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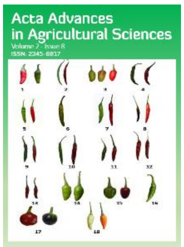

Research Article

Assessment of effect of water chemical potential decrease on seed germination in wheat and water potential of nutsedge leaf

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ABSTRACT

Salinity is one of the important cause to stresses of the agricultural productions limiting through water chemical potential decrease particularly in the early stages of growth. Effective methods of greenhouse studies assess these changes and the amount of plant interact in the stages of growth. In this research, the objective was to evaluate wheat seed germination and nutsedge water potential in cultivation with media by different osmotic potential. Seeds of wheat and leaves of nutsedge were placed in Petri dishes with varying concentrations of sucrose ($\Psi s=0$, -0.5, -1, -1.5 and -2 MPa) at room temperature (24 ± 2°C) in complete randomized design (CRD). The line slope for rate of water potential of nutsedge is -0.39. It presented that decrease of water potential cause to decrease water obtained of plant during rang of osmotic potential. Indeed, with increasing osmotic pressure, plant's ability to absorb water had decreasing trend in the plants. Most swelling weight loss of the plant was related to the osmotic potential of -1.5 MPa (i.e . %12 fresh weight plant), wheat germination was not occurred during 8 days in this osmotic potential. Germination percent of wheat was similar to control in -0.5 MPa. Critical point of germination wheat and water potential of nusdage leave were Ψs =-1.66 and -1.78 Mpa, respectively. So, wheat germination was more sensitive than osmotic potential of nusdage leave. Effect of each of the solution increased over time.

Introduction

Soil and water salinity are one of the main reasons for decreasing the production in the world. It has caused commonly a decrease in the average yield of some crops. Eslami *et al* (2009) reported that tolerance of plants to environmental stresses at different stages of the life cycle is different and early stages are usually considered as the most sensitive growth stages in the most plants. Plants tolerance is important for stability, because weak germination and seedling development decrease in high salinity (Soltani *et al.*, 2006). From international statistics, Iran is the eighth country of wheat consumption in the world (1.6%). Iran is one of the most wheat consuming countries. Per capita consumption of wheat in Iran is about 135 kg, while the average global wheat consumption is 68 kg (Aataee., 2009). Over many years, the effects of high osmotic stress on during plant stages have been the subject of scientific reports by several authors (Almansouri *et al*., 2001; Javed and Ikram., 2008; Cakmak *et al*., 2010). Numerous factors may inhibite on the germination of wheat. Upon exposure to osmotic stress, plants exhibited a wide range of responses at the molecular, cellular, and whole-plant levels (Hasegawa *et al*., 2000; Xiong and Zhu, 2002). Almansouri *et al* (2001) observed under taken in order to compare the effects of NaCl and iso-osmotic stresses induced on germination processes in wheat cultivars differing in their level of salt and drought resistance. He concluded that stress inhibition of germination could not be attributed to mobilization of reserves and main effect is an inhibition of water uptake while detrimental effects of NaCl may be linked to long-term effects of accumulated toxic ions for growing. Selection for salinity tolerance appears as a laborious and hazardous task and plant breeders; therefore, seeking for quick, cheap and reliable ways to assess the salt-tolerance of selected material. Determination of germination potential of seeds in saline conditions could appear as a simple and useful parameter (Ashraf *et al*., 1987). Ashagre *et al* (2014) indicated that at higher concentrations of born in water a deleterious effect on germination and seedling growth traits of wheat. Moreover, tolerance of plants to high concentration of different elements and material is varied in different species and environmental condition.

Nutsedge weeds are perennial obnoxious weeds inhabiting in most warm regions worldwide (Akin and Shaw, 2001). According to cultivation condition and soil region, there is nutsedge in adjacent of fields of wheat and rice in north of Iran (Gilan). It causes high yield losses in many crops worldwide. Since it has become a serious weed in several regions where vegetables are produced, growing vegetables in heavily infested fields should be abandoned due to their low competitiveness and the lack of available effective herbicides (Keller *et al*., 2014). Chase and Appleby (1979) reported that purple nutsedge (*Cyperus rotundus* L.) is more resistance at −2 bars than at −11 bars of plant water potential. To knowledge of water potential of plant can be realized water requirement of crops. If water potential of plant is less than zero, it indicated the shortage of water in the plant. This parameter can be used to criteria for absorbing water and transpiration. It seemed to be the best way to assess the potential of water status in plant tissues. The availability of water to soil-grown plants is determined in largest part by the interaction of water with the surfaces of soil particles and by the effects of soil solutes. It has been convenient to group the surface forces, usually adsorptive and capillary forces, in a single term, matric potential (Kramer *et al*., 1966). Various methods for measuring water potential were suggested by researchers. Many researches were carried out about measuring matric potentials in some parts of plants for example sunflower, (*Helianthus annuus* L.), yew (*Taxus cuspidata* Sieb. and Zucc.), and rhododendron (*Rhododendron roseum* Rehd.). Calculations indicated that the water potential of the solution in the cell could be estimated for living tissue from the sum of matric and osmotic potentials acting on water outside the protoplasts (Boyer., 1966).

The aim of this paper is to explore the role of chemical potential of water decrease on germination of wheat and simultaneously decrease of chemical potential impact also on water potential of leave in nutsedge (genotypes from Iran (Gilan province) as along plant.

Materials and Methods

Experimental Set up

Firstly, the solutions were prepared with osmotic potentials of 0, -0.5, -1, -1.5, -2 MPa (Almansouri et al., 2001). Then, we used 1M mother solution of sucrose with the titration method, after calculation of requirement volume of each potential through this equation (M = mol solute 1/ Vsolution1 = mol solute2 / L solution2) (distilled water and sacarose) (Table 1).

Parameters of leaves

Dry to fresh weight water ratio (%): In according to equations (1 and 2), % water plant weight based on the fresh weight (WC_f), % water plant weight based on the dry weight (WC_d) were calculated (Alizadeh, 2010).

Equation (1)

$$WCf = \frac{Fresh\ leaf\ weight - Dry\ leaf\ weight}{fresh\ leaf\ weight}$$

Equation (2)

$$WC_d = \frac{Fresh\ leaf\ weight - Dry\ leaf\ weight}{Dry\ leaf\ weight}$$

Relation swollen: In according to equation (3 and 4), relative water content (RWC), Water saturate deficit (WSD) were calculated (Alizadeh, 2010).

Equation (3)

$$RWC = \frac{Fresh\ leaf\ weight - Dry\ leaf\ weight}{Swollen\ leaf\ weight - Dry\ leaf\ weight}$$

Equation (4)

$$WSD = \frac{Swollen\ leaf\ weight - Fresh\ leaf\ weight}{Swollen\ leaf\ weight - Dry\ leaf\ weight}$$

Liquid balance method for measuring water potential in plants: Since nutsedge has a high growth rate, in addition to water potential of plants is the best index to determination of the water status of plant cells, leave of nutsedge was selected as a suitable part of plant in order to changing water potential. Each of weighed leave samples directly dipped into a solution that had known water potential. Because the most of the cells plant cannot easily absorb sucrose, it was used for preparation of solutions with different osmotic potential. It placed in a cool, dry site until received to balance for 24 hours. After passing the time balance, leaves were brought out, dried wiped on Whatman filter paper and then weighted them, immediately. After drawing graphs, the point that water potential in plant balanced with water potential was estimated (Figure 1 and 3) (Alizadeh, 2010).

Seeds Germination: In germination stage, plant tolerance was only evaluated by the survival of seedlings or the so-called percentage of seed emergence. Seeds of wheat (*Durum*) (Poaceae: Triticeae) were prepared from Rice Research Institute (Rasht). Ten wheat seeds were dipped in each Petri dish (100mm Diameter x 15mm Height and without filter paper). Petri dishes were collocated in a chamber at 24 ± 2°C and 600-700 Lux light in soil and plant lab of Gilan university (from 6am to 6pm pacific time) (Cakmak *et al*., 2010). The number of germinated seeds was counted in each petri dish during 8 days, every day.

Data analysis and Data treatment: The data were subjected to statistical analysis using complete randomized design (CRD). Draw graphs was taken placed with Excel 2010 program.

Results and Discussion

Nutsedge (Cyperus spp.)

The primary characteristic of the plant is as following (Table 2); From 3rd to 7th days, Osmotic and fresh weight changes indifferent osmotic potential has been presented in figure 1.

In general, leave weights in each osmotic potential decreased through osmotic potential decrease during (0 to -2 MPa).

Table1. *Materials for preparing the desired solution*

ψ_s (Mpa)	Volume of Primery solution of sacarose ($C_{12}H_{22}O_{11}$) (Cm3)	Volume of Distill water (Cm3)	Total (Cm3)
0	0	100	100
-0.5	20.8	79.2	100
-1	41.7	58.3	100
-1.5	62.5	37.5	100
-2	83.3	16.7	100

Table 2. *Some plant parameters*

WSD %	RWC %	WC_d %	WC_f %	Leave dry weight (g)	Leave fresh weight (g)	weight(g) Swollen leave
39	61	42.9	81	0.27	1.43	2.17

WC_f (% water plant weight based on the fresh weight), WC_d (% water plant weight based on the dry weight), RWC (relative water content), WSD (Water saturate deficit)

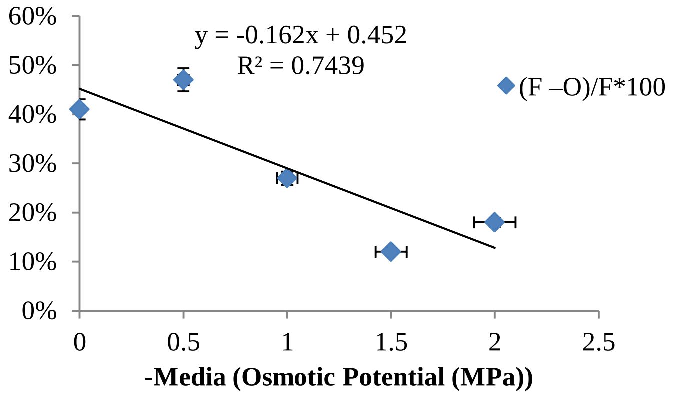

Fig 1. Trend of change in plant weight in each osmotic potential and trend of decrease

* Leave Fresh weight (F), Plant weight in each osmotic potential (O), (F –O)/F*100

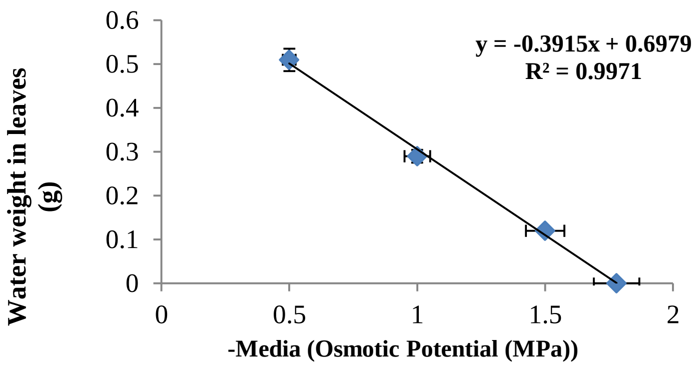

Fig 2. Changes of weight obtained or lost water in Osmotic potential (0.5- 1.78 MPa)

The water content of leaves could be observed in figure2. It reduced with increasing of osmotic potential (0.5 g to 0 during 0 to -1.78 MPa) that it could be verified by comparing in figure1. It received from 41% to 12% during potential osmotic change (0-2 MPa). Because of osmotic potential decrease, it caused to reduce performance in plant. The total reduction fresh weight is 56% osmotic weight.

Germination of Wheat

In according to figure 3 (a and b), germination percent of wheat seeds increased 0-10 % at Ψs =0 in first two days. In the third and seventh days remained stable 50% and it reached to 60% eighth day. While germination percentage was zero at Ψs =-0.5MPa in the first and second days, until the incremented trend reached to 60% in the eighth day. However in both osmotic potential (0 and -0.5MPa), the germination rate is equal (60%) in the eighth day. But changes trend was different. In Ψs =-0.5 MPa, firstly days were influenced.

The most germination was occurred in 0 and -0.5 MPa. The trend of germination decreased by decreasing the osmotic potential, germination value was received to zero percent at Ψs = -1.66 MPa (Figure 4).

Conclusion

Increasing the sucrose concentration caused to reduction of water potential in solution water, thus reducing the water obsorption in the leaves and germination was carried out. In according result comparisons showed that the osmotic potential -1.5 to -2 MPa should be consider as the critical limit to a sharp reduction in percent of wheat seed germination and water potential in leave of nutsedge as strategically and herbaceous plant, respectively. This critical level was -1.74 MPa for potential in leave of nutsedge and -1.66 MPa for wheat seed germination. Moreover, the lowest dry and osmotic weight was observed at this range of water osmotic potential. This range was obtained same content in two plants in the performance of different parts. Salinity is one of the environmental factors that has limited the distribution and productivity of major crops. In this condition, dry matter loss was occurred due to factors such as reducing of cell swollen pressure. Plants kept water potential in organs lower than surrounding media, until needed pressure and absorption was continued for growth (Munns and James., 2003). Final germination percent was reduced in response to the highest dose of NaCl in agreement with Almansouri *et al*., 2001. With increasing levels of osmotic stress declined germination rate and percentage of Isabgol (*Plantago ovata*) (Hosseini and Rezvani Moghadam., 2006). Salt and water stresses could be reduce germination either by limiting water absorption by the seeds through affecting the mobilization of stored reserves (Bouaziz and Hicks, 1990 ;Lin and Kao, 1995; Prakash and Prathapasenan., 1988) or by directly affecting the structural organization or synthesis of proteins in germinating embryos (Ramagopal, 1990). These parameters could be affected by both ionic and osmotic components of salt stress although the relative importance of each component is a matter of debate and could differ among species and even among cultivars of a given species (Dodd and Donovan, 1999). Salinity caused to disturb the nutrient imbalances, also toxic and impaired effects on plant growth by reducing the osmotic potential solution. Germination was not occurred over 0.5 MPa during 8 days. This result is in according to result's Almansouri *et al* (2001). They observed that wheat germination in 0.58,

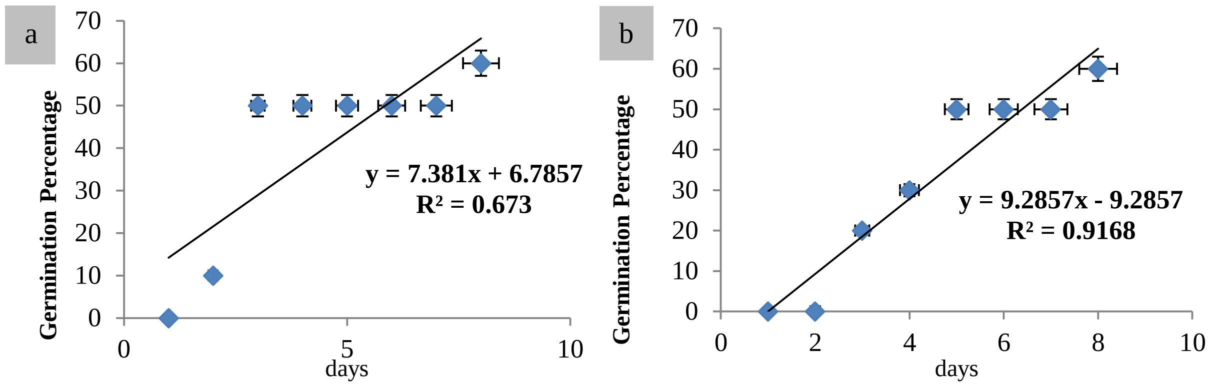

Fig 3. Trend of germination percent at Ψs =0 (a) and Ψs = -0.5 (b) during 8 days

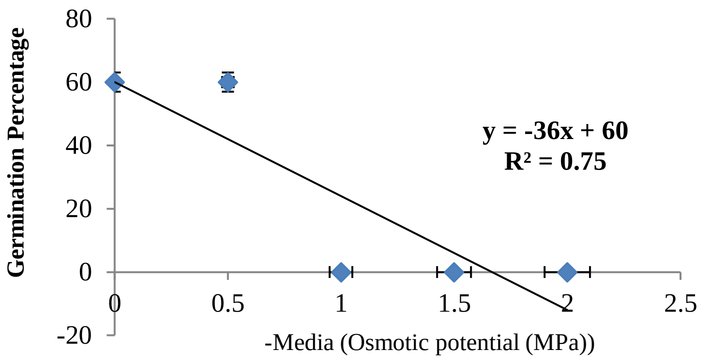

Fig 4. Trend of germination percent at Ψs =0.5 MPa during 8 days

1.05 and 1.57 MPa a slight decrease trend and germination is more intense reduce with increasing osmotic pressure. This osmotic potential reduced slightly fresh weight of germinating seeds in comparison of the control solution in wheat. It is suggested to evaluate effect of more osmotic potentials on other plant species in the future studies.

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