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Effect of Seed Priming on Germination and Seedling Parameters of Cucumber (Cucumis sativus L.) in Lamjung, Nepal

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ABSTRACT

Poor seed germination obstructs the early and uniform seedling emergence at the sub-optimal conditions which can be a major setback to early spring cucumber growers. Different seed priming methods ought to be efficient solutions for the problem. To standardize the best priming method, an experiment was laid out in a Completely randomized design at the Horticulture lab of IAAS, Lamjung Campus. The treatment consisted of demineralized distilled water (hydropriming), hormonal priming (GA_3 100ppm and GA_3 200 ppm), halopriming (NaCl 0.5% and KNO_3 0.5%), and non-primed seeds as control. The seeds were soaked in the respective treatment for 24 hours and then dried to initial moisture content under shade conditions. Observation recorded significantly highest germination percentage in GA_3 100ppm (19.25%) and hydro priming (19.25%). The lowest mean germination time was found in GA_3 100ppm (4.19days) which was significantly at par with GA_3 200ppm (4.33days) and hydro priming (4.48days). The germination energy was found highest in GA_3 100ppm (39.58) followed by GA_3 200ppm (33.65) and dry weight was recorded highest in hydropriming (0.0252g) followed by GA_3 100ppm (0.0250g) whereas the highest root length was observed in KNO_3 priming (12.955cm) which is statistically at par with hydropriming (11.42cm), GA_3 200 ppm (10.872cm) and NaCl priming (10.42cm). The plumule length was observed highest in KNO_3 (13.00cm) followed by NaCl (11.25cm). All primed seeds showed increased seedling vigor compared to the unprimed seeds. The study showed that applied treatment notably increased the germination characteristics and seedling stand.

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Introduction

Seed priming is a pre-sowing treatment that can improve seed germination performance (Anwar et al., 2020) and abiotic stress tolerance (Piri et al., 2009; Dhakal and Subedi, 2020; Khan et al., 2020; Mahdy et al., 2020). Priming treatments widely used in different horticultural crops are hydropriming, osmopriming, halopriming, and solid matrix priming. hormonal priming and hydro priming in cucumber showed good results and a better plant stand.

Hydro priming is one of the most adopted and widely used practices in many fields and horticultural crops, however with regards to the present changing climatic scenario hydro priming may or may not be effective thus various priming methods are in practice (Thapa et al., 2020). Hormonal priming is one of the widely used practices in cucurbits and vegetables. Many authors reported a reduced germination time and high seed vigor index in hormonal priming with improved germination under stress (Passam and Kakouriotis, 1994; Dhakal and Subedi, 2020; Khan et al., 2020; Mahdy et al., 2020; Gnawali and Subedi, 2021). Here in this study, we aim to study the effect of different chemicals, hormones (GA_3), NaCl, and water such that to identify the most effective and economical method, such that could be easily adopted in the farmer's field.

Methodology

Description of the experimental site

The research was conducted in the laboratory of Agronomy IAAS, Lamjung Campus in September 2021. The experimental site is located in the mid-hill region and is one of the hotspot areas for growing vegetables.

Seed Materials

Seeds of cucumber (*Cucumis sativus* L.*)* of a variety of Bhaktapur local with a minimum 75% germination percentage and 98% genetic purity and 97% physical purity were used.

Sterilization

The germination chamber, Petri-plates, wash bottles, experimental trays, and all other required equipment were surface sterilized using formaldehyde solution and ethanol to avoid contamination.

Treatment Details

The experiment was laid out in Completely Randomized Block Design with altogether of six treatments (Table 1) and four replications. Each Petri plate was considered as a single treatment replicated four times; thus, the overall study was concentrated on a total of 24 Petri plates.

Table 1. Treatment details

Treatment	Priming agent
T1	Hydropriming (distilled water)
T2	GA3 100ppm
T3	GA3 200ppm
T4	KNO3 0.5%
T5	NaCl 0.5%
T6	Control

Preparation of Priming Solution

For GA3 priming, 1 gm of GA3 was taken in a test tube 3 mL of 70% ethyl alcohol was added to that test tube. And it was heated continuously by shaking it. The heated solution of the test tube was diluted in 1 L of water. In this way, 1000ppm of 1 L Stock solution was prepared. Finally, it was diluted to 100ppm and 200 ppm. For the preparation of NaCl 0.5% solution, 0.5g of NaCl is added to 100mL of water. Likewise, for KNO3 0.5% solution 0.5g of KNO3 is added to 100mL of water. Seeds were primed for 24 hours in priming solution.

Post Priming Operation

The primed seeds were removed and thoroughly rinsed with distilled water three times and were labeled and air-dried on blotting paper at room temperature for 24 hours.

Germination Medium

The filter paper was used as a substrate that covers the base of Petri-plates. Germination assays were performed by even distribution of seeds linearly in sterilized Petri-plates. And then was placed in the germinator maintaining its temperature at 24°C with relative humidity at 85% and daylight of 8 hrs.

Data Collection Parameter

Germination Percentage (GP)

Germination percentage is an estimate of the viability of a population of seeds. Seeds with a radical length of at least 2 mm were considered germinated. Observations on Petri-plates were done regularly at 12 hrs. interval and the total no. of seeds germinated were recorded. GP was calculated using the formula adopted by (Piri et al., 2009; Dhakal and Subedi, 2020; Gnawali and Subedi, 2021; Kj et al., 2022):

GP= (no. of seeds germinated /total no. of seeds used) ×100

Mean Germination Time (MGT)

MGT is an accurate measure of the time taken for a lot to germinate but does not correlate this well with the time spread or uniformity of germination. The lower the MGT, the faster a population of seeds has germinated (Orchard, 1977). MGT as adopted by (Dhakal and Subedi, 2020; Gnawali and Subedi, 2021) is:

MGT=Sum of Dn/Sum of n

Where

Dn =the no. of days counted from the beginning of germination

n = no of different seed lots.

Germination Energy (GE)

It is defined as the percentage of seeds germinated in 3 days i.e.,72hrs (Bam et al., 2006). Germination energy is the rapidity of germination and was measured by modifying the formula of (Yan Li, 2008).

GE = <u>No. of total germinated seeds in different priming solutions in 72 hrs</u>

Total no. of seeds used for germination

Measurement of radicle length (RL), plumule length (PL)

10 samples from each Petri-plates were selected randomly to measure the length of the overall seedling, root, and plumule length by using a measuring scale (in centimeters). Radical and plumule length was measured after one week of seed germination (Gnawali & Subedi, 2021).

Seedling vigor index (SVI)

Seedling vigor index (SVI) was calculated using the following formula as given by Abdul-Baki & Anderson, (1973) and adopted by (Dhakal and Subedi, 2020; Gnawali and Subedi, 2021)

Seedling Vigor Index (SVI) = Germination (%) × Mean seedling length (cm)

Dry weight of Seedling (DW)

After the measurement of root and shoot length, the seedlings from each dish were packed up in an envelope, labeled the envelope, and were allowed to oven-dry in a hot air oven at 90°C for 12hrs (Bhardwaj et al., 2012). After that, seedlings from each envelope were weighed and calculated as the dry weight of seedlings.

Statistical Analysis

Data tabulation and parameters were calculated in MS Excel whereas statistical analysis was done using R software (4.0.1) and the least significant digit (LSD) was used to separate means and compare treatment means at a 5% probability level.

Result and Discussion

Germination Percentage

Germination is a complex process in which a fully mature seed resumes growth and transitions from a maturation- to a programmed germination-driven development, with subsequent seedling growth followed by development (Rajjou et al., 2012; Finch-Savage, 2013). Primed seeds have completed germination stages I and II and are ready for germination under physiological and biochemical circumstances (Eisvand, 2008). Primed seeds germinate more quickly and in a more coordinated manner, and young seedlings are often more vigorous and resistant to abiotic stress than seedlings obtained from unprimed seeds (Benincasa et al., 2016).

Analysis of variance showed that there was a significant effect of priming treatments on germination % of cucumber seeds. The total germination percentage was found highest in GA_3 100ppm (91.75%) and Hydropriming (91.25%) which is significantly at par with GA3 200 ppm (87.50%) (Table 2). The control (66.25%) showed the lowest germination. The induction of higher seed germination in response to hydro and GA_3 priming could be attributable to changes in seed physiological and metabolic activities, as well as the stimulation of hydrolytic enzymes (AA et al., 2014). (2002) and (2009) reported that hydropriming treatment can be successfully applied to watermelon and cucumber seeds to improve germination performance, respectively. Primed seeds further exhibited tolerance to abiotic stress conditions (high temperature and water stress) as evident from higher germination compared to unprimed (Pandey et al., 2017).

Mean Germination Time

Mean germination time differed significantly due to different priming treatments. Analysis of the result showed that the lowest MGT has recorded in GA3 200 ppm (4.19 days) which was statistically at par with GA3 100 ppm (4.33 days) (Table 2). GA3 100 ppm was statistically at par with hydropriming (4.48 days). Control recorded the highest MGT (4.825 days). Reduced MGT as compared to control has been reported in hormonal priming by (Afzal et al., 2008) which is in line with our findings. Similarly, (2010) reported that priming with GA3 (200 ppm) boosted seedling vigor index, root and shoot length and seedling dry matter in bell pepper seeds.

Germination Energy

Analysis of the result showed that there was a significant effect of treatments at $P \leq 0.001$. A comparison of means showed that germination energy was found highest in GA_3 100ppm (39.58cm) statistically at par with GA_3 200ppm (33.65). GA_3 200ppm had statistical similarity with hydropriming (30.58) and NaCl (30.08) and control showed the lowest germination energy (19.33). hormonal Priming at low concentrations has higher germination energy as compared to control and hydro priming. (Mahdy et al., 2020) reported that hormonal priming at low and effective dosage had a significant impact on germination % and energy of seeds; however, it does not have a significant effect on the increment of leaves number.

Root and Plumule Length

Data about the root length of cucumber seeds revealed a significant effect of priming treatments over unprimed seeds. Analysis showed that KNO_3 had the highest root length (12.95cm) which is statistically at par with hydropriming (11.43cm), GA_3 200 ppm (10.87cm), and NaCl (10.42cm). The control showed the lowest root length (4.57cm) compared to primed seeds. Zhang et al. (2012) reported that NPK plays an important role in root architecture and growth of cucumbers which refers that the highest root length in our experiment in KNO_3 treated seed is due to absorption of potassium by plants.

Analysis showed priming had a significant effect on the plumule length. A comparison of means showed priming increases the plumule length of cucumber seeds as compared to control. The highest plumule length is observed in KNO_3 (13.00cm) followed by NaCl (11.250cm) and hydro priming (9.125cm). Hydropriming is statistically at par with GA_3 200 ppm (9.1cm) and GA_3 100ppm (8.905cm). Control (7.9cm) showed the lowest plumule length.

Seed Vigor Index

Analysis of variance showed that all the treatments were significant in increasing the seedling vigor index of cucumber. The result depicted the highest seedling vigor in KNO_3 0.5% (2040.682) which is statistically at par with hydropriming (1872.62), GA_3 200ppm (1773.062), NaCl 0.5% (1759.512) and GA3 100 ppm (1708.612) whereas control showed lowest seedling vigor (799.716). (Kumari et al., 2017) reported that different priming treatments had shown significant differences with the control and the vigor indices were observed in GA3 priming for 12 hours. GA_3 induces the seed vigor under optimum and drought stress environments and is mainly associated with better scavenging of reactive oxygen species (ROS) through the activation of antioxidant enzymes and more accumulation of proline (Khan et al., 2020).

Table 2. Effect of seed priming on germination and seedling parameters of cucumber seeds.

Treatments	G%	MGT (days)	RL (cm)	PL(cm)	SVI	GE	DW (g)
Hydropriming	91.25^{a}	4.485000^{bc}	11.4275^{ab}	9.125^{c}	1845.012^{a}	30.5800^{bc}	0.02525^{a}
GA3(100ppm)	91.25^{a}	4.195000^{d}	9.6150^{b}	8.905^{c}	1708.612^{b}	39.5800^{a}	0.02500^{a}
GA3(200ppm)	87.50^{ab}	4.335000^{cd}	10.8725^{ab}	9.100^{c}	1773.062^{ab}	33.6575^{ab}	0.02150^{a}
KNO_3 (0.5%)	82.50^{b}	4.481075^{bc}	12.9550^{a}	13.000^{a}	2040.862^{a}	26.3775^{c}	0.01725^{b}
NaCl (0.5%)	75.00^{c}	4.541825^{b}	10.4200^{ab}	11.250^{b}	1759.512^{ab}	30.0850^{bc}	0.01600^{bc}
Control	66.25^{d}	4.825000^{a}	4.56667^{c}	7.325^{d}	799.716^{c}	19.3350^{d}	0.01300^{bc}
Grand Mean	82.29167	4.47715	10.12611	9.78417	1654.46	29.93583	0.019666
SEM (±)	1.9461151	0.0695669	0.6573666	0.42467	91.11985	0.0362649	0.001079
CV, %	5.405888	2.618038	9.971111	10.4165	12.7917	14.36056	14.00199
LSD	6.608727	0.1741296	2.664529	1.5140	314.3986	6.386423	0.004090
F-Test	***	***	***	***	***	**	***

Means followed by the same letter(s) in a column are not statistically different at 5%level of significance ($P \leq 0.05$); SEM: Standard Error of Mean; CV: Coefficient of Variation; LSD: Least significant difference; ***: Significant at 0.001 level of significance; **: Significant at 0.01 level of significance

Dry Weight

The analysis of variance shows that the effect of seed priming on dry weight was significant. Data about the dry weight of cucumber seeds revealed a significant effect of priming treatments over unprimed seeds. The result showed the highest dry weight in Hydropriming (0.02525g), which is statistically at par with GA_3 100ppm (0.025g) and GA_3 200ppm (0.021g) (Table 2). The lowest dry weight is found in the control (0.013g) which is statistically at par with NaCl (0.016g). (Anwar et al., 2020) reported that dry weight was highest in 5%KNO_3 which contradicts our finding where hydropriming and GA_3 100ppm had the highest dry weight in cucumber.

Conclusion

Present study concludes that priming is found to be effective over control for various germination and seedling characteristics. Based on overall result obtained in the experiment, GA3 and hydropriming performed better than halopriming and control in increasing germination percentage and germination energy, reducing mean germination time and increasing dry weight. KNO3 0.5% was found more effective in increasing root and plumule length of cucumber but was statistically at par with GA3 and hydropriming in case of root length. Hence GA3 and hydropriming seems to be more effective among the used treatments.

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