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Response of wild okra (*Corchorus olitorius* L.) seeds to drought stress condition

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ABSTRACT:

This study was laid out in order to evaluate the effect of drought stress by Poly Ethylene Glycol (PEG) on seed germination, seedling growth and heterotrophic growth of wild okra at the Laboratory of Horticulture Faculty of Gorgan Agricultural and Natural Resources University, Iran, March 2015. The corresponding treatments were different drought stress levels of PEG (0, -2, -4, -6, -8 and -10 bar). 25 seeds of each lot evenly placed on Whatman filter paper No.1 at sterilized 9 cm petri dishes separately and 10 ml of each solution were added to the related treatment. Seed germination parameters, seedling growth and heterotrophic growth components were determined. The results showed that, the effect of drought stress was significant on germination percentage, germination rate, radicle dry weight, seedling length and seed vigor index and seed reserves utilization. Mean comparison data showed that maximum germination percentage, germination rate, hypocotyl dry weight, radicle dry weight, seedling length, and seed vigor index and seed reserves utilization and conversion efficiency of mobilized seed reserve were recorded for -2 bar water potential and the lowest of them was recorded for the -10 bar water potential for all traits. However, maximum ratio of utilized seed reserve was found at 0 bar water potential treatment and minimum of it was recorded for the -10 bar water potential. In final, results of this study showed that with an increase in the drought levels of wild okra-seed germination medium, seed germination parameters, seedling growth and heterotrophic growth components decreased.

Keywords:

Germination, Seedling growth and Wild Okra.

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INTRODUCTION

Wild okra (*Corchorus olitorius* L.), is a wild leafy vegetable and an annual dicotyledonous herb. It is a popular vegetable, grown in both dry and semi-arid regions and in the humid areas of world, because of its importance in giving good nutrients to the body (Sosa *et al.,* 2005). Wild okra belongs to the Tiliaceae family and is an erect annual herb that varies from 60 cm to approximately 150 cm in height depending on the cultivar (Natale *et al.,* 2010). *C. olitorius* is a remarkable vegetable food to many families in Africa, Asia and in the Middle East. The edible leaves are rich sources of vitamins and minerals including: iron, calcium, thiamine, riboflavin, niacin, foliate, dietary fiber and protein (Shao *et al.,* 2008). *Corchorus* seeds show a high degree of dormancy, which can be broken by means of hot water treatment (Denton, 1997). Denton (1997) recommended a solution to the incidence of seed dormancy through the application of seed parboiling process. The seed dormancy syndrome may partly be as a result of condition outside the embryo which can be: physical, chemical, mechanical or even morphological in nature. The vegetable does well in acid, neutral and basic (alkaline) soils (Facciola,1990). It tolerates soil pH of 4.5 to 8.0, but more extreme pH conditions will reduce the availability of iron in the soil and cause yellowing between leaf veins (Takel, 2000). Its seeds tend to show poor germination. Hardseededness is likely to be the most prevalent problem in germination tests for stored seeds, but can be avoided by suitable treatments to the seed covering (Jajarmi, 2009).

Plants are generally exposed to diverse ecological stresses which edge their growth and productivity as well as effect considerable loss to global agricultural manufacture (Shao *et al*., 2008). One of the greatest significant factors affecting plant growth and the construction of secondary metabolites is the drought stress. Production of green buds and seeds are strongly affected by drought stress, resulting in the poor plant establishment at dry and saline soils (Afzal, 2005). Germination is one of the most drought-sensitive plant growth stages severely inhibited with increasing drought levels and salinity. It can be said that it is one of the most devastating environmental stresses. Iran, with an annual rainfall of 240 mm, is classified as one of those dry regions (Palada and Chang, 2003).

Several studies have been carried out on pre-germination treatments of seeds of wild okra (Basra *et al.,* 2007). These include hot water, mechanical scarification and acid treatment. Pre-treatment by salicylic acid is not performed on wild okra anyway. Therefore, this study was conducted to evaluate the response of wild okra (*Corchorus olitorius* L.) to drought stress.

MATERIALS AND METHODS

A field experiment was laid out in order to evaluate the response of wild okra to drought stress. This experiment was laid out in a completely randomized design with four replicates at the Laboratory of Horticulture, Faculty of Gorgan Agricultural and Natural Resources University, Iran, during March, 2015. Seeds were surface-sterilized with a 3% sodium hypochlorite solution, rinsed in distilled water for three times and dried for 36 h before the experiment. Treatments were done on different irrigation drought stress levels of PEG (0, -2, -4, -6, -8 and -10 bar). 25 seeds of each lot evenly placed on Whatman filter paper No.1 in sterilized 9 cm petri dishes separately and 10 ml of each solution were added to related treatment. All petri dishes were sealed to prevent the loss of moisture and to avoid contamination, and then placed in a plant growth chamber for 12 days. The seeds were allowed to germinate at 27°C with 12/12 h light/dark periodicity. The photosynthetic photon flux density was 340 $molm^{-2}s^{-1}$, provided by metal halide lamps, with a relative humidity of 45%. Germination was determined by counting the number of germinated seeds at 24 h intervals over a 12 day period and expressed as

Table 1. Analysis of variance of wild okra seeds germination under drought stress

S.O.V	df	Germination percentage %	Germination rate	Hypocotyl dry weight (g)	Radicle dry weight (g)	Seedling length (mm)	Seed vigor	Seed reserves utilization (mgg^{-1})	Conversion efficiency of mobilized seed reserve (mgg^{-1})	Ratio of utilized seed reserve
Drought stress	5	4698.49^{**}	1.501^{**}	0.00005^{ns}	0.000005^{**}	1591.85^{**}	18629882^{**}	37619741^{**}	150.4^{ns}	0.0000005^{ns}
Error	15	47.11	0.015	0.000004	0.0000004	12.65	126465.3	3469189	13.9	0.00000004
CV(%)		7.39	0.24	0.0047	0.001	4.62	18.06	49.3	6.5	0.0004

**, * and ns: Significant at the 1% and 5% levels of probability

total percent germination. Seeds were considered to be germinated at the emergence of the radicle (Bewley and Black, 1994). Radicle and hypocotyl lengths were measured 12 days after germination. The root and stem dry weight were determined by drying the plant material in an oven at 80°C for 24 h prior to weighing. Seed vigor index is determined by using the radicle length.

Germination percentage and germination rate were calculated using the following formula.

G% = (n/N)*100 [3]

RG =∑(Ni /Di) [3]

G: Germination percentage, n: Number of seeds germinated, N: Total number of seed in each petri dishes, RG: Rate of Germination (seed /day), Ni: Germinated seeds in each numeration, Di: Day of each numeration.

After germination test, oven-dried weight of seedlings were determined. The weight of the utilized (mobilized) seed reserve was calculated as the dry weight of the original seed minus the dry weight of the seed remnant. Conversion efficiency of mobilized seed reserve and ratio of utilized seed reserve to initial seed dry weight was considered as Seed Reserve Depletion Percentage (SRDP).

The statistical analyses to determine the individual and interactive effects of treatments were conducted using JMP 5.0.1.2 (Thakur and Sharma, 2005). Statistical significance was declared at P≤0.05 and P≤0.01 (Thakur and Sharma, 2005).

RESULTS

Germination percentage: The results showed that the effect of drought stress on germination percentage was significant at 1% (Table 1). Mean comparison table showed that the Germination Percentage (GP) reduced with increase in drought level so that the highest GP was recorded for -2 bar water potential with germination percentage of (96%) and the lowest GP was recorded for the -10 bar water potential (0%) (Table 2).

Germination rate: The results showed that the effect of drought stress on germination rate was significant at 1% (Table 1). Mean comparison table showed that the Germination Rate (GR) reduced with increasing drought level so that the highest GR was recorded for -2 bar water potential (1.72) and the lowest GR was recorded for the -10 bar water potential (0) (Table 2).

Hypocotyl dry weight: The effect of drought stress on hypocotyl dry weight was not significant (Table 1).

Radicle dry weight: The effect of drought stress on radicle dry weight was significant (Table 1). The response of this trait varied at different levels of water potential. Radicle dry weight decreased with the increasing drought levels. Maximum radicle dry weight was obtained at –2 bar water potential while the minimum of this trait resulted from the lowest level of water potential (-10 bar) (Table 2).

Seedling length: Results showed that the effect of drought stress on seedling length was significant at 1% level (Table 1). Mean comparison table showed that the seedling length reduced with increasing drought level so that the highest seedling length was recorded for -2 bar

Table 2. Means comparison of wild okra seed germination under drought stress

Treat-ments	Germi-nation per-centage (%)	Germi-nation rate	Hypo-cotyl dry weight (g)	Radicle dry weight (g)	Seedling length (mm)	Seed vigor index	Seed reserves utiliza-tion (mgg^{-1})	Conversion efficiency of mobilized seed reserve (mgg^{-1})	Ratio of utilized seed reserve (mg)
0	88[a]	1.57[a]	0.009[a]	0.0030[a]	50.67[b]	4447.3[b]	70.56[a]	14.1[a]	0.0010[a]
-2bar	96[a]	1.72[a]	0.010[a]	0.0033[a]	59.45[a]	5716.4[a]	88.97[a]	17.8[a]	0.0008[ab]
-4bar	30.67[b]	0.55[b]	0.003[b]	0.0013[b]	19.79[c]	604.7[c]	33.06[b]	6.6[b]	0.0006[b]
-6bar	26.67[bc]	0.48[bc]	0.002[b]	0.0013[b]	18.82[dc]	515.1[c]	23.67[b]	4.7[b]	0.0008[b]
-8bar	16[c]	0.28[c]	0.002[b]	0.0003[c]	13.13[c]	229.1[c]	7.32[b]	1.5[b]	0.0001[c]
-10bar	0	0	0	0	0	0	0	0	0

Means with at least one similar letter in each column have no signification difference at %5 of probability level

water potential (59 mm) and the lowest seedling length was recorded for the -10 bar water potential (0) (Table 2).

Seed vigor index: The effect of drought stress on seed vigor index was significant at 1% level (Table 1). Mean comparison table showed that the highest seed vigor index was recorded for -2 bar water potential and the lowest seed vigor index was recorded for the -10 bar water potential (Table 2).

Heterotrophic growth: Results for heterotrophic growth showed that the effect of drought stress on seed reserves utilization was significant at 1% level but on conversion efficiency of mobilized seed reserve and ratio of utilized seed reserve were not significant (Table 1). Mean comparison for seed reserves utilization showed that the highest seed reserves utilization was recorded for -2 bar water potential and the lowest seed reserves utilization was recorded for the -10 bar water potential (Table 2).

DISCUSSION

The results of the present study showed that the effect of drought stress was significant on all traits (Table 1). With increasing drought stress, there was significant difference between treatments in all evaluated traits ($p<0.01$). With increasing PEG concentration, germination percentage, germination rate, radicle and hypocotyl dry weight, seedling length and heterotrophic growth of wild okra were decreased (Table 2). Generally, germinated seeds in environments under stress conditions have shorter shoot and root

(SAS Institute,1990). The maximum of all traits was obtained at -2 bar treatment and minimum of them was obtained at -10 bar treatment (Table 2). Decreased root length was reported with increasing in water stresses and one of the causes of shoot length reduction in drought stress conditions has been found as reduction or non-transfer of nutrients from seed storage tissues to the embryo by Takel. In the present study germination rate decreased with increasing in drought level. Barzegar and Rahmani (2004) reported that there was a significant difference between values of percentage averages and germination speed of Hyssop seed (*Hyssopus officinalis*) under different of drought stress levels (0, -1, -3, -6 and -9 bar), and with increasing stress intensity, the values of these traits got lower. Their results are consistent with our results. Also, reduction of root length with increasing in water potential has been reported by Takel. However, decreasing in water absorption by seed under drought stress causes to decrease in hormones secretion and enzymes that result to impair seedling growth (root and shoot) (Asghari, 2002). Falleri (1994) reported that germination rate of *Pinus pinaster* seeds in drought stress conditions reduced more than germination percent. The results showed that seed vigor index had more reaction to moisture by increase in PEG concentration and was adversely affected when moisture stress reached -10 bars. In this treatment, seed vigor index was zero (Table

2). Decreasing seed vigor index is probably due to decreasing moisture availability, which causes enzyme activity by some problems in the transfer of endosperm reserves in the form used for the growth of embryonic axes and synthesis of compounds on seed (Shao *et al.,* 2008). When the seeds are exposed to drought, flexibility decreased in cells wall growing, so that reduces cell expansion and consequently organs growth (Soltani *et al.,* 2006).

In the present study, heterotrophic growth components such as seed reserves utilization, conversion efficiency of mobilized seed reserve and ratio of utilized seed reserve decreased with the increasing drought levels (Table 1). The highest seed reserves utilization was recorded for -2 bar water potential and the lowest seed reserves utilization was recorded for the -10 bar water potential (Table 2). Decrease of hydrolytic enzymes activity laid to the decrease of heterotrophic growth components under drought stress. Soltani *et al*. (2002) showed that the increase of osmotic pressure under drought and salinity stresses lead to decrease in seed reserve enlistment, but no significant differences were set up between stressed and non-stressed plants with high opinion to the conversion efficacy of mobilized reserves. They stated that decrease in seed reserve mobilization rate was the cause for decreased seedling growth. They had reported similar results for chickpea seedling growth as influenced by salinity and seed size
(Vorster *et al.,* 2002).

The results of this study showed that with increase in drought levels in wild okra, seed germination parameters, seedling growth and heterotrophic growth components decreased significantly.

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