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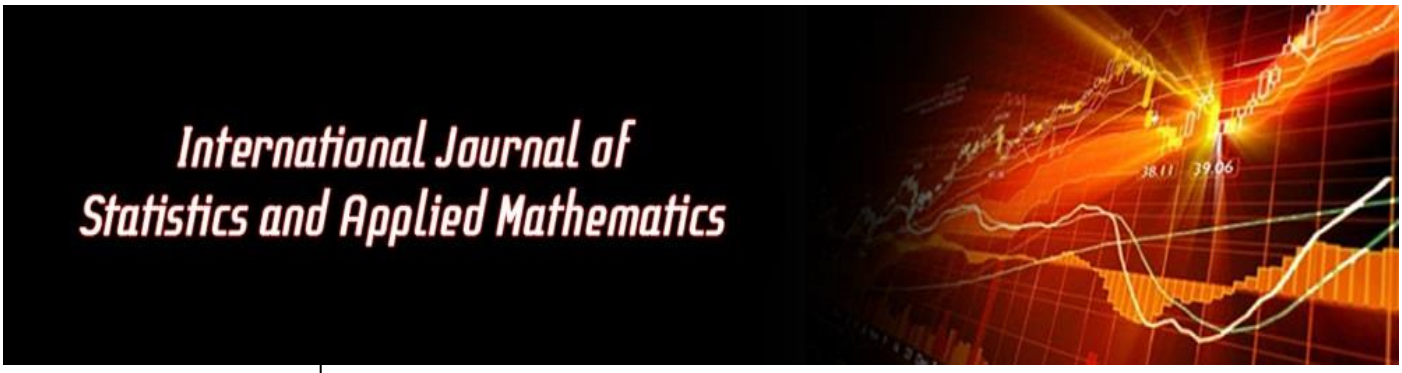

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Effect of seed priming on germination and Vigour in onion seeds

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Abstract
The priming may encourage a larger manifestation of the seeds' physiological potential and aid in their ability to germinate in unfavorable environmental conditions. The objective of this study was to evaluate different seed priming treatments which shows good germination with increased vigor. Seeds of two varieties namely Arka Kalyan and Bhima super were subjected to priming with three chemical agents at different concentration (Control: water (hydropriming); chelated micronutrient (2.5 and 5 g), calcium nitrate (2.5 and 5 g) and sulphate of potash 2.5 and 5 g) considering a completely randomized design in three replications. The results indicated seeds primed with sulphate and potash and calcium nitrate at different concentrations resulted in increased germination percentage, seedling length as well as seed vigour index than control. Therefore, seed priming with these chemicals can be effectively used to improve germination and viability in onion seeds.

Keywords: Seed priming, seed vigour, germination, onion

Introduction
A vital bulb crop grown all throughout the world is the onion (*Allium cepa* L.). India is foremost in terms of farmed area (1.31 million hectares), but comes in second place overall (22.42 million tonnes) behind China (FAO, 2017). However, onion seeds exhibit some poor attributes like inferior longevity and storability, which ultimately result in rapid loss of viability (Khan *et al*., 2004) [8]. Furthermore, low-quality seeds result in low and asynchronous germination and high numbers of abnormal seedlings under stress conditions in early spring planting (Borowski and Michalek, 2006) [3]. In the end, the quality of onion seed depends on a number of variables, including the environment in which the plant grows and the environment in which the seeds develop, the location of the seeds on the plant, the time of the harvest, the methods used to harvest the seeds, the storage conditions, and the treatment of the seeds prior to sowing. In the case of onions, where seed size is small, and seed establishment is poor, seed priming is the most promising method to improve seed establishment. Seed priming is a pre-sowing, controlled hydration treatment where physiological and biochemical activities are stimulated in the seed, but radicle protrusion is prevented (Khan, 1992) [7]. Priming is a process in which seeds are imbibed in either water or osmotic solution or a combination of solid matrix carrier and water in specific proportions followed by drying before radicle emergence. During storage, the viability and vigour of the seeds not only vary from genera to genera and variety to variety, but it is also regulated by many physicochemical factors namely moisture content, atmospheric relative humidity, temperature, initial seed quality, physical and chemical composition of seed, gaseous exchange, storage structure, packaging materials etc. (Doijode, 1988) [5].

The seed industry and farming community will greatly benefit from knowing how seeds can be stored effectively using chemicals and inert materials at a cheap cost under ambient storage and refrigeration conditions, with the least amount of quantitative and qualitative loss. Since it is intended to function well in any environmental situation, seed quality plays a significant role in achieving higher returns. The seed industry and farming community will greatly benefit from knowing how seeds can be stored effectively using chemicals and inert materials at a cheap cost under ambient storage and refrigeration conditions, with the least amount of quantitative and qualitative loss.

Since it is intended to function well in any environmental situation, seed quality plays a significant role in achieving higher returns. Keeping in view the above facts, the present study was conducted with the objective of determining the most appropriate seed priming treatment that results in good seed germination and exhibits good vigour.

Materials and Methods

Experimental layout

Experiment was conducted at laboratory of Seed Science and Technology, College of Horticulture, Bagalkot, India during may 2022. The freshly harvested seed of two onion cultivars *viz*., Arka Kalyan and Bhima Super were brought to the laboratory and stored in cloth bags under room temperature conditions (27±1 °C, relative humidity (RH) 54±3%) with seed moisture 7-8%. The seeds were stored in ambient conditions in the laboratory of Seed Science and Technology, College of Horticulture, Bagalkot, India. These varieties were selected based on their extensive cultivation and popularity among local farmers.

Treatments

Six seed priming treatments were compared with untreated control. The treatments are detailed below:

T_1	Hydration with chelated micronutrient (2.5 g)	0.6 gm of chelated micronutrient was dissolved in 250 ml of water
T_2	Hydration with chelated micronutrient (5 g)	1.2 gm of chelated micronutrient was dissolved in 250 ml of water
T_3	Hydration with calcium nitrate (2.5 g)	0.6 gm of calcium nitrate was dissolved in 250 ml of water
T_4	Hydration with calcium nitrate (5 g)	1.2 gm of calcium nitrate was dissolved in 250 ml of water
T_5	Hydration with sulphate of potash (2.5 g)	0.6 gm of sulphate of potash was dissolved in 250 ml of water
T_6	Hydration with sulphate of potash (5 g)	1.2 gm of sulphate of potash was dissolved in 250 ml of water
T_7	Control	Seeds were soaked in water

The seed of each lot was soaked in a sufficient amount of solution for 16 h in each treatment. Then the seed was dried in the shade to attain the initial seed weight to maintain original or near to safe moisture content.

Observations

Germination and seed vigour determination

Seeds were placed in Petri plates for germination at 20–22 °C and 90–2 percent RH (100 sterilised seeds per Petri plate in three replicates) in a germination chamber to perform germination tests as per the protocol outlined by International guidelines for seed testing (ISTA, 2015). At radicle growth of 2 mm or higher, germination (percent) was measured, and counting of normal and aberrant seedlings began on the eighth day. After the germination test, seedling length, root length, shoot length and seed vigour index were measured after 12 days and calculated as per the standard procedure. Seedling length (cm) was measured from 10 randomly selected healthy seedlings in each petri plate at the time of final count of germination. Seedling vigour was calculated by formula suggested by Abdul Bakshi and Anderson (1973) [1].

Vigour index = Germination (%) * Seedling length

Statistical analysis: The statistical analysis was carried out for each observed character under the study using MS-Excel and SPSS Statistics 20.

Experimental results and discussion

Of variety Arka kalyan

Among the different seed priming treatments studied, hydration with sulphate of potash at 5 gm showed the higher germination % (99.33) than control followed by hydration with chelated micronutrient 5 gm (98%). With respect to seedling length and shoot length, highest length was reported in the seeds primed with sulphate of potash 2.5 gm than control whereas root length was highest in primed seed with calcium nitrate 5 gm followed by primed seed with sulphate of potash 2.5 gm. Priming of seeds with various treatments was found competent to improve the quality of seeds. Seed vigour index was reported highest in sulphate of potash primed seeds followed by seeds primed with calcium nitrate when compared to control. Increased germination percentage and seedling length in sulphate of potash primed seeds may be due to increased potassium content inside the seeds that leads to better establishment of seedling. Similar results were obtained in a study by Chauhan *et al*. (2016) [4] in sorghum and the priming of tomato seeds with KNO3 solution was efficient to improve the seedling growth under salinity conditions (Ebrahimi *et al*., 2014) [6]. Similarly, Batista *et al*. (2015) [2] reported that the priming with KNO3 resulted in greater growth of pepper (*C. frutescens*) seedlings. However, the priming of cucumber seeds with potassium nitrate showed little effect in improving the germination and growth rate of seedlings under salt stress conditions (Oliveira & Steiner, 2017) [9]. The obtained results indicate that the seed priming with sulphate of potash and calcium nitrate solution was capable of promoting greater expression of pre-existing seed vigour, resulting in a higher germination rate. Increased germination and vigour in calcium nitrated primed seeds is due to the fact that nitrate stimulates the pentose phosphate pathway connected with the glycolytic pathway, responsible by the supply of free energy in the form of ATP and carbon skeleton that are used to the embryonic axis growth. In this case, the priming with the calcium nitrate favoured radicle emission and promoted a higher germination percentage.

Of variety Bhima super

Among different priming treatments, seeds primed with calcium nitrate 2.5 gm showed highest germination percentage in this variety followed by sulphate of potash primed seeds when compared with the control. Overall seedling length was highest in calcium nitrate 5g primed seeds even though maximum shoot and root length was observed in chelated micronutrient (2.5 gm) and sulphate of potash (2.5 gm) primed seeds respectively. Increased germination percent and seedling length in calcium nitrate primed seeds may be due to the fact that nitrate undergoes reduction and changes to the nitrite form, causing the reoxidation of NADPH, later making NADP available, which will act by stimulating the pentose phosphate pathway and, consequently, the shikimic acid pathway through the erythrose-4-phosphate. These two pathways are essential for the biosynthesis of new compounds (Silva *et al*., 2021) [11]. Similar results were obtained by Silva *et al*. (2021) [11] in pepper whose germination and growth of seedlings were enhanced by application of calcium nitrate. Another study which supports he result is by Salles *et al*., 2019 who concluded that the priming of eggplant seeds with calcium nitrate solution and antioxidant L-phenylalanine either alone or in combination promotes greater expression of the physiological potential of the seeds, resulting in greater germination rate.

Table 1: Germination percentage, shoot length, root length, seedling length and seed vigour index of variety Arka Kalyan

Treatment	Germination %	Shoot length (cm)	Root length (cm)	Seedling length (cm)	Seed Vigour index
T_1	96.33	6.00	6.06	12.08	1163.83
T_2	98.00	5.43	6.00	10.65	1044.13
T_3	93.66	6.01	5.16	10.65	997.51
T_4	96.00	5.58	6.55	12.15	1168.15
T_5	97.00	6.66	6.40	13.40	1299.48
T_6	99.33	5.88	6.18	11.86	1178.33
T_7	96.33	4.73	4.66	9.41	906.83
CD @ 5%	2.90	0.77	0.86	1.15	121.70
CD @1%	4.03	1.06	1.20	1.60	168.91

Table 2: Germination percentage, shoot length, root length, seedling length and seed vigour index of variety Bhima Super

Treatment	Germination (%)	Shoot length (cm)	Root length (cm)	Seedling length (cm)	Seed Vigour index
T_1	89.00	6.67	6.23	13.28	1187.31
T_2	92.00	5.75	5.65	11.25	1034.33
T_3	94.33	6.43	5.83	12.43	1172.53
T_4	91.00	5.35	6.40	12.65	1151.95
T_5	93.33	6.25	6.63	12.18	1136.46
T_6	93.66	6.33	5.70	12.03	1127.10
T_7	86.00	4.45	4.75	8.78	755.58
CD @ 5%	3.26	0.83	0.58	1.07	106.99
CD @1%	4.53	1.15	0.81	1.48	148.50

Conclusion

This study has shown that primed onion seeds had higher germination performance as indicated by the percentage of germination. Out of all priming treatments, seed priming with sulphate of potash and calcium nitrate were found to be beneficial in enhancing germination, seedling length as well as having good vigour index in both the varieties when compared with control. However other treatments also exhibited better result compared to control seeds. From this study it may be concluded that seed priming with potassium and calcium sources can enhance the seedling establishment and vigour of onion genotypes.

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