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Benefits of seed priming in different vegetables

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Abstract
Priming of seed is said to be one of the controlled methods of seed filling to the extent that it allows pre-germinative metabolism for seed to function, but interferes with the emergence of radicles. Seed germination is a beautiful and complex process and there are many different ways of planting seeds, which are caused by different aspects of plant seeds. Priming improves seed quality may be performance or seed characteristics. Selected planting methods should be affordable and suitable for seeds in its flexibility. Seed formation improves the uniformity of seed performance. Major psychological and biological changes in primed seeds are seed water content, cell cycle control, seed modification of control of large oxidative stress structure and spatial integration. Seed planting plays an important role in agriculture. It promotes growth and controls plant stress. The different methods of planting seeds are: - Halo-Priming, Hydro-Priming, Osmo-Priming, GA3 Priming. This review paper focuses on different seed germination techniques / methods and their use in field plants to improve plant growth.

Keywords: Seed priming, vegetable crops, priming techniques

1. Introduction

Vegetable plants are important for human nutrition and their demand is increasing everywhere. Rapid germination and seedling growth are required to produce a good harvest. With outstanding crop production, reliable and high quality crop production is recognized by scientists and farmers as major challenges (Chivasa *et al*., 1998 and Murungu *et al*., 2004) [6, 23]. Many techniques can be used to increase yields, a simple and acceptable way to compare seed germination, increase germination and establish a seed is seed priming (K.Ghassemi-Golezani *et al*., 2012) [15].

Heydecker began proposing seed formation in 1973. It is done before sowing the seeds, where the seeds are watered in sufficient quantities to make metabolic events before germination take place, although high-occurrence events will be prevented (Nascimento *et al*., 2004). It has produced wonderful and wonderful results with the seeds of many plants (Bradford, 1986) [3].

A major factor affecting seed aging during seed storage is temperature. Factors including light, wind, temperature, time and normal seed are controlled by the onset of seed. It has a dramatic impact on agriculture. Controlling water content in seeds is permitted in three ways such as immersing the seed in water or solute or by exposing it to water vapor. It activates physiological processes in seeds that increase germination by soaking seeds in water. seeds to some degree. These processes are set correctly at the right stage and the seeds are carefully dehydrated. Thus, the seeds in the field are left in the same condition to grow evenly after planting. Priming is a beautiful and complex process and there are various ways to get started. This is due to the different signs and characteristics of each type of seed and the many situations in which plants are planted with their specific problems. There is no standard solution. A guided approach is required in each plant challenge. Seed priming has worked for a high yield and high yield on crops. Growth controls can be added to the initial solution to promote processes.

For expensive and hybrid vegetable seeds, it is important that this germination process occurs quickly. It tolerates the harsh growth of the state and produces normal seedlings. Seed intensity is shown as the first factor that controlled seed quality and attracted researchers because of its high industrial and economic implications. The best methods for better measurement and plant balance are seed maturity. (Pandey *et al*., 2017) [26].

Increased germination rate and emergence in soil where there is little moisture, soaking the seeds in water overnight before sowing should be acceptable (Clark *et al*., 2001) [7]. Priming causes seeds to germinate and germinate even under harsh agricultural conditions such as cold and humid or humid temperatures. It will bring an early period of flowering and harvesting and promote stress-producing plants (Harris *et al*., 1999). It stimulates plants to open their immune responses very quickly and has the potential to emerge as a strategic tool for modern plant protection methods. It is often used to reduce the time between sowing and emergence of seedlings and to adapt to emergence (Parera and Cantliffe, 1994) [27]. In addition, it increases the seed strength of low-energy grains. Injuries to imbibitions are also prevented by seed treatment using the first techniques shown to improve plant science. It can also increase germination rate by promoting DNA repair techniques and stimulating pre-emergence metabolism. Primed seeds significantly improved the percentage of germination, root length and seed strength (Moosavi *et al*., 2009) [22].

Priming requires a certain temperature and time, if not followed, seed can deteriorate due to the release of the embryo. There should be continuous air in the seed solution, otherwise the seeds will suffer the negative effects of anaerobic aeration. If priming is done for a long time, proper precaution against microbial attacks should be taken. Uncontrolled seed absorption of water is often detrimental to hydropriming. As a result of subsequent dry storage, primed seeds tend to decay and lead to the loss of beneficial ripening effects (Schwember and Bradford, 2005) [37]. Reduced seed retention time, chemical toxicity and difficulty in handling large numbers of seeds are serious disadvantages to seed growth.

Types of seed priming

1) Hydro – priming

Hydro-priming is a method in which the seeds are soaked in hot or cold water for a period of time (7-14 hours) before sowing in a large field or other growing area or nutrients. This allows the seed to absorb water and eventually soften the seed coat enough to allow seed germs to emerge easily and quickly. Germination begins, but no radicles emerge. Apply the seeds to the priming solution and let it dry. This allows the seeds to quickly reach higher water levels through regular oxygen supply, which increases the levels of metabolites (intermediate metabolites) involved in germination and the enzymes involved in producing energy for germination. Here, the seeds should be weighed and taped twice the amount of seed should be kept at room temperature (25 + 2 °C) in a container, depending on the treatment. After processing, and after extracting excess / excess water, the seeds are weighed again to determine the percentage of water absorption. The following formula is used:

$$\text{Water imbibition \%} = \frac{\text{Weight of seed after priming} - \text{Weight of seed before priming}}{\text{Weight of seed before priming}} \times 100\%$$

The soaked seeds will be dried in the bottom of the hut for about 45 hours before sowing in the pre-prepared main field. Seeds are sown in each treatment area at the recommended times of the selected crop. The germination rate is then calculated using the following formula, based on daily observation of static seeds:

$$(\text{Germination \%} = \frac{\text{Number of germinated seeds}}{\text{Number of the total seed}} \times 100\%)$$

Hydro-priming is one of the most satisfying, environmentally friendly, cheap and easily accessible methods used to break down seed germination and promote seed germination. Increases germination speed and consistency. It also improves the storage of plants in the garden. The germination period is short and it grows vigorously. Improves the germination process and emergence of seedlings in a salty and saline environment.

The drawback of this special process is the unlimited water absorption of seeds. This is a result of the availability of excess / unused water during seed hydropriming. The rate at which water is absorbed depends on the interaction of the seed tissue in the water. In addition, this process leads to uneven fluid infiltration, which leads to a lack of simultaneous metabolic activity within the seed, followed by an unbalanced appearance.

2) Halo priming

Halo priming is a method of immersing seeds in an inorganic salt solution such as NaCl (sodium chloride), KNO3 (potassium nitrate), CaCl2 (calcium chloride), CaSO4 (calcium sulfate). Here the seeds are seasoned with various salts. A solution that supports the germination process, which promotes the emergence of seeds and seedlings even under adverse environmental conditions is used. Seeds are treated with a tolerable NaCl solution. A lot of research has been done and the following conclusions have been reached on halopriming regeneration, which includes significant improvements in seed germination, seedling emergence and establishment and eliminating crop yields in saline soils in retaliation for halo-priming. Seed preparation using NaCl (sodium chloride) and KCl (potassium chloride) was very helpful in eliminating the harmful effects of salt. Halopriming is an inexpensive and simplified farming method and is therefore recommended to farmers as it leads to better compatibility of seedling germination and canopy of plants under different environmental conditions. Halopriming with sodium chloride solution has been previously described to improve milk thistle germination and seedling colonization (Sedghi *et al*. 2010) [38], and melon plants performed better under salt (Sivritepe *et al*. 2003, 2005) [42, 43]. In sugarcane, NaCl halopriming has been found to be a productive pre-germination practice to overcome the harmful effects of salt and drought (Patadeetal 2009). Farhoudi and Sharifzadeh (2006) [12] explain that using rapeseed, salt salts promote seed germination, seedling emergence, and further growth under natural saltwater conditions. In mung beans, early seed treatment with a low dose of sodium chloride reduces the adverse effects of NaCl stress (Saha *et al*. 2010) [34].

3) Osmo-priming

Osmotic priming, also known as osmo-priming or osmo-conditioning, involves the immersion of the seeds in shallow water in an osmotic solution instead of pure water. Due to the low water content of the osmotic solution, water slowly seeps into the seeds, allowing the subtle absorption of water and promoting seed growth, but not prominent radicals. The osmotic priming process involves a wide range of chemicals, including inorganic salts such as NaCl (Sodium chloride), KCl (potassium chloride), KNO3 (Potassium Nitrate), K3PO4 (Tripotassium phosphate), KH2PO4 (Potassium dihydrogen phosphate), and CaCl2 (Calcium chloride). The most common chemical used in the treatment of osmotic priming is PEG, mainly due to its specific properties. The large size of the PEG molecule limits its penetration into the seed, avoiding the introduction of potentially cytotoxic effects and decreased seed penetration capacity. However, PEG also has other drawbacks, such as high viscosity which limits the rate at which oxygen is dispersed in the solution. Therefore, the ventilation system is widely used in the implementation of PEG. Seed treatment with PEG has provided an effective means of better seed germination, seed germination, and better tolerance for a variety of plants under stressful conditions.

4) Hormonal priming

Hormonal seed priming is a process that involves sowing in advance with various hormones to improve plant growth and development. During the preparation of hormones, seeds absorb plant growth controls, ultimately having a direct effect on seed metabolism. Abscisic acid, auxin, gibberellin, kinetin, ethylene, polyamines and salicylic acid (SA), gibberellic acid (GA3) are some of the most commonly used priming agents. This helps the seeds to germinate and come out better as inorganic salts improve germination and the limits of purified seed growth. KNO3 increases yield, fruit size and improves the quality of garden and vegetable crops. Seed preparation with gibberellic acid improves soybean germination and emergence. Cytokinins are also used as priming agents and are mainly involved in breaking down seed dormancy in a few seeds.

5) Solid Matrix priming

Solid matrix priming (SMP), also known as matrix-conditioning, is a seed-based control of water absorption and is a different method than osmotic priming. Solid Matrix Priming (SMP) is used to improve the biological control of Trichoderma by controlling seed water content. First time posted by Eastin, Kamterter, Inc. (Lincoln, NE). This allows for proper colonization of the seed area before sowing the seeds with the correct pH and matrix material. This is a process of mixing informed seed with organic carrier to bring the water content of the mixture to a slightly lower level than is required for seed germination. When a solid matrix is prepared, the seeds are mixed and placed in a solid water carrier for some time. The seeds are then removed from the matrix solution, thoroughly washed and dried again. Strong media allows seeds to absorb water at a slower rate, mimicking the natural absorption process that takes place in the soil. To complete an SMP without obstruction, the materials used, such as the matrix, are less likely to have a matrix, have very low water solubility, have high water retention and surface, are not seed toxic, and adhere. on the surface of the seed. In fact, commercial substrates such as vermiculite, peat moss, coal, sand, clay, and Celie and microcell are examples of solid support used in SMP. It grows over the seed during the initial process, increasing the potential for the seed to be treated and increases the number of dispersions. SMP is a simpler and less expensive method of seed preparation compared to osmo-priming.

6) Bio-priming

Biopriming is a biological seed treatment process that involves the combination of seed hydration which is essentially a part of the body's immune system, as well as the injection that is part of the biological control of seed seeds with a beneficial body to protect the seed. Biopriming mainly involves injecting seeds with germs.

Hydration of Seeds + Bio agents = Biopriming of seeds

This method of planting helps to increase the rate of germination and germination, and has other additional effects such as protecting the seeds in the soil and the germs found in the seeds. Infected seeds when immersed during germination can eventually grow vigorously and may have a negative impact on plant health. Using antagonistic microorganisms during maturation is an effective, eco-friendly way to solve this problem. Some of the existing bacteria are used as bio-control agents and are able to integrate the rhizosphere and help plant after the germination phase in a direct and indirect way. Bio-priming proved to be the most effective way to deal with disease control compared to other techniques such as covering and covering the film. Some of the benefits include improved growth percentage, speed and uniformity of germination. It also describes the resistance of plants to water and heat stress. Extend the shelf life of seeds. It is best suited for small seeds, which leads to increased yields.

Table 1: List of the different types of seed priming in vegetables

SI. no.	Crops	Types of priming	Advantages	References
01	Okra	Hydro priming	Rapid germination, improved seed growth and uniform stand establishment.	Yadav, *et al*., 2011.
		Hydro priming	Greatest mean stem length and diameter.	Sharma, *et al*., 2014 [39].
02	Onion	Hydro priming	Shortening the average germination duration.	Nascimento, *et al*., 2003 [23].
		Halo priming (NaCl)	Enhance onion percentage and time of seedling emergence	Tajbakhsh, *et al*., 2004 [45].
03	Tomato	Primed with GA3(Halo priming)	Improved seed Vigor as well as viability	Farooq, *et al*., 2005 [13].
		Hydro priming	Uniform seedling growth	Maiti, *et al*., 2009 [21].
		Hormonal-priming	Increased germination by 30.56%.	Soubhagyabehera, 2016
	Cherry tomato	KNO3	Increase in antioxidants system ability, yield quality, enhance tolerance to high osmotic tolerance during seed germination.	Dahal, *et al*., 1990 [9].
04	Brinjal	Osmo-priming	Increase the number of leaves, plant height, fruit yield, fruit length and days of 50% flowering also minimize	Satishkumar, *et al*., 2005 [36].
05	Capsicum	Osmo-priming and Solid-matrix priming	Improves seed germination over non–primed seeds also reduce mean days to germinate	Pandita *et al*., 2007
06	Chili	Osmo-priming (KNO3)	Reduce soil and seed borne pathogens. Uniform seed germination.	Lanteri, *et al*., 2009 [20].
07	Cow pea	Osmo-priming	Maintenance of tissue water content, increase in antioxidant activities and carbohydrate metabolism, increased the number and biomass of plant knots.	Singh, *et al*., 2014 [40].
08	Bean	Hydro-priming	Improve plant performance	Ghassemi-Golezani *et al*.,

				2010 [14].
09	Cabbage	Halo-priming (KH2PO4)	Remarkable improvement in seedling size	Jagadesh *et al.*, 1994
10	Coriander	Halo-priming	Increase germination, enhance plant and leaf area	Hamidi *et al.*, 2013
11	Cucumber	Hydro priming (CaCl2)	Changes in physiological- total seedling, dry weight, seedling vigor index. Biochemical parameters – total soluble sugars and proteins, dehydrogenase activity, amylase activity isoenzyme, protein profile.	Pandey, *et al*., 2017 [26].
12	Bitter gourd	Hydro-priming	Improves plant performance and helps in maintaining tissue water content	Rishabh, *et al*., 2017 [33].
13	Watermelon	Hydro-priming	Improves germination and initial growth of seedlings	Singh *et al.* 2001 [41].
14	Pumpkin	Hydro-priming	Improve metabolism activities along with biochemical parameters	Pritima, *et al*., 2017.
15	Sponge gourd	Hormonal-priming (GA3)	Significant increase in shoot length	Pill and Kilian, 2000
16	Radish	Osmo-priming (KNO3)	Increase in seed quality parameters	Alverado and Bradford, 1988
17	Carrot	Osmo-priming (PEG)	Increase in germination	Peluzio *et al.*, 1999 [30].
18	Beetroot	Halo-priming	Improved yield, accelerated germination	Durant *et al.*,1974
19	Lettuce	Osmo-priming (PEG)	Improved germination, improved field emergence	Cantliffe *et al.*, 1981 [4].
20	Asparagus	MgSO4, NaCl, KNO3	Speed of seedlings growth, germination rate increases.	Bittencourt, *et al*., 2004 [2].
21	Spinach	Halo priming with ZnSO4.7H2O	Improved function against the biotic and abiotic factors, early seedlings growth.	Chen, *et al*., 2011 [5].

Conclusion

Seed priming is the best option for boosting the crop performance under fragile ecosystems. It enhances the metabolic events taking place throughout the priming intervention and the subsequent germination is felicitated. It is an inexpensive technology for maximizing the seed performance i.e., in the germination processes, though it is viable to be fragile. It is desirable to restore or highlight the advantages of seed priming irrespective tot eh harsh environment and sustainable production of degraded land.

Further through this paper we have come to notice that the Halo-priming is more effective and gaining importance due to the controlled release and site directed to nutrients. It can also be concluded that NaCl could easily stimulate the effect related to the toxic effect as a result of salt stress in the seeds. Overall NaCl was more effective type of seed priming as compared to the above-mentioned priming types.

References

1. Adhikari B, Dhital PR, Ranabhat S, Poudel H. Effect of seed hydro-priming durations on germination and seedling growth of bitter gourd (*Momordica charantia*). PloS one. 2021;16(8):e0255258.
2. Bittencourt MLC, Dias DCFS, Dias LAS, Araujo EF. Effects of priming on asparagus seed germination and vigour under water and temperature stress. Seed Science and Technology. 2004;32(2):607-616.
3. Bradford KJ. Manipulation of seed water relations via osmotic priming to improve germination under stress. Hort Science. 1986;21(5):1105-1112.
4. Cantliffe DJ, Shuler KD, Guedes AC. Overcoming seed thermodromancy in a heat sensitive romaine lettuce by seed priming. Hort Science, 1981.
5. Chen K, Arora R. Dynamics of the antioxidant system during seed osmopriming, post-priming germination, and seedling establishment in Spinach (*Spinacia oleracea*). Plant Science. 2011;180(2):212-220.
6. Chivasa W, Harris D, Chiduza C, Nyamudeza P, Mashingaidze AB. Agronomic practices, major crops and farmers’ perceptions of the importance of good stand establishment in Musikavanhu Communal Area, Zimbabwe, 1998.
7. Clark LJ, Whalley WR, Ellis-Jones J, Dent K, Rowse HR, Finch-Savage WE, *et al.* On-farm seed priming in maize: A physiological evaluation. In Seventh eastern and southern Africa regional maize conference, 2001, 268-273.
8. Cumagun CJR. Advances in formulation of Trichoderma for biocontrol. In Biotechnology and Biology of Trichoderma. Elsevier, 2014, 527-531.
9. Dahal P, Bradford KJ, Jones RA. Effects of priming and endosperm integrity on seed germination rates of tomato genotypes. I. Germination at suboptimal temperatures. Journal of Experimental Botany. 1990;41:1431-1439.
10. Dalil B. Response of medicinal plants to seed priming: a review. International Journal of Plant, Animal and Environmental Sciences. 2014;4(2):741-745.
11. Durrant MJ, Payne PA, Mclaren JS. The use of water and some inorganic salt solutions to advance sugar beet seed. I. Laboratory studies. Annals of Applied Biology. 1983;103(3):507-515.
12. Farhoudi R, Sharifzadeh F. The effects of NaCl priming on salt tolerance in canola (*Brassica napus* L.) seedlings grown under saline conditions. Indian Journal of crop science. 2006;1(1and2):74-78.
13. Farooq MSMA, Basra SMA, Saleem BA, Nafees M, Chishti SA. Enhancement of tomato seed germination and seedling vigor by osmopriming. Pakistan Journal of Agricultural Sciences. 2005;42:3-4.
14. Ghassemi-Golezani K, Chadordooz-Jeddi A, Nasrullahzadeh S, Moghaddam M. Influence of hydro-priming duration on field performance of pinto bean (*Phaseolus vulgaris* L.) cultivars. African Journal of Agricultural Research. 2010;5(9):893-897.
15. Ghassemi-Golezani K, Hosseinzadeh-Mahootchy A, Zehtab-Salmasi S, Tourchi M. Improving field performance of aged chickpea seeds by hydro-priming under water stress. Int. J Plant Animal Environ. Sci. 2012;2:168-176.
16. Harris D, Pathan AK, Gothkar P, Joshi A, Chivasa W, Nyamudeza P. On-farm seed priming: using participatory methods to revive and refine a key technology. Agricultural systems. 2001;69(1-2):151-164.
17. Jagadish GV, Prasanna KPR, Ranganathaiah KG. Influence of storage conditions and containers on seed storability in onion (*Allium cepa* L.). Seed Tech. News. 1994;24:15.
18. Jisha KC, Puthur JT. Halopriming of seeds imparts tolerance to NaCl and PEG induced stress in *Vigna radiata* (L.) Wilczek varieties. Physiology and Molecular

Biology of Plants. 2014;20(3):303-312.
19. Khan HA, Ayub CM, Pervez MA, Bilal RM, Shahid MA, Ziaf K. Effect of seed priming with NaCl on salinity tolerance of hot pepper (*Capsicum annuum* L.) at seedling stage. Soil Environ. 2009;28(1):81-87.
20. Lanteri S, Portis E, Bergervoet HW, Groot SPC. Molecular markers for the priming of pepper seeds (*Capsicum annuum* L.). Journal of Horticultural Science and Biotechnology. 2000;75(5):607-611.
21. Maiti RK, Gupta A, Umasahankar P, Raj Kumar D, Vidyasagar P. Effect of priming on seedling vigour and growth and productivity of few vegetable species: Tomato, Chilli, Cucumber and Cabbage. International Journal of Environment, Agriculture and Biotechnology. 2009;2(4):368-374.
22. Moosavi A, Tavakkol Afshari R, Sharif-Zadeh F, Aynehband A. Effect of seed priming on germination characteristics, polyphenoloxidase, and peroxidase activities of four amaranth cultivars. J Food Agric. Environ. 2009;7(3-4):353-358.
23. Murungu ES, Chıduza C, Nyamugafata P, Clark LJ, Whalley WR. Effect of on farm seed prim-ing on emergence, growth and yield of cotton and Maize in a semi-arid area of Zimbabwe. Experimental Agriculture. 2004;40(1):23-36.
24. Nakkeeran S, Marimuthu T, Renukadevi P, Brindhadevi S, Jogaiah S. Exploring the biogeographical diversity of Trichoderma for plant health. In Biocontrol Agents and Secondary Metabolites. Woodhead Publishing, 2021, 537-571.
25. Nascimento WM. Muskmelon seed germination and seedling development in response to seed priming. Scientia Agricola. 2003;60:71-75.
26. Pandey P, Bhanuprakash K. Effect of seed priming on biochemical changes in fresh and aged seeds of cucumber. Journal of Agricultural Studies. 2017;5(3):62-74.
27. Parera CA, Cantliffe DJ. Presowing seed priming. Horticultural reviews. 1994;16(16):109-141.
28. Durrant MJ, Payne PA, Mclaren JS. The use of water and some inorganic salt solutions to advance sugar beet seed. I. Laboratory studies. Annals of Applied Biology. 1983;103(3):507-515.
29. Patade VY, Bhargava S, Suprasanna P. Halopriming imparts tolerance to salt and PEG induced drought stress in sugarcane. Agriculture, ecosystems & environment. 2009;134(1-2):24-28.
30. Peluzio LE, Silva R, Reis MS, Cecon PR, Dias D, Peluzio J. Efeito do condicionamento osmótico na embebição e na germinação de sementes de cenoura (*Daucus carota* L.). Revista Brasileira de Sementes. 1999;21(2):161-169.
31. Pill WG, Kilian EA. Germination and emergence of parsley in response to osmotic or matric seed priming and treatment with gibberellin. Hort Science. 2000;35(5):907-909.
32. Pratima Pandey, Bhanuprakash K, Umesh. Effect of Seed Priming on Seed Germination and Vigour in Fresh and Aged Seeds of pumpkin. International Journal of Environment, Agriculture and Biotechnology (IJEAB). 2017;2(4):2261-2264.
33. Saini, Rishabh, Prashant Kumar Rai, Bineeta M Bara, Purooshottam Sahu, Taqui Anjer, *et al*. Effect of different seed priming treatments and its duration on seedling characters of Bitter gourd (*Momordica charantia* L.). Journal of Pharmacognosy and Phytochemistry. 2017;6(5):848-850.
34. Saha P, Chatterjee P, Biswas AK. NaCl pretreatment alleviates salt stress by enhancement of antioxidant defense system and osmolyte accumulation in mungbean (*Vigna radiata* L. Wilczek), 2010.
35. Saini R, Rai PK, Bara BM, Sahu P, Anjer T, Kumar R. Effect of different seed priming treatments and its duration on seedling characters of Bitter gourd (*Momordica charantia* L.). Journal of Pharmacognosy and Phytochemistry. 2017;6(5):848-850.
36. Satishkumar L. Influence of presoaking seed treatment and seed pelleting on storability in brinjal (*Solanum melongena* L.). Indian Horticulture. 2005;32:78-82.
37. Schwember AR, Bradford KJ. Drying rates following priming affect temperature sensitivity of germination and longevity of lettuce seeds. Horticultural Science. 2005;40(3):778-781.
38. Sedghi M, Nemati A, Amanpour-Balaneji B, Gholipouri A. Influence of different priming materials on germination and seedling establishment of milk thistle (*Silybum marianum*) under salinity stress. World Applied Sciences Journal. 2010;11(5):604-609.
39. Sharma AD, Rathore SVS, Srinivasan K, Tyagi RK. Comparison of various seed priming methods for seed germination, seedling vigour and fruit yield in okra (*Abelmoschus esculentus* L. Moench). Scientia Horticulturae. 2014;165:75–81.
40. Singh A, Dahiru R, Musa M, Haliru BS. Effects of osmo-priming duration on germination, emergence and early growth of cowpea [*Vigna unguiculata* (L.) Walp.] in the Sudan savanna Nigeria. Int J Agron. 2014a;4ID841238:4.
41. Singh S, Singh P, Sanders DC, Wehner TC. Germination of watermelon seeds at low temperature. Report-Cucurbit Genetics Cooperative. 2001;24:59-64.
42. Sivritepe N, Sivritepe HO, Eris A. The effects of NaCl priming on salt tolerance in melon seedlings grown under saline conditions. Scientia Horticulturae. 2003;97(3-4):229-237.
43. Sivritepe HÖ, Sivritepe N, Eriş A, Turhan E. The effects of NaCl pre-treatments on salt tolerance of melons grown under long-term salinity. Scientia Horticulturae. 2005;106(4):568-581.
44. Soubhagya Behera. A study on the effect of hormonal priming (ga3) on seed quality parameters of solanaceous vegetables. International journal of agricultural science and research. 2016;6(3):337-348.
45. Tajbakhsh M, Brown PH, Gracie AJ, Spurr CJ, Donovan N, Clark RJ. Mitigation of stunted root abnormality in onion (*Allium cepa* L.) using seed priming treatments. Seed Science and Technology. 2004;32(3):683-692.
46. Yadav SK, Kumar D, Kumar V, Hussain Z, Sharma AD, Kumar A. Seed priming effects on diverse germplasm of okra [*Abelmoschus esculentus* (L.) Moench]. Vegetos. 2012;25(1):202-209.
47. Zulueta-Rodríguez R, Hernández-Montiel LG, Murillo-Amador B, Rueda-Puente EO, Capistrán LL, Troyo-Diéguez E, *et al*. Effect of hydropriming and biopriming on seed germination and growth of two Mexican fir tree species in danger of extinction Forests. 2015;6(9):3109-3122.