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Effect of NaCl and Na_2SO_4 salinities and light conditions on seed germination of purslane (*Portulaca oleracea* Linn.)

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ABSTRACT

Portulaca oleracea Linn., commonly known as purslane, is a C_4 succulent and salt tolerant weed. This work was focused on the seed germination of purslane under different levels of NaCl and Na_2SO_4 (25, 50, 100 and 200 mM) salinity along with continuous dark and light conditions. Results indicated that both salinity treatments had a negative impact on seed germination under both light and dark conditions. Interestingly, seed germination percentage of purslane was high under both salinity treatments and continuous light conditions as compared to dark conditions. The differential response of purslane's seed germination under NaCl and Na_2SO_4 salinity and light conditions suggests weediness of this plant under adverse environmental conditions. This work might be helpful for agricultural practices dealing with the problem of this weed.

KEY WORDS: Light conditions, purslane, salinity, seed germination

INTRODUCTION

Portulaca oleracea Linn commonly known as purslane, belonging to family Portulacaceae is an annual herb with succulent stem and leaves. It may grow erect or prostrate. It is 8^{th} common plant on earth (Liu *et al.*, 2000) that grows in cultivated fields, gardens, and waste places. It has long history of its use as human food, animal feed, and medicinal purpose. Purslane is identified as an excellent source of omega-3 fatty acids among the leafy vegetables. leafy vegetable (Simopoulos, 2004).

P. oleracea is a common weed, which can complete its life cycle within 2-4 months in both tropical and temperate regions (Singh, 1973). It was noticed that a single plant can produce as many as 10,000 seeds (Chauhan and Johnson, 2009). Seed germination of purslane was initially studied by Singh (1973) and then by Chauhan and Johnson (2009). Both studies found that seed germination of this plant is influenced by light and dark conditions along with temperature and depth of soil. However, seed germination of this plant under different light regimes is not studied. Hence, the main aim of the present experiment was to study the effect of NaCl and Na_2SO_4 salinity and light conditions on seed germination of purslane. This work might be helpful for agricultural practices dealing with the problem of this weed.

MATERIALS AND METHODS

Seeds of *P. oleracea* Linn. were collected from the campus of Shivaji University, Kolhapur. These were germinated in glass petriplates. 25 healthy seeds for each treatment were surface sterilized (0.1% $HgCl_2$) for 5 min., washed with distilled water and kept on blotting paper moistened with 10 ml of distilled water as control. To study the effect of NaCl and Na_2SO_4 salinity on seed germination, blotting papers were moistened with 10 ml of different concentrations (25, 50, 100 and 200 mM) of salts separately. The continuous dark and continuous light conditions were maintained by putting Petri plates in dark and light chambers. The room temperature during this study was 28±2°C. Seed germination percentage after 7 days of soaking was calculated by formula:

Seed germination %=Number of seeds germinated/total number of seeds (25)×100.

RESULTS

Effect of NaCl and Na_2SO_4 Salinity and Light Conditions on Seed Germination Percentage of *P. oleracea*

Seed germination of *P. oleracea* in continuous dark and continuous light conditions and under NaCl and Na_2SO_4 salinities is recorded in Table 1 and depicted in Figure 1.

Table 1: Effect of NaCl and Na_2SO_4 salinities on seed germination percentage of *Portulaca oleracea* under continuous dark and continuous light conditions. Results are after 7 days of wetting at 28°C±2°C temperature

Treatments	Germination %	
	Continuous dark	Continuous light
NaCl (mM)		
0 (Control)	57.66±2.08[a]	71.00±2.64[a]
25	41.67±3.51[b] (−27.74)	62.33±2.51[b] (−12.20)
50	35.00±2.64[c] (−39.30)	55.32±3.21[c] (−22.06)
100	30.34±2.52[d] (−47.39)	27.00±2.64[d] (−61.97)
200	9.00±0.57[e] (−84.39)	3.00±1.00[e] (−95.77)
Na_2SO_4 (mM)		
0 (Control)	63.67±1.52[a]	83.33±3.05[a]
25	63.32±1.15[a] (−0.52)	72.65±2.08[b] (−12.80)
50	57.66±2.51[b] (−9.42)	66.00±2.00[c] (−20.80)
100	31.65±1.52[c] (−50.26)	53.33±3.05[d] (−36.00)
200	1.66±0.57[d] (−97.38)	6.67±1.52[e] (−92.00)

Values in parenthesis indicate percent increase (+) or decrease (−) over the control. Values in a column followed by the same letter are not significantly different at the 0.05 level, as determined by Duncan's multiple range test. Each value is the mean of three replications of three different batches. Mean±standard deviation

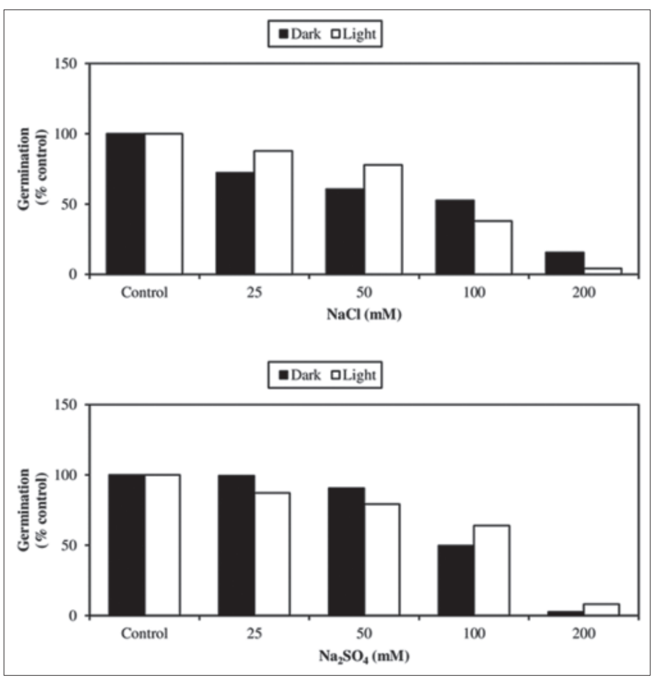

Figure 1: Effect of NaCl and Na_2SO_4 salinities on seed germination percentage of *Portulaca oleracea* under continuous dark and continuous light conditions. Results are after 7 days of wetting at 28°C±2°C temperature

It is clear from the data that both salinity treatments have negative effect on seed germination under both dark and light conditions. It was noticed that the percent seed germination under control conditions was significantly higher under light condition than that under dark condition. It was decreased with increasing levels of NaCl salinity under dark condition. It was noticed that at the lower levels of NaCl salinity (25 and 50 mM) and the under dark condition, germination was more affected than that under light condition. However, under NaCl salinity + light condition, it was significantly declined under 100 and 200 mM NaCl treatments. It was also noticed that seed germination was more affected under higher levels of NaCl under light condition than that under dark condition. The concentration of 100 and 200 mM NaCl under both dark and light conditions were found to be toxic.

Germination of *P. oleracea* under 100 and 200 mM Na_2SO_4 salinity was decreased significantly under dark than that under light condition. It was noticed that at lower levels of Na_2SO_4 salinity (25 and 50 mM) and under dark condition, it was less affected than that under light condition. From these observations, it appears that there was differential response of seed germination toward NaCl and Na_2SO_4 salinities under both dark and light conditions. Seed germination was more affected under NaCl + light and Na_2SO_4 + dark combinations. It was also noticed that light favors seed germination of *P. oleracea* without any treatment.

DISCUSSION

Soil salinity is an important factor limiting growth and development of plants. Life of plant starts with seed germination by absorbing water from surrounding media. Seed germination, seedling emergence, and early endurance are sensitive to substrate salinity (Houle *et al.*, 2000) because high salinity decreases substrate water potential and lead to restriction of water and nutrient uptake (Pessarakli, 2010). Furthermore, high salinity also causes ionic imbalance and toxicity in plants (Azooz and Ahmad, 2015). There are several reports which have recorded that the salinity affects seed germination of different plants. Furthermore, temperature and light conditions are also important factors during seed germination. Khan *et al*. (2000) noticed that *Salicornia rubra* Nels., one of the most salt tolerant species, exposed to increasing levels of NaCl salinity (200-1000 mM) and temperature regime of 25°C night and 35°C day showed higher seed germination. Seed germination studies of a halophytic grass, *Aeluropus lagopoides* under various levels of NaCl salinity and temperature regimes revealed that at low temperature (10/20°C) and high salinity (300 mM) no germination was noticed (Gulzar and Khan, 2001). However, at 20/30°C temperature and lower salinity levels, the seed germination percentage was significantly increased. Huang *et al*. (2003) noticed that seed germination of *Haloxylon ammodendron* was the highest at 10°C temperature, lower levels of salinity and under dark conditions. Zia and Khan (2004) studied the effect of light, salinity and temperature on seed germination of *Limonium stocksii*. They noticed that the highest percentage of seed germination (about 100%) at 0, 100, and 200 mM NaCl at 20:30°C and further increase in salinity resulted in decreased seed germination percentage. They found that seed germination of *Limonium stocksii* was lowered in the dark in comparison to that in a 12-h photoperiod under saline conditions. Oh *et al*. (2006) found that seed germination of *Arabidopsis* was promoted by light by degradation of PIL5 protein (a phytochrome-interacting bHLH protein) leading to increased gibberellin (GA) biosynthesis and decreased GA degradation. From this discussion, it was found that light is an important factor during seed germination.

Effect of temperature and light on seed germination of two ecotypes of *P. oleracea* with obovate leaf and narrowly obovate leaf was studied by Singh (1973). He noticed that 1-year-old seeds showed significant temperature-dependent dark germination and complete germination with a single light exposure at a high temperature. They found that seeds of the narrowly obovate leaf ecotype were more sensitive to light than those of obovate leaf ecotype. Experimental work of Chauhan and Johnson (2009) on seed germination and seedling emergence of *P. oleracea* under the influence of environmental factors revealed that germination in the dark was low and was not influenced by the temperatures (35/25°C, 30/20°C and 25/15°C alternating day/night temperatures). They further noticed that in the light/dark regime, germination was lower at 25/15°C and 35/25°C than that at 30/20°C (70%, 75% and 81% germination, respectively). In conditions of 106 mM sodium chloride or −0.34 MPa osmotic potential, seeds germinated to only 50% of maximum germination of the control. Seed germination in *P. oleracea* was the greatest for seeds placed on the soil surface, but emergence was declined with increasing seed burial depth in soil; no seedlings emerged from the depth of 2 cm. From these observations, they postulated that light and temperature are important environmental factors responsible for widespread of weed *P. oleracea* in the humid tropics.

The results obtained during this experimental work are in agreement with the findings of Rahdari *et al*. (2012). They studied the effect of NaCl salinity on seed germination of *P. oleracea* and found that it was decreased with increasing level of NaCl concentration. According to them, low osmotic potential and high ionic toxicity imposed due to salinity stress caused reduction in seed germination of *P. oleracea*. It was noticed that seed germination was influenced by environmental conditions. It was the highest in continuous light conditions without any salinity treatment, indicated that light might be an important factor for seed germination of this plant. There might be degradation of PIL5 protein (a phytochrome-interacting bHLH protein) leading to increased GA biosynthesis and decreased GA degradation by light (Oh *et al*., 2006) which promotes seed germination in *P. oleracea*. This characteristic feature may contribute toward weediness of *P. oleracea*.

CONCLUSION

The studies on the effect of NaCl and Na_2SO_4 salinity on seed germination under continuous dark and light conditions suggested that seed germination of *P. oleracea* was more affected under NaCl + light and Na_2SO_4 + dark combinations. The differential response of purslane's seed germination under NaCl and Na_2SO_4 salinity and light conditions suggests weediness of this plant under adverse environmental conditions. This work might be helpful for agricultural practices dealing with the problem of this weed.

CONFLICT OF INTERESTS

The authors have not any conflict of interests.

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REFERENCES

Azooz MM, Ahmad P, editors. Legumes Under Environmental Stress: Yield, Improvement and Adaptations. Chichester, UK: John Wiley & Sons, Ltd.; 2015.

Chauhan BS, Johnson DE. Seed germination ecology of *Portulaca oleracea* L: An important weed of rice and upland crops. Ann Appl Biol 2009;155:61-9.

Gulzar S, Khan MA. Seed germination of a halophytic grass *Aeluropus lagopoides*. Ann Bot 2001;87:319-24.

Houle G, Morel L, Reynolds C, Siegel J. The effect of salinity on different developmental stages of an endemic annual plant, *Aster laurentianus* (*Asteraceae*). Am J Bot 2001;88(1):62-7.

Huang ZY, Zhang XS, Zheng GH, Gutterman Y. Influence of light, temperature, salinity and storage on seed germination of *Haloxylon ammodendron*. J Arid Environ 2003;55:453-64.

Khan MA, Gul B, Weber DJ. Germination responses of *Salicornia rubra* to temperature and salinity. J Arid Environ 2000;45:207-14.

Liu L, Howe P, Zhou YF, Xu ZQ, Hocart C, Zhan R. Fatty acids and beta-carotene in Australian purslane (*Portulaca oleracea*) varieties. J Chromatogr A 2000;893:207-13.

Oh E, Yamaguchi S, Kamiya Y, Bae G, Chung WI, Choi G. Light activates the degradation of PIL5 protein to promote seed germination through gibberellin in *Arabidopsis*. Plant J 2006;47:124-39.

Pessarakli M, editor. Handbook of Plant and Crop Stress. 3rd ed. USA: CRC Press; 2010.

Rahdari P, Tavakoli S, Hosseini SM. Studying of salinity stress effect on germination, proline, sugar, protein, lipid and chlorophyll content in purslane (*Portulaca oleracea* L.) Leaves. J Stress Physiol Biochem 2012;8:182-93.

Simopoulos AP. Omega-3 fatty acids and antioxidants in edible wild plants. Biol Res 2004;37:263-77.

Singh KP. Effect of temperature and light on seed germination of two ecotypes of *Portulaca oleracea* L. New Phytol 1973;72:289-95.

Zia S, Khan MA. Effect of light, salinity, and temperature on seed germination of *Limonium stocksii*. Can J Bot 2004;82:151-7.