# INFLUENCE OF PRIMING ON THE PHYSIOLOGICAL TRAITS OF CORN SEED GERMINATION UNDER DROUGHT STRESS

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**ABSTRACT**
*This study was performed to investigate the effect of drought stress and priming on germination of corn seeds (cultivar SC704) as a factorial experiment based on completely randomized design with three replications. Treatments were drought stress in four levels including 0,-3,-6 and -9 bar and priming as control, hydro, osmo, vitamin and hormone priming. Results showed that interaction of two factors was significant on radicle and plumule dry weight, seedling vigor and germination rate. Osmo-priming remained the radicle dry weight and seedling vigor index same to control but germination rate decreased in this treatment about 38% to control. Drought stress at any severity caused seed reservoirs were not use inefficiently. In conclusion, osmo and hormone primings were the best treatments for seed invigoration under severe drought stress.*

**KEY WORDS:** *PEG, corn, priming, germination, drought stress.*

**INTRODUCTION**

Corn (*Zea mays* L.) from Poaceae family is the cheapest and purest source of organic materials for industrial uses (Noor-mohammadi *et al,* 2001). It is cultivated in the whole planet except of poles for desired properties and placed in the third order following wheat and rice considering cultivation area (Manochehrifar *et al,* 2014). In the arid and semiarid regions of the world lack of sufficient water supply is the major problem for corn cultivation and is a restriction for its production, so studies on the growth limitation and germination of corn seeds under drought conditions seems very necessary (Manochehrifar *et al,* 2014). Germination and rapid establishment of seedlings are the critical phases of plant life cycle and successful establishment of plant not only is related to rapid germination and homogeneity of seeds but also is the function of seed ability to rapid germination under stress conditions specially drought stress (Windor *et al,* 2007). Controlled water uptake of seeds before planting is known as priming which water is absorbed by seed but radical is not emerged. Soon after planting because of completing of two phases of water uptake, seeds germinate more rapidly and uniformly (McDonald, 2000; Sedghi *et al,* 2010). It is possible to increase vigor and viability by priming under stress conditions (Bradford & Bewely, 1979). Main purposes of priming are increasing germination percentage, decreasing mean of germination time, growth enhancement and increasing vigor under both favorable and unfavorable conditions (Sedghi *et al,* 2010) which causes to increase rate and percentage of germination, emergence and homogeneity of germination under stresses like salinity, temperature and drought (Soltani *et al,* 2008; Yarniya *et al*, 2008; Ianovici, 2011). Drought is the one of reasons for loss of crop performance (Vazan *et al,* 2002). Considering decreasing of annual precipitation and increasing of air temperature and drought due to global warming, introducing tolerant and high yielding cultivars has very importance to plant breeders (Golpar *et al,* 2003). Basra *et al.* (1989) concluded that priming of corn seeds with poly ethylene glycol (PEG) and potassium salts is very effective for rapid germination. Mohseni *et al.* (2014) reported that priming of seeds causes to improve in rate and homogeneity of germination and reduces seed susceptibility to environmental conditions. Massarat *et al.* (2014) found that priming with PEG 6000 and NaCl had beneficial effects on germination and seedling establishment of corn seeds under drought and saline conditions.

This study was conducted to investigate the effects of seed priming on the physiological traits of corn seeds under drought stress.

## MATERIALS AND METHODS

In order to study the effect of priming types on germination traits of corn seeds (cultivar SC 704) under drought stress a factorial experiment was performed incompletely randomized design arrangement with three replications at the University of Mohaghegh Ardabili in 2014. Treatments were drought stress imposed by PEG 6000 as 0, -3, -6, and -9 bar and different priming materials including control, hydro priming, osmo priming with PEG, vitamin priming with 100 mg $lit^{-1}$ ascorbic acid and hormone priming with 20 mg $lit^{-1}$ gibberellic acid. At the end of experiment germination rate and percentage, radical, plumule and seed residual dry weight were measured.

Germination rate was calculated according to Ellis and Roberts (1980) by below formula:

$$GR=\frac{\Sigma n}{\Sigma Dn}$$

which, GR = germination rate (number of seeds germinate per day), n =number of seeds germinated on day D and D = number of days elapsed since the start of the experiment.

Seedling vigor index (SVI) was calculated by following formula (Anonymous, 2010):

$$SVI = (R+S) \times GP$$

which R is the radicle dry weight, S plumule dry weight and GP is the germination percentage.

Seed reservoirs using rate (SRUR) and fraction of used seed reservoirs (FUSR) was calculated according to Soltani et al (2008) and Sedghi et al (2010):

$$SRUR = ISDW - RSDW \qquad FUSR = \frac{SRUR}{ISDW}$$

which ISDW is the seed dry weight at the beginning of the experiment and RSDW is the residual seed dry weight.

Data analysis was performed after normality test using SPSS18 and SAS9.1softwares. Means were compared by Duncan's multiple range test at %5 probability level.

**RESULTS AND DISCUSSIONS**

Interaction of priming and drought was significant on radical and plumule weight, seedling vigor and germination rate but the simple effect of drought was only significant on seed residual dry weight.

**TABLE 1. Analysis of variance for the effect of seed priming and drought on the studied traits in corn**

| Mean of squares | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| SOV | Df | R | S | RSDW | GP | SVI | SRUR | FUSR | GR |
| Drought (D | 3 | 0.001** | 0.002** | 0.0425** | 69.75 | 14.63** | 0.123 | 0.0004 | 127.7** |
| Priming(p) | 4 | 0.0003 | 0.0003** | 0.0037 | 15.4 | 7.72* | 0.543 | 0.0002 | 14.09** |
| D×P | 12 | 0.001** | 0.001** | 0.007 | 34.86 | 25.63** | 0.403 | 0.0002 | 4.19* |
| Error | 40 | 0.0001 | 0.00002 | 0.0077 | 50.86 | 2.64 | 0.459 | 0.0002 | 1.913 |
| Cv (%) | - | 17.09 | 8.719 | 7.447 | 8.101 | 13.86 | 9.382 | 1.916 | 11.753 |

*, **: significant at p≤0.05 and p≤0.01, respectively. R, radicle weight, S, plumule weight, RSDE, residual seed dry weight, GP, germination percentage, SVI, seedling vigor index, SRUR, seed reservoirs using rate, FUSR, fraction of used seed reservoirs, and GR, germination rate.

The highest radical dry weight (0.108 g) was observed without priming in -9 bar drought stress (Table 2), followed by osmo-priming in -9 bar (0.103 g). Osmo-priming in non-stressed conditions produced the lowest radical dry weight. Under drought stress resistant cultivars have higher radicle growth rate and increase the radical to plumule ratio (Eissenstat *et al,* 1999). Sanchez *et al*. (2001) reported that under non-stressed conditions, radicle length of pepper and cucumber seed increased by hydro priming.

Plants increase their root length and volume under drought to discover more area of rhizosphere and find more water, so cell division and length increases which causes to increase in dry weight (Davies, 2007).

The highest plumule dry weight observed at control conditions (0.116 g) and the lowest value (0.035 g) was related to vitamin priming in -9 bar drought stress (Table 2). Plumule length and weight decreases under any drought conditions (Pessarakli, 2002).

Seedling vigor index was the highest (15.99) in control treatment, which followed by hormone priming at non stressed condition (15.23) and the lowest SVI (8.225) was related to osmo-priming at control stress (Table 2).

The highest GR was observed in hormone priming and without stress (17.556 seeds $day^{-1}$). GR decreased by increasing drought severity and the lowest GR (7.403 seeds $day^{-1}$) was related to -9 bar drought and osmo-priming (Table 2).

**TABLE 2. Comparison of means for some traits of corn under different priming and drought treatments**

| Drought (bar) | Priming | R (g) | S (g) | SVI | GR (seed $day^{-1}$) |
|---|---|---|---|---|---|
| 0 | Control | 0.066 efg | 0.116 a | 15.996a | 11.956 defgh |
| | Hydro Priming | 0.057 efg | 0.07 cd | 11.372 def | 15.583 abc |
| | Osmo Priming | 0.043 g | 0.048 gh | 8.225 f | 13.667 bcde |
| | Hormone Priming | 0.09 abcd | 0.071 c | 15.229 a | 17.556 a |
| | Ascorbic acid | 0.077 cde | 0.098 b | 15.165 a | 15.82 ab |
| -3 | Control | 0.061 efg | 0.038 ij | 9.12 ef | 10.937fghi |
| | Hydro Priming | 0.063 efg | 0.061 de | 11.828 bcde | 14.222 bcd |
| | Osmo Priming | 0.062 efg | 0.061 de | 11.536 cde | 13.131 cdef |
| | Hormone Priming | 0.058 efg | 0.051 fgh | 9.053 ef | 12.389 defg |
| | Ascorbic acid | 0.081 bcde | 0.079c | 14.537 ab | 14.944 bc |
| -6 | Control | 0.077 cde | 0.045 hi | 10.648 ef | 10.075ghij |
| | Hydro Priming | 0.063 efg | 0.056 efg | 10.857 def | 11.5 efgh |
| | Osmo Priming | 0.078 cde | 0.045 hi | 10.665 ef | 9.567 hiJk |
| | Hormone Priming | 0.099 abc | 0.072 c | 14.357 abc | 11.25 efgh |
| | Ascorbic acid | 0.051 fg | 0.048 gh | 8.845 ef | 12 defgh |
| -9 | Control | 0.108 a | 0.06ef | 15.079 a | 8.578 ijk |
| | Hydro Priming | 0.074 def | 0.036 j | 9.161ef | 7.617 jk |
| | Osmo Priming | 0.103 ab | 0.058 ef | 13.767 abcd | 7.403 k |
| | Hormone Priming | 0.062 efg | 0.059ef | 10.401 ef | 7.722jk |
| | Ascorbic acid | 0.068 def | 0.035 j | 8.779 ef | 9.492 hijk |

In each column means with same letter is not different statistically at %5 probability level. R, radicle weight, S, plumule weight, SVI, seedling vigor index, and GR, germination rate.

Kaur *et al.* (1998) reported that seed priming with gibberellins causes to improve germination and growth of Iranian and chickpea during stress. Priming with hormones can increase germination and decrease in mean germination time of seeds (Wang and Li, 2006). Isvand *et al*. (2008) with studying the effect of hormone priming on tall fescue under drought stress reported that drought causes to decrease in germination rate, seed vigor, seedling fresh weight, plumule and seedling length and priming caused to increase in germination rate and speed under stress situation. Mohseni *et al.* (2014) reported that the highest rate and percentage of germination was achieved by hydropriming and non primed seeds. Afzal *et al* (2006) and Basra *et al* (2003) demonstrated that germination rate increased in rapeseed with priming. With increasing drought severity seed residual weight was increased (Fig 1). Under favorable conditions seeds consume their reservoirs to buildup seedling structure and reach their optimum growth, but under stress conditions reservoirs remain intact in seeds and were not used for growth efficiently (Sedghi *et al,* 2010).

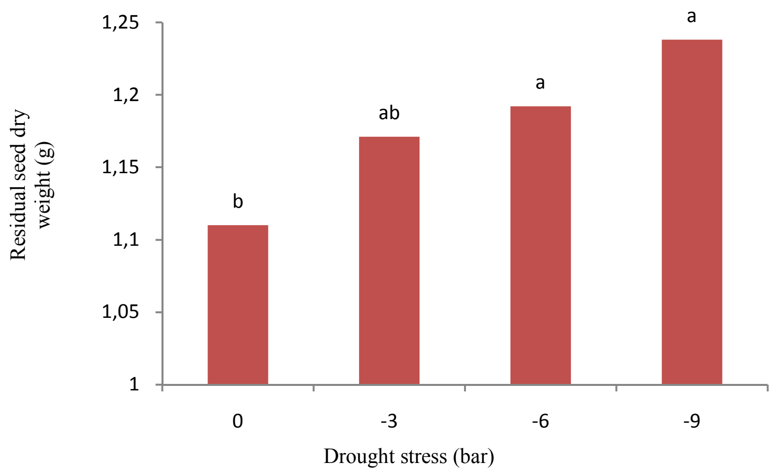


**FIG 1. Effect of drought stress levels on the residual seed dry weight of corn seed**

In the literature there are many reports about the increasing of percentage, rate and homogeneity of germination and emergence by priming (Murungu, 2003). Fazliani (2011) primed chick pea seed by PEG 8000 and observed that there was significant difference in germination between primed and non-primed seeds. Chiu *et al.* (2002) demonstrated that during priming some antioxidants like ascorbate and glutathione increase in seed and prevent of peroxide radicles which destroy lipids and membranes. Soltani *et al*. (2008) resulted that with increase in drought severity, germination rate linearly decreased, but primed seeds had lower reduction slope. They concluded that priming has positive effect on germination rate under stressed and non-stressed conditions.

## CONCLUSIONS

Drought stress affected all corn seed characteristics and some priming treatments were sufficient to invigorate the seed germination. Hormone priming under moderate drought and osmo-priming under severe drought were the best cases for seed improvement.

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