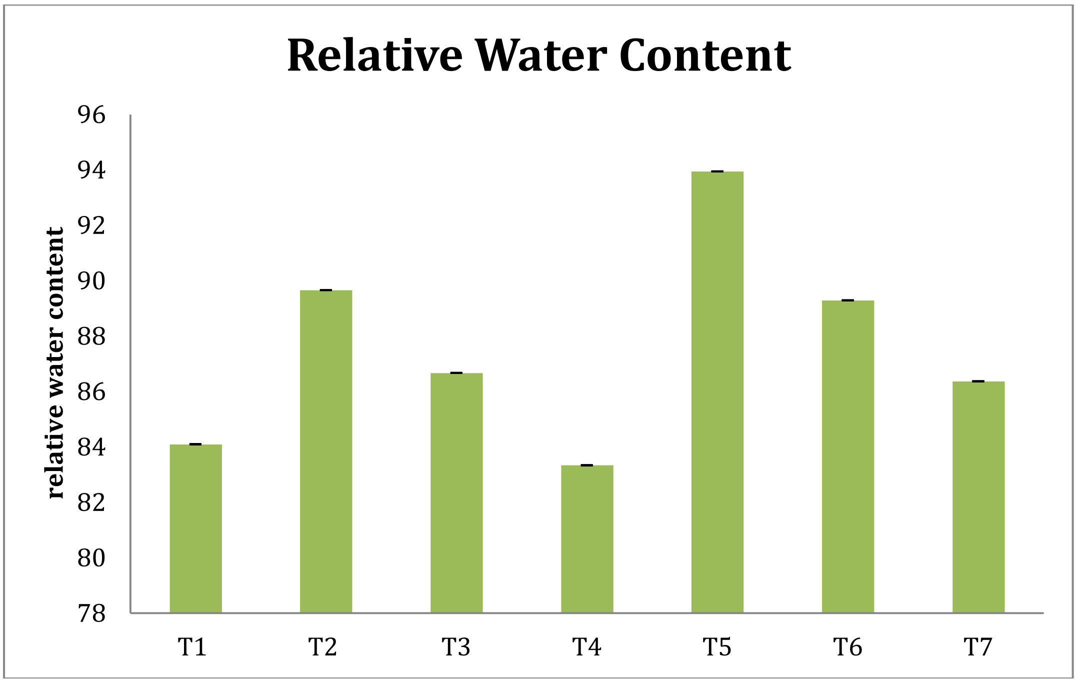

Fig. 2. Effect of concentrations of plant growth regulators i.e salicylic acid and gibberelic acid on relative water content of bitter gourd. Vertical bars are SEM (n=3)

4. DISCUSSION

The process of seed germination is the first and most critical stage in the growth of a plant because it helps seedlings adapt to their constantly changing environment and increase their production [4,24,25]. Due to this feature, several pre-treatment application procedures are frequently utilized to promote seedling germination and establishment. Because the bitter gourd's seed coat is so thick, it takes longer for the seed to soften before germination, which causes a delayed emergence [3]. By assisting the biological processes necessary for germination and weakening the seed coat before to sowing, phytohormone pre-sowing promotes early germination [26]. Early seed germination cause seedlings to grow quickly and become taller. According to the results of our study, 3mM, 6mM, and 1 mM SA and GA_3 increased germination %, seedling vigor, shoot and root length, fresh weight and dry weight of seedlings, and RWC which positively supports the above statements. On the other hand, bitter gourd germination and growth were negatively impacted by greater SA and GA_3 concentrations. These findings are in line with several studies that have demonstrated the effectiveness of low quantities of signaling molecules in promoting germination and growth [5,13,27-30]. Plants grown from primed seeds grow more quickly than those grown from unprimed plants, resulting in taller seedlings (Table 2). Similar to this, [31-33] reported that cucurbits had longer shoots when they were sown after priming than when they were not. The positive impact of priming on plant growth can be attributed to better root development and, as a result, an increased capacity for utilizing nutrients that permits a higher relative growth rate [14] and better plant water status regulation [13]. The direct impact of pretreatment on the regulation of the cell cycle and the mechanisms of cell elongation can also be the reason.

5. CONCLUSION

It has been determined that the seed priming concentration has a substantial positive and negative impact on the bitter gourd's quick germination and seedling growth. The germination percentage, shoot and root length, seedling vigor, and fresh and dry weight of the shoot and root all significantly increased with priming concentrations of 3mM SA, 6mM SA, and 1mM GA_3. So it stands to reason that these concentrations might be utilized to ensure consistency in boosting the production of bitter gourd. To confirm our findings, it is strongly advised to carry out the same experiment on field level.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded bythe producing company rather it was funded by personal efforts of the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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