Response of Onion (Allium Cepa) Seeds to Different Osmopriming Agents During Germination and Plant Growth

Amal Nabih Al khatib

PhD. Researcher, Faculty of Agriculture, Department of horticulture, Jordan University of Science and Technology, Irbid, Jordan, alkhatib.amal@yahoo.com

Abstract

Osmopriming Giza 20 and Texas Grano onion (Allium cepa L.) seeds using different concentrations of polyethylene glycol 8000 (PEG), KNO3, NaCl solutions and water (hydropriming) were investigated in a laboratory experiment. The influence of osmopriming and hydropriming on germination % (GR), germination rate index (GRI), the effect of onion cultivar, seed treatment and their interaction were studied. Results showed that the germination percentages and germination rate indexes varied significantly among the two onion genotypes, the highest GR % was (91 %) for Texas Grano treated with PEG (-1Mpa) and the lowest (25 %) was for Geza 20 seeds treated with 0.6 M NaCl. The highest value for GRI was 71 for Texas Grano onion seeds treated with PEG (-1.0 Mpa) and the lowest value was 18.3 for Giza 20 onion seeds treated with 0.6 M NaCl. Results also showed that the germination percentage and the germination rate index were significantly influenced by cultivar, osmopriming treatment and their interaction.

Keywords: *Osmopriming, Onion Seed, Geza, Germination and Plant Growth, Allium Cepa.*

1. INTRODUCTION

In ordering to decrease onion importing to Jordan, we need to increase area of production. Onions are typically produced from bulbs or seeds, which may be seeded directly or transplanted. However, when growing onions on a commercial scale, it is preferable to utilize seedlings that have been grown in beds because little onion bulbs typically provide lesser yields due to bolting (Almanac, 2023 &Ghunaim, et al. 2008).

In Jordan, it takes a long time to produce onion seedlings from seeds for field transplantation (8-10 weeks). Osmopriming, the process of treating seeds with osmotic solutions, may be a beneficial method for reducing the time needed for transplant production and ensuring a high likelihood of successful establishment for each seed planted. For crops including wheat, barley, carrots, parsley, leeks, onions, muskmelon, and guinea grass, seed osmopriming is frequently used to speed up seed germination, improve the uniformity of seedling emergence, and improve crop establishment (Sharifi-Rad et al.,2016; Yari et al., 2010 & Pereira Kikuti& Marcos-Filho, 2008).

Osmopriming is a pre-sowing procedure called Osmopriming increases seed germination and stress tolerance. We looked at the antioxidant system dynamics across three stages: Osmopriming, post-priming germination, and seedling establishment in order to understand Osmopriming physiology and its relationship to post-priming stress tolerance. After being primed with 0.6 MPa PEG at 15 °C for 8 days, spinach seeds (Spinacia oleracea L. cv. Bloomsdale) were dried at room temperature for 2 days. Unprimed and primed germinating seeds and seedlings were stressed with desiccation and chilling (Chen & Arora, 2011).

Osmopriming effects on seed germination, At the Research Farm of the University of Tabriz in Iran, laboratory tests and two field experiments in RCB design were carried out in 2006 and 2007 to determine the effects of hydro and osmo- priming (PEG: Polyethylene glycol 6000 at -0.8MPa) on seed germination and field emergence of lentil. When compared to other seed treatments, hydropriming considerably increased germination rate and root weights, according to an analysis of variance of laboratory data. However, the germination rates for seeds primed with PEG and water were statistically comparable but greater than those for seeds that had not been primed (Ghassemi-Golezaniet al., 2018).

There is proof that priming improved seed germination and seedling establishment in the majority of field and horticultural crops 16. Efficiency in water intake by prime derived plants is correlated with improvements in seedling growth, development, and implantation. In the current study, seeds that had been treated with KNO3 had better seed germination rates, MET with robust seedlings, and a larger number of established plants per unit area (Hassanpouraghdam, Pardaz& Akhtar, 2009).

The transfer of nutrients from the maternal phloem of the seed coat to the filial cotyledon (endosperm and embryo) of growing seeds is essential for seed development. The release of nutrients into the filial apoplasm is carried out by efflux transfer cells, which are found in the maternal tissues. Membrane transporters, aquaporins, and channels for sugars, amino acids, and peptides or inorganic ions have been discovered at the plasma membrane of these cells and have been shown to play an important function. Other macro and micro elements, including inorganic phosphate (P), potassium (K), zinc (Zn), sulfur (S), and iron (Fe), are transferred into the filial seed and play crucial roles in seed development and production in addition to carbon and nitrogen, which are present in the forms of sucrose and amino acids, respectively. Additionally, during seed development, K is a major cation that is delivered from the coats' phloem into the seed apoplasm. We know more about seed homeostasis thanks to the identification and distribution of transporter genes as well as the fact that seeds are the ultimate target for nutrients in plants' life cycles (Martínez-Ballesta et al., 2020).

Identifying the effects of seed osmopriming on germination, seedling performance, ionic components, and proximate analyses of osmoprimed seeds in relation to germination of two onion cultivars was the aim of this study.

2. Materials and Methods

2.1. Seed Samples

In this study, seeds from two types of onion cultivars—Giza 20 and Texas Grano harvested in 2012 were utilized. The National Center for Agricultural Research and Technology Transfer provided the seeds for these varieties (NCARTT). Until they were employed in this study, the seeds were kept in a refrigerator at 4 °C.

2.2. Preparation of osmopriming solutions

After being surface sterilized for 5 minutes with sodium hypochlorite 6%, the seeds were totally submerged (1:2, w/v) in polyethylene glycol 20% (-0.6 MPa) (PEG6000) for 24 hours at 25 °C under aseptic conditions. The PEG solutions were made by adding the appropriate amounts of PEG6000 to autoclaved distillated water (w/v) and filtering through a 0.25 sterile filter (Rahimi, 2013). Following priming, seeds were three times washed with distilled water, dried for 48 hours at room temperature (23 to 25 °C), and then used right away for germination assays (Amooaghaie, 2013; Carvalho et al., 2020; Jeong et al., 2008 & El-Araby et al., 2006).

2.3. Experiment 1: Effects of different osmopriming agents on onion seed germination

This experiment was designed to compare several priming agents at different concentrations and to identify the most effective treatment in improving onion seed germination.

The chemical compounds used as osmotic agents, their concentration and duration of the treatments were:

1. Seeds as a control (no treatment).

2. Seeds soaked in distilled water (hydropriming) for 12 hours for both cultivars.

3. Seeds soaked in polyethylene glycol-8000 (PEG) at –0. 5 MPa for 48 hours for Giza 20 and 12 hour for Texas Grano.

4. Seeds soaked in polyethylene glycol-8000 (PEG) at –1.0 MPa for 48 hours for Giza 20 and 12 hour for Texas Grano.

5. Seeds soaked in polyethylene glycol-8000 (PEG) at –1.5 MPa for 48 hours for Giza 20 and 12 hour for Texas Grano.

6. Seeds soaked in 0.2 M KNO3 solution for 48 hours for Giza 20 and 12 hour for Texas Grano.

7. Seeds soaked in 0.4 M KNO3 solution for 48 hours for Giza 20 and 12 hour for Texas Grano.

8. Seeds soaked in 0.6 M KNO3 solution for 48 hours for Giza 20 and 12 hour for Texas Grano.

9. Seeds soaked in 0.2 M NaCl solution for 48 hours for Giza 20 and 12 hours for Texas Grano.

10. Seeds soaked in 0.4 M NaCl solution for 48 hours for Giza 20 and 12 hour for Texas Grano.

11. Seeds soaked in 0.6 M NaCl solution for 48 hours for Giza 20 and 12 hour for Texas Grano.

The optimum duration of seed priming in dark room at 22± 2 °C was determined by soaking onion seeds (2 g) in the previous solutions in 250 ml beakers before the first seed appears its radicle (no seeds were germinated during osmopriming) for both cultivars and it was 48 hours for Giza 20 and 12 hours for Texas Grano.

The effect of osmopriming on germination percentage of onion seeds was determined by using the following equation:

Germination percentage = number of germinated seeds/numbers of total seeds x 100

The germination rate index was determined by modifying the procedure described by Bouton et al. (1976) using the following formula:

Germination rate index = G3/3+G6/6+G9/9+G12/12

Where, G3, G6, G9 and G12 are the germination percentages at 3, 6, 9 and 12 days after sowing time.

2.4. Onion seeds osmopriming

For each treatment, 100 seeds of each onion cultivar were utilized. The seeds were steeped in various solutions as indicated in section 3.3 in 250 ml beakers, covered with parafilm, and given an air supply through tiny tubes through a hole drilled in the top of the beaker. Beakers were put in a room that was 22 °C and 2 °C dark. The start of priming was timed to coincide with the conclusion of each treatment. After priming, seeds were washed three times in distilled water for 10 minutes, and then their surfaces were dried with paper towels at room temperature. Additionally, vacuum drying ovens were used to dry seeds until their natural moisture content was preserved.

2.5. Experiment 2: Seedling emergence and plant growth in the greenhouse

Between August 2001 and October 2001, a greenhouse experiment was performed. The best osmopriming chemical and/or amount for boosting germination were utilized in this experiment based on the findings from Experiment 1. In polystyrene trays filled with peatmoss and perlite (1:1 v/v) and heat pasteurized (80 °C) for 24 hours, seeds from each onion cultivar and each osmopriming treatment were sowed. Split plot design was used for the experiment. Twelve eyes were used for each treatment, and four seeds were placed at a depth of 6 to 9 mm in each eye. In this experiment, every piece of data was measured per seedling.

Each tray had two rows that were equally spaced apart. 20 to 25 °C was the temperature at the time of the emergency. Plants received twice-daily irrigation. The experiment was stopped after the seedlings had grown to the proper size for transplantation, which depends on the number of leaves (13–15), the diameter of the neck (3.5–5 mm), and the length of the shoot (13-15 cm). After seeds were sown, the number of seedlings that had emerged was counted each day. Shoots that had sprouted above the soil surface were judged to have emerged.

At the end of experiment, onion plants were removed from the trays. Water was used gently to remove the residues of perlite and peatmoss. Plant heights were measured using a ruler. Neck diameters were measured using a caliper. Plants were separated into shoots and roots, shoots and roots were oven dried to a constant weight (70 °C for 48 h). Number of leaves, shoot and root fresh and dry weights were recorded.

Emergence percentage was computed using the following equation:

Emergence percentage = number of emerged seeds/number of total used seeds x 100

Emergence speed was determined as described by Maguire, (1961) as follows:

$$GS = \frac{\text{Number of normal seedling}}{\text{Days to first count}} + \ldots\ldots\ldots\ldots + \frac{\text{Number of normal seedling}}{\text{Days to final count}}$$

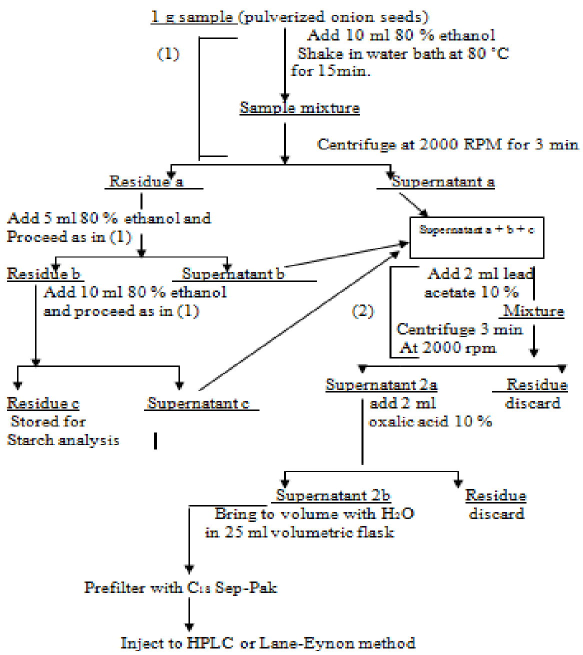
2.6. Chemical composition of onion seeds

Primed and non-primed onion seeds were analyzed for moisture, fat and protein according to AOAC (1984) methods. The total oligosaccharide was determined according to Lane-Eynon procedure outlined in AOAC (1984).

Sugars were extracted as shown in Fig. 1. The weight of sugars expressed as glucose required to reduce all copper (Cu) in 10 ml soxhlet solution was calculated from the second titration of soxhlet solution, were aliquot of sample was added to the soxhlet solution, the weight of sugar required to reduce the copper which was not reduced by sample sugar was computed by multiplying the standard sugar volume by its concentration. The difference represented amount of sugar in the sample aliquot, then sugars in onion seeds were computed:

% Sugars = (g) Sugar in aliquot x (Final volume /Aliquot) x (100 /Sample weight)

Figure 1 Flow diagram of sugar extraction



2.7. Mineral composition of onion seeds

In a cyclone laboratory mill, control and osmoprimed onion seeds from both cultivars were crushed. One gram of the powder was weighed into crucibles, heated in a Muffle furnace overnight to 550 °C until the ash became white-gray, then cooled to room temperature in a desiccator. The weight was then recorded. Ash was transferred quantitatively into a 50 ml volumetric flask after being quantitatively dissolved in 2 N HCl. Distilled water was used to denote the volume. Following the method described by Ereifej and Gharaibeh, sodium, potassium, and calcium concentrations were measured using a Flame Photometer (Corning, M410), whereas calcium concentrations were measured using an Atomic Absorption Spectrophotometer (Unicam, model SP9, UK) (1993). On a dry weight basis, the concentrations of Na, K, and Ca were determined and reported.

2.8. Statistical analysis

The MSTATC software was used to statistically evaluate the gathered data using analysis of variance (ANOVA) (Michigan State Univ., East Lansing, MI). Laboratory experiment data were examined using a wholly random design. In accordance with the method described by Lentner and Bishop, split-plot analysis was used to evaluate the data from the greenhouse experiment for each parameter. The least significant difference (LSD) test (p0.05) was used to compare the means and the probability of significance was utilized to identify significant treatment and interaction effects.

3. Results and discussion

The likelihood of significance for each parameter tested in this research of onion cultivars in the lab and greenhouse is displayed in (Table 1).

Table 1: Statistical analysis of the measured parameters of Giza 20 and Texas Grano onion cultivars using different Osmopriming agents.

Parameter	Cultivars (C)	Seed Osmopriming (S)	C x S
Germination percentage	*	*	*
Germination rate index	*	*	*
Emergence percentage	*	NS	NS
Emergence rate index	*	NS	NS
Leaf number	NS	*	*
Neck diameter	NS	NS	*
Root length	NS	NS	NS
Dry root weight	NS	NS	*

Fresh root weight	NS	NS	*
Dry shoot weight	*	NS	*
Fresh shoot weight	*	*	*
Whole plant weight	*	*	*
Shoot length	*	*	*
Shoot: root ratio	*	NS	NS
Days for seedlings to reach the appropriate size	NS	*	*
Protein content	*	*	*
Fat content	*	*	*
Reducing sugars content	*	NS	*
Potassium content	*	*	*
Sodium content	*	*	*
Calcium content	*	*	*

NS: not significant;*: significant ($P<0.05$).

The findings show that cultivars and the "seed osmopriming x cultivars" relationship greatly influenced the germination experiment, chemical analyses, and mineral analyses. However, cultivars, seed osmopriming treatments, and the "seed osmopriming x cultivars" interaction substantially influenced fresh shoot weight, plant weight, and shoot length in the greenhouse experiment. Cultivars, seed osmopriming treatments, and the "seed osmopriming x cultivars" interaction all had a substantial impact on neck diameter, dry and fresh root weights, dry shoot weight, and other measurements as well.

3.1. Experiment 1: Effects of different osmopriming agents on onion seed germination

Table 2 includes germination percentages and germination rate indices. Results reveal that Texas Grano had higher values for germination % and the germination rate index than Giza 20 (Table 2).

When compared to the control, hydropiming and osmopriming had no effect on the germination rate index of any treated seeds of the Texas Grano cultivar; the data are shown in Table 2.

Table 2: The germination percentage (GR %) and germination rate index (GRI) of Giza 20 and Texas Grano onion cultivars as affected by different osmopriming agents. a

Seed treatment	GR %		GRI	
Giza 20				
Control	57.0	Gh	33.2	Gh
Hydropriming	69.0	d-f	43.6	Ef
PEG (-0.5 MPa)	51.5	Hi	33.7	Gh
PEG (-1.0 MPa)	41.5	I	32.6	Gh
PEG (-1.5 MPa)	52.0	Hi	35.5	f-h
KNO_3 (0.2 M)	65.0	Fg	41.3	Fg
KNO_3 (0.4 M)	27.5	j	18.5	j
KNO_3 (0.6 M)	50.0	hi	31.1	h
NaCl (0.2 M)	40.5	i	21.0	ij
NaCl (0.4 M)	40.5	i	29.2	hi
NaCl (0.6 M)	25.0	j	18.3	j
Texas Grano				

Control	87.5	ab	67.7	ab
Hydropriming	81.0	a-c	64.2	a-c
PEG (-0.5 MPa)	81.0	a-c	60.6	b-d
PEG (-1.0 MPa)	91.0	a	71.0	a
PEG (-1.5 MPa)	73.5	c-f	55.0	d
KNO_3 (0.2 M)	79.0	b-d	60.7	b-d
KNO_3 (0.4 M)	73.0	c-f	57.4	cd
KNO_3 (0.6 M)	67.0	e-g	52.4	de
NaCl (0.2 M)	80.5	a-d	60.5	b-d
NaCl (0.4 M)	78.5	b-e	60.7	b-d
NaCl (0.6 M)	77.5	b-e	58.6	cd
LSD ($P \leq 0.05$)	11.68		8.91	

In the final germination % and germination rate index, the effects of the interaction "seed priming x cultivar", cultivars, and seed osmopriming were extremely significant. The large origin-related difference between the two cultivars might be the cause. Giza 20 is an Egyptian-born cultivar, whilst Texas Grano is an American-born hybrid.

The different origins of the seed lots caused celery, grown from a single cultivar, to not respond to priming as predicted. It is unclear if this variation in response is a real cultivar impact or a result of how these specific seed lots were grown and handled afterward.

3.2. Experiment 2: Seedling emergence and plant growth in the greenhouse

The most effective treatments to increase germination were chosen to carry out the greenhouse experiment based on the findings from experiment 1, which was conducted (Table 3). Each cultivar's onion seeds were hydroprimed for 12 hours, osmoprimed with -1.0 MPa PEG and 0.2 M KNO3 for 48 hours for Giza 20 seeds, and osmoprimed with the Texas Grano seeds for 12 hours.

Table 3: The osmopriming agents, their concentrations and duration that were used in treating Giza 20 and Texas Grano onion seeds in the greenhouse experiment.

Cultivar	Hydropriming	Polyethylene glycol(MPa)	KNO_3(M)
Giza 20(48 h) ^{x}	12 h ^{y}	-1.0	0.2
Texas Grano(12 h)^{x}		-1.0	0.2

xThe duration of the priming treatment.

yThe duration of the hydropriming treatment for both cultivars.

The greatest value among all treatments came from hydroprimed Texas Grano seeds, which produced an emergence rate index of 55.7. Other seeds that had been exposed to other osmopriming agents, including the control, had values that were in the middle.

Table 4. Emergence percentage and emergence rate index of Giza 20 and Texas Grano onion cultivars as affected by different osmopriming agents.

Cultivar	Seed treatment	Seed emergence (%)	Emergence rate index	Average leaf number/ seedling		Average neck diameter (mm)/seedling		Root length (cm)/ seedling	Plant weight (g)/seedling	
Giza 20	Control	44.4	29.1	3.5	*cd	0.33	2.3 *bc	4.8	2.3	*bc
	Hydropriming	33.3	29.6	4.7	a	0.41	5.5 a	5.2	5.5	a
	PEG (-1.0 MPa)	27.8	29.2	4.8	a	0.42	6.0 a	5.4	6.0	a
	KNO_3 (0.2 M)	25.0	18.5	4.4	ab	0.35	3.4 b	4.9	3.4	b
Texas Grano	Control	63.9	46.7	3.9	b-d	0.39	3.2 b	5.3	3.2	b
	Hydropriming	61.1	55.7	3.5	d	0.33	2.1 c	5.4	2.1	c
	PEG (-1.0 MPa)	69.4	52.2	4.0	bc	0.29	2.0 c	5.1	2.0	c
	KNO_3 (0.2 M)	63.9	48.9	4.1	b	0.39	3.1 bc	4.5	3.1	bc

In emergence % and emergence rate index, the negligible "cultivar x seed osmopriming" interaction was visible. The difference between cultivars with a higher emergence percentage and emergence rate index for Texas Grano and Giza 20 was significant (Table 4).

Leaf number was significantly impacted by seed priming. The number of leaves on the Giza 20 cultivar ranged from 3.5 (control) to 4.8. (-1.0 MPa PEG). Texas Grano leaves have a number between 3.5 (hydropriming) to 4.1. (0.2 M KNO3). Another growth indicator, neck diameter, showed improvement in hydroprimed and osmoprimed Giza 20 seeds but did not vary substantially from the control. The diameter of the Texas Grano neck was unaffected by osmopriming. These findings in Giza 20 show a modest improvement in leaf number and neck diameter as a result of hydropriming and osmopriming treatments. This improvement may be attributable to priming's slight improvement effect on germination rate index. Root length was statistically unaffected by "cultivar x seed priming," although cultivar and seed priming were significant (Table 1). Michalska-Klimczak et al. (2018) found no significant effect of seed priming on root yield development.

The data for root length and shoot: root ratios. Giza root length the root length of 20 seedlings developed from untreated seeds was 4.8 mm, the smallest value among all treatments, and the maximum value was 5.4 cm, produced by seeds that had been osmoprimed with -1.0 MPa PEG.

The results of the plant weight measurements of onion seedlings. In comparison to the control and 0.2 M KNO3, Giza 20 seeds that were hydroprimed and -1.0 MPa PEG osmoprimed had the greatest plant weights (5.5 and 6.0 g) (2.3 and 3.4 g).

3.3. Chemical composition of onion seeds

Table 5 displays the chemical composition of Giza 20 and Texas Grano onion. Comparing the hydroprimed seeds to the untreated, -1.0 MPa PEG, and 0.2 M KNO3 osmoprimed seeds, fat levels in Giza 20 seeds were greatest in the hydroprimed seeds (22.6%). Comparing Texas Grano untreated seeds to other osmoprimed treatments, which shown a considerable decrease from the control, the Texas Grano untreated seeds had the greatest fat content

(20.2%). Texas Grano seeds osmoprimed at -1.0 MPa PEG (12.1) had the least amount of fat.

Table 5: Protein and fat content of Giza 20 and Texas Grano onion seeds as affected by different osmopriming agents. a

Seed treatment	Protein (%)		Fat (%)	
Giza 20				
Control	28.1	*a	19.1	c
Hydropriming	28.4	a	22.6	a
PEG (-1.0 MPa)	23.7	d	13.1	g
KNO_3 (0.2 M)	24.5	c	16.2	e
Texas Grano				
Control	26.4	b	20.2	b
Hydropriming	22.5	f	17.7	d
PEG (-1.0 MPa)	22.2	f	12.1	h
KNO_3 (0.2 M)	23.1	e	14.1	f
LSD ($P\leq0.05$)	0.4		0.7	

* Means within columns for each treatment followed by the same letter are not significantly different at P<0.05 according to the least significant difference (LSD) test.

a Values are on dry weight basis.

Chemical analysis of Allium caepa L. var Tropeana (red onion) seeds showed high amounts of oil (20.4%), fibre (22.4%), crude protein (24.8%), calcium (175.0 mg/100 g), potassium (1010 mg/100 g), low amounts of sodium (11.2 mg/100 g) and six cysteine derivatives, of which the S-propylmercapto-cysteine has never been reported in onion before. The antioxidant capacity of seed extracts containing cysteine derivatives (SECCD), before and after boiling the seeds, and of cooking water extracts containing cysteine derivatives (CWECCD), was also evaluated, by the ferric reducing antioxidant power (FRAP) and 1,1-diphenyl-2-picrilhydrazyl (DPPH) assays. The extracts showed discrete antioxidant capacity which increased after boiling, although cooking methods caused significant losses of the cysteine derivatives in water (Dini et al., 2008; Dorna et al., 2021& Amalfitano et al., 2019).

3.4. Mineral Composition of onion seeds

Table 6. Potassium, sodium and calcium concentrations in Giza 20 and Texas Grano onion seeds as affected by different osmopriming agents. a

Seed treatment	K (mg/ kg)	Na (mg/ kg)	Ca (mg/ kg)
Giza 20			
Control	1.77 a	0.05 b	0.51 *c
Hydropriming	0.80 d	0.03 d	0.31 e
PEG (-1.0 MPa)	0.82 d	0.04 c	0.28 e
KNO_3 (0.2 M)	1.99 a	0.06 a	0.37 d
Texas Grano			
Control	1.51 b	0.05 b	0.68 a
Hydropriming	0.88 d	0.04 c	0.56 b
PEG (-1.0 MPa)	0.79 d	0.02 e	0.51 c
KNO_3 (0.2 M)	1.19 c	0.03 d	0.47 c
LSD ($P \leq 0.05$)	0.22	0.0015	0.05

* Means within columns for each treatment followed by the same letter are not significantly different at P<0.05 according to the least significant difference (LSD) test.

a Average of three replications on dry weight basis

One of the things limiting onion production is proper nutrition. The use of macro- and micronutrient fertilizers has an impact on onion production and quality. Nitrogen, phosphorus, and potassium are macronutrients that have a big impact on onion production. Fertilization with nitrogen and phosphorus has a big impact on onion growth, production, and quality. Depending on various conditions in the growing areas, different locations have varying requirements for mineral fertilizer. Utilizing N, P, and K fertilizer effectively relies on the irrigation system, soil quality, environmental conditions, and management considerations. Onion is regarded as a strong feeder for N, P, and K in all study papers, and the addition of these mineral elements greatly increases output.

4. Conclusions

The findings of this research are:

1. Osmopriming improved Giza 20 onion seed germination and plant growth.

2. Hydropriming and osmopriming Giza 20 onion seeds in –1.0 MPa PEG is an effective method for increasing vigor and seedling quality.

3. Texas Grano had higher tolerance for osmopriming with potassium nitrate and sodium chloride as compared with Giza 20 cultivar under laboratory conditions.

4. Genetic variation of onion cultivars is a considerable importance for the beneficial improvement effects of seed osmopriming.

5. Reduction in protein and fat content in osmoprimed seeds as compared with the control in both cultivars helps in understanding seeds adjustment to water stress.

Reference

Almanac. (2023).Growing Onions: Planting, Growing, and Harvesting. Retrieved February 1, 2023, from https://www.almanac.com/plant/onions

Amalfitano, C., Golubkina, N. A., Del Vacchio, L., Russo, G., Cannoniero, M., Somma, S., Morano, G., Cuciniello, A., & Caruso, G. (2019). Yield, Antioxidant Components, Oil Content, and Composition of Onion Seeds Are Influenced by Planting Time and Density. Plants, 8(8), 293. https://doi.org/10.3390/plants8080293

Amooaghaie, R. 2013. The effect of hydro and osmopriming on alfalfa seed germination and antioxidant defenses under salt stress. African Journal of Biotechnology 10(33):6269-6275. doi:10.5897/AJB10.2448.

Beithou, N., Qandil, A., Khalid, M. B., Horvatinec, J., &Ondrasek, G. (2022). Review of Agricultural-Related Water Security in Water-Scarce Countries: Jordan Case Study. Agronomy, 12(7), 1643. https://doi.org/10.3390/agronomy12071643

Carvalho, A., Gaivão, I., & Lima-Brito, J. (2020). Seed osmopriming with PEG solutions in seeds of three infraspecific taxa of Pinus nigra: Impacts on germination, mitosis and nuclear DNA. Forest Ecology and Management, 456, 117739. https://doi.org/10.1016/j.foreco.2019.117739

Chen, K., & Arora, R. (2011b). Dynamics of the antioxidant system during seed osmopriming, post-priming germination, and seedling establishment in Spinach (Spinacia oleracea). Plant Science, 180(2), 212–220. https://doi.org/10.1016/j.plantsci.2010.08.007

Dini, I., Tenore, G. C., & Dini, A. (2008). Chemical composition, nutritional value and antioxidant properties of Allium caepa L. Var. tropeana (red onion) seeds. Food Chemistry, 107(2), 613–621. https://doi.org/10.1016/j.foodchem.2007.08.053

Dorna, H., Szopińska, D., Rosińska, A., &Górski, R. (2021). Chemical Composition of Fir, Pine and Thyme Essential Oils and Their Effect on Onion (Allium cepa L.) Seed Quality. Agronomy, 11(12), 2445. https://doi.org/10.3390/agronomy11122445

El-Araby, M. M., Moustafa, S. M. A., Ismail and, A. I., & Hegazi, A. Z. A. (2006). Hormone and phenol levels during germination and osmopriming of tomato seeds, and associated variations in protein patterns and anatomical seed features. Acta AgronomicaHungarica, 54(4), 441–457. https://doi.org/10.1556/aagr.54.2006.4.7

GHASSEMI-GOLEZANI, K., Aliloo, A. A., Valizadeh, M., & MOGHADDAM, M. (2008). Effects of hydro and osmo-priming on seed germination and field emergence of lentil (Lens culinarisMedik.). NotulaeBotanicaeHortiAgrobotanici Cluj-Napoca, 36(1), 29-33.

Ghunaim, A., Phillips, R., Abuamoud, I., Khaled, S., Corgan, J., Al-Tabini, R., Al-Jazi, N. & Al-Oun, N. (July 2008). Production and Market Opportunities for Fall-Planted Onions in Southern Jordan. Component of the Sustainable Development of Drylands Project. New Mexico State University & The Badia Research and Development Center.

Hassanpouraghdam, M. B., Pardaz, J. E., & Akhtar, N. F. (2009). The effect of osmopriming on germination and seedling growth of Brassica napus L. under salinity conditions. Journal of Food, Agriculture and Environment, 7(2), 620-622.

Jeong, P. H., Shin, D. H., & Kim, Y. S. (2008). Effects of Germination and Osmopriming Treatment on Enhancement of Isoflavone Contents in Various Soybean Cultivars andCheonggukjang(Fermented Unsalted Soybean Paste). Journal of Food Science, 73(8), H187–H194. https://doi.org/10.1111/j.1750-3841.2008.00897.x

Martínez-Ballesta, M. D. C., Egea-Gilabert, C., Conesa, E., Ochoa, J., Vicente, M. J., Franco, J. A., Bañon, S., Martínez, J. J., & Fernández, J. A. (2020b). The Importance of Ion Homeostasis and Nutrient Status in Seed Development and Germination. Agronomy, 10(4), 504. https://doi.org/10.3390/agronomy10040504

Michalska-Klimczak, B., Wyszyński, Z., Pačuta, V., Rašovský, M., & Różańska, A. (2018). The effect of seed priming on field emergence and root yield of sugar beet. Plant Soil and Environment, 64(5), 227–232. https://doi.org/10.17221/136/2018-pse

Pereira Kikuti A.L., Marcos-Filho J., 2008. Drying and storage of cauliflower (Brassica oleracea var. botrytis) hydroprimed seeds. Seed Sci. Tech. 36, 396–406.

Rahimi, A. (2013). Seed priming improves the germination performance of cumin (Cuminumsyminum L.) under temperature and water stress. Industrial Crops and Products, 42, 454–460. https://doi.org/10.1016/j.indcrop.2012.06.026

Sharifi-Rad, J.; Mnayer, D.; Tabanelli, G.; Stojanović-Radić, Z.; Sharifi-Rad, M.; Yousaf, Z.; Vallone, L.; Setzer, W.; Iriti, M. Plants of the genus Allium as antibacterial agents: From tradition to pharmacy. Cell. Mol. Biol. 2016, 62, 57–68.

Yari L., AghaalikhaniM. and Khazaei F. 2010. Effect of Seed priming duration and temperature on seed germination behavior of bread wheat (Triticum aestivum L.). ARPN Journal of Agricultural and Biological Science.