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Research Paper

Effect of Hydro and Osmo Priming on Seed Germination and Seedling Growth of Durum Wheat (*Triticum durum*) Under Drought Stress

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ABSTRACT: *In Tunisia, among the most vulnerable country to climate change in the world, durum wheat (Triticum durum Desf.) production is strongly limited by drought stress. Seed germination and vigor seedling, which can be improved by seed priming, are key phase for a successful crop establishment. A laboratory experiment was performed to study the effect of seed treatments (hydro priming and osmo priming with Silicon and Selenium) on three durum wheat varieties (Maâli, Nasr and Maghrbi) under drought stress induced by polyethylene glycol solution PEG 6000 (water potential of -3.02 bar). Germination percentage, mean daily germination, vigor index, coleoptile length, shoot and root length were monitored. Variance analysis showed significant (p<0.001) effect of different treatment in all studied traits. Compared to non primed seeds, hydro and osmo priming treatments had positive effects on seed germination and seedling growth. Silicon seed priming resulted in higher seed germination (95 %), vigor index (1051.23), coleoptile length (3.44 cm), shoot length (3.55 cm) and root length (7.43 cm). It is concluded that germination attributes and seedling growth traits were improved under drought stress by seed priming, especially using silicon.*

KEYWORDS: *hydro priming, osmo priming, durum wheat, drought*

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I. INTRODUCTION

Water resources were severely decreased by climate change in the world [1]. Also, complementary irrigation will decrease due to the global warming [2]. In the Mediterranean basins, Tunisia's water resources are among the weakest ones [3]. Climate variability lead to frequent and severe droughts, thus surface water will not meet crops irrigation needs [4]. Face to this situation, it's important to find other methods to alleviate adverse impacts of drought stress on plant performances. Seed priming is an important and very promising technology in plant production management. Though, it is an easily applied, low cost, sustainable and effective method to improve seed quality and plant stress responses [5, 6]. It stimulates physiological and biochemical plant states by soaking seeds in natural and synthetic solution. Seed priming techniques are classified into conventional methods such as hydro-priming (water), osmo-priming (low osmotica), chemical priming, and priming with plant growth regulators and advanced methods such as nano-priming [7]. It activates pre germination metabolic activity, however it interrupts radical emergence [8]. It improves germination process and seedling growth under stressed conditions [9]. Also, seedlings of primed seeds are robust and have early, quick and uniform germination and better yield compared to plants of non primed seeds [10, 11]. By 27.7 %, Silicon represents the second most abundant element in the earth's crust after the oxygen (47 %) [12]. It showed beneficial effects on plant growth and productivity under abiotic and biotic stress [13]. It can be used by different methods: seed priming, foliar application and fertigation. Under drought stress condition, silicon seed priming improved germination and seedling growth attributes (germination percentage, germination index, shoot and root length and seedling vigor index) in wheat [14, 15, 16]. Selenium a trace element, considered beneficial for plants, it confers tolerance to environmental stress (drought, salinity, pathogens…) [17]. Despite, little researches about it's role under water stress [18], selenium application improved seed germination, physiological, biochemical and agro-morphological plant response under drought stress in wheat [19], maize [20] and rice [21].

The present research work aimed to determine the impact of hydro priming and osmo priming with Silicon and Selenium on durum wheat (*Triticum durum*) seed germination and seedling growth under induced drought stress.

II. MATERIALS AND METHODS

Seed sterilization and seed priming

Seeds of three durum wheat (*Triticum durum* Desf.) varieties, two improved varieties: Maâli and Nasr and landrace: Maghrbi obtained from Regional Research Development Office of Agriculture in Semi Arid North West of kef were used in this study.

All Kernels were sterilized 12% sodium hypochlorite for 5 min and rinced for 5 min three times with distilled water, then they were subjected to two treatments:

The hydro priming treatment: seeds were soaked in distilled water for 24 h.

The osmo priming treatment: seeds were soaked in i)Silicon solution (33 mM of Si) using sodium silicate powder (Na_2SiO_3, $9H_2O$) for 12 h and ii) Selenium solution (75 µM of Se) using 99% sodium selenate (Na_2SeO_4) for 12 h. All priming treatment have been carried out at 20°C in the dark, then seeds were re dried to original weight [22].

Drought stress induction and seed germination

Drought stress induced by Polyethylene glycol solution PEG 6000 (200 g/l)(molecular weight 6000 g mol-1, purity >99.0%; Sigma Aldrich solutions, St. Louis, USA), inducing a water potential of -3.02 bar. Ten non primed (control) and primed seeds of each variety were placed in Petri dishes (90-mm diameter, Steril in Ltd., Cambridge, Royaume-Uni) with two layers of filter paper. Every 2 days, 5 ml of each PEG solution was added to Petri dishes as follows. Durum wheat varieties were germinated in a dark growth chamber for 7 days at 50% relative humidity at 22 ± 2°C (Marmar et al., 2013). Seeds were scored germinated when radicle length had protruded 2 mm or more [24].

Drought stress (DS)
Drought stress +Hydro priming (DS + H)
Drought stress + Si Osmo priming (DS + Si)
Drought stress +Se Osmo priming (DH + Se)
Germination and seedling growth attributes
Every day germinated seed were counted,
Germination potential (GP)
GP = (Total number of germinated seeds/ Total number of seeds) × 100
Mean daily germination (MDG)
MDG = Final emergence/10 [25]
Coleoptile length (CL, cm)
Shoot length (SL, cm)
Root length (RL, cm)
Seedling vigor index (SVI)
SVI= GP × SL, where SL (seedling length) is the average of SL + RL

Statistical data analysis

Data were subjected to variance analysis (ANOVA) using SPSS Statistics (Version 20) followed by mean comparisons using Duncan's Multiple Range ($p<0.05$, $p<0.01$ and $p<0.001$).

III. RESULTS AND DISCUSSION

Analysis of variance revealed a highly significant effect ($p<0.001$) of applied treatments and varieties on all studied traits. Except for MDG, CL and GP significant ($P \leq 0.001$) interactions between different treatments and varieties were observed (table 1).

Table1: Analysis of variance (F value) of germination percentage (GP, %), mean daily germination (MDG), vigor index (VI), coleoptile length (CL, cm), shoot length (SL, cm) and root length (RL, cm) of durum wheat tested varieties under different treatments

Variance sources	Df	GP	MDG	VI	CL	SL	RL
Treatments	3	1379.861***	8.54***	1510488.756***	128.035***	12.310***	74.279***
Varieties	2	1614.583***	9.671***	984963.463***	25.527***	10.010***	30.340***
Treatments × Varieties	6	284.028ns	2.094ns	207881.625***	2.762ns	2.354**	9.523***

***p<0.001;**p<0.01; * p<0.05; ns: not significant

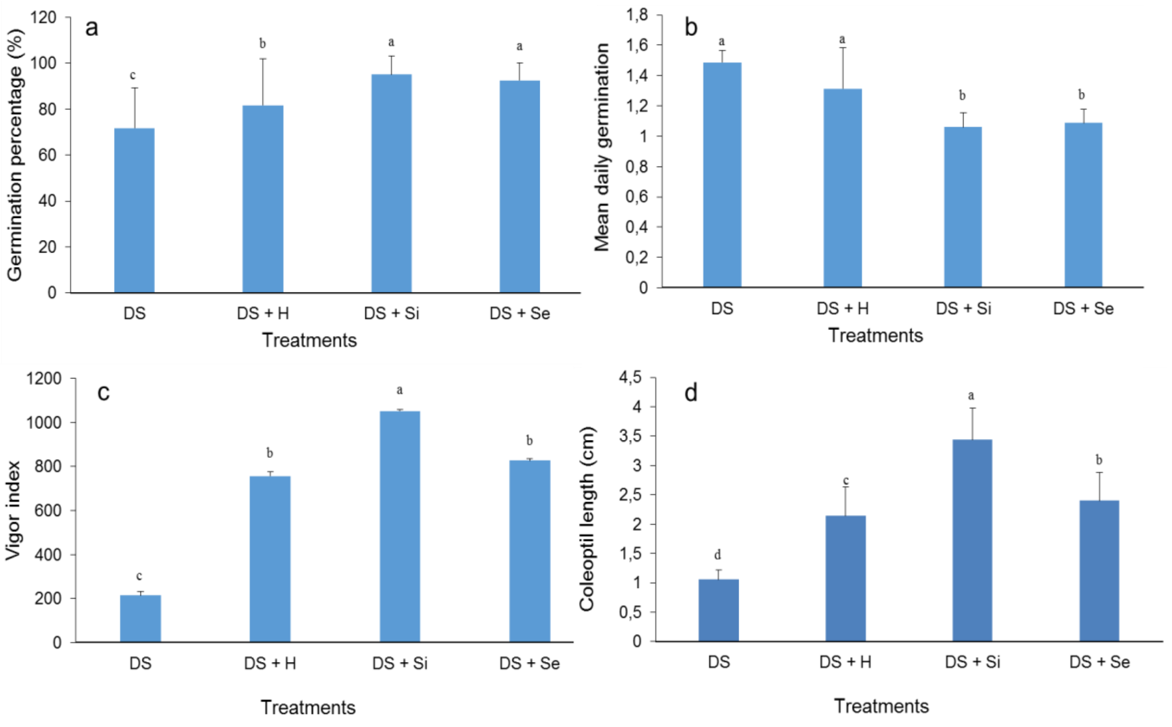
Table 2: Means comparison of germination percentage (GP, %), mean daily germination (MDG), vigor index (VI), coleoptile length (CL, cm), shoot length (SL, cm) and root length (RL, cm) of durum wheat varieties under different treatments

Varieties	GP (%)	MDG	VI	CL (cm)	SL (cm)	RL (cm)
Maâli	92.50a	1.45 a	914.07 a	2.49 a	3.08a	6.39a
Nasr	89.38a	1.11 b	787.98 b	2.45 a	2.55b	5.96a
Maghrbi	73.75b	1.14 b	435.38 c	1.82 b	1.53c	3.82b

Means with the same letters in each column are not significantly different (Duncan's Multiple Range test, P < 0.05 level)

1. Germination percentage

Obtained results showed that the lowest germination percentage (71.66%) is recorded under PEG-6000 induced water deficit. Similar results obtained by Mujtaba et al. [26] on six wheat genotypes. However, hydro priming and osmo priming by Se and Si improved the GP by 13.95, 29.06 and 32.55 % respectively. Kahlon et al. [27] showed that hydro priming for 24 h increased grain yield in wheat. The highest PG (95%) is obtained using the Si (figure 1 a). These results are consistent with those obtained by Othmani et al. [28] in eleven durum wheat varieties under different level of water potential.



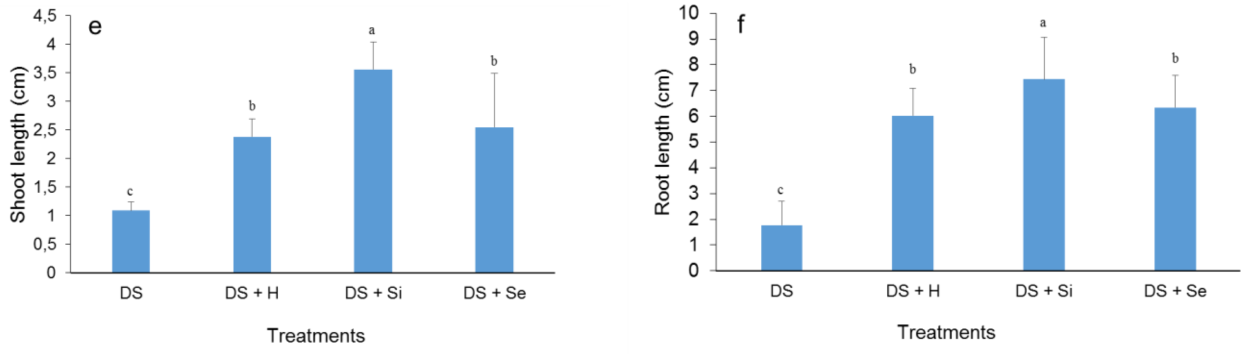


Figure 1: Effect of drought stress and different seed priming treatments on germination percentage (a), mean daily germination (b), vigor index (c), coleoptile length (d), shoot length (e) and root length (f) of durum wheat varieties

2. Mean daily germination

Lower values of MDG (1.06 and 1.08), were obtained in osmo-primed seeds by Si and Se respectively, which revealed an increase of germination speed. Maximum MDG was observed under drought stress treatment, which did not differ significantly to hydro primed seeds (figure 1b). In fact, seeds under water deficit stress need more time to germinate [29]. Results of Abdoli and Saeidi [30] and Dodig et al. [31] showed that MDG augmented by water deficiency in wheat.

3. Vigor index

Osmotic stress induced by PEG decreased significantly durum wheat vigor index. The highest VI (1051.23) was recorded under osmo-priming treatment using Si (figure 1 c), which differ significantly from the VI of Se primed seeds. In wheat, Hameed et al. [14] revealed that the use of different sodium silicate concentrations for grain priming improved the vigor index.

4. Coleoptile length

The coleoptile is associated with emergence capacity, it is essential for successful emergence, plant vigor which leads to improve grain yield [32, 33]. The shortest coleoptile length (1.05 cm) was obtained under drought stress treatment (figure 1 d). Similar results were obtained by Othmani et al. [34] in eleven durum wheat varieties where minimum value of CL (0.54 cm) was unregistered under the lowest water potential (-7.73 bars). Seed priming had a positive effect on this trait, compared to drought stress treatment, it is improved by 128.57, 103.80 and 227.61 % using hydro priming, Se and Si respectively for seed priming

5. Shoot length

Water deficit has a negative effect on durum wheat seedling shoot length (figure 1 e). This may be the result of reduced cell expansion and mitosis prevention (Faisal et al., 2017). Hydro priming and osmo priming using Se and Si improved SL by 120.37, 135.18 and 288.70 % respectively.SL from the Se-treated grains was gradually improved as the concentration of Se solution increased (30, 45 or 60 μmol L−1 Se) in two rice cultivars [36]. The highest SL value (3.55 cm) was obtained with Si treatment. These results confirm those obtained by Othmani et al. (2016) in durum wheat varieties. According to Rizwan et al. (2015), silicon has been able to improve germination, plant development and biomass accumulation under water stress conditions. Lee et al. [38] reported that Si treatment alleviate water stress damage in wheat varieties.

6. Root length

Drought stress significantly reduced seedling root length (figure 1 f). Hydro priming and osmo priming by Se and Si increased RL by 70.53, 71.95 and 76.13%, respectively. Results of Nawaz et al. (2013) showed that Se increased root length of wheat under drought stress induced by PEG-6000. Khaliq et al. [36] revealed that even at low concentrations (15, 30, 45, 60, 75, 90 and 105 μmol L-1 of Se), priming with Se solution can improve root length of rice varieties. In the present study, Si was more effective than Se. Hattori et al. [39] reported that Si stimulates root growth, which may be due to improved hydraulic conductivity following cell growth.

7. Durum wheat varieties response to seed priming treatments

Average over all treatments, studied varieties showed significant differences for measured parameters (table 2). Maâli variety seems to be the most performing variety. It showed the highest GP (92.50%), VI (914.07), CL (2.49cm), SL (3.08 cm) and RL (6.39 cm). Wheat variety with long coleoptile is recommended in low rainfall regions, it has successful emergence compared to variety with short coleoptile [33].

IV. CONCLUSION

The obtained results revealed that germination attributes and seedling growth traits of durum wheat varieties were improved by various seed priming sources (water, silicon and selenium) under drought stress condition. Silicon osmo priming was the most efficient treatment, it showed highest germination percentage, coleoptile length, vigor index and seedling shoot and root length compared to the unprimed seeds. Seed priming seems to be a promising technique to alleviate adverse effect of drought stress during germination and seedling growth phase. Maâli variety could be recommended in regions threatened by drought stress.

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