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Initial Seedling Growth of Pepperweed (*Lepidium Perfoliatum* L.) as Affected by Salinity and Burial Depth

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Effects of Salinity and Burial Depth on Pepperweed Seedling Growth
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Abstract – **Pepperweed (*Lepidium perfoliatum* L.) is a problematic weed in arable lands of East Azerbaijan, Iran. Laboratory experiments were undertaken to assay seedling growth traits (length and dry weight) in response to light and burial depth. Saline conditions simulated by different NaCl concentrations, impaired largely seedlings growth. The reductions were more evident till 12 dS m^{-1} salinity level and thereafter reduced more slowly at 18, 24 and 30 dS m^{-1} NaCl concentrations. It is presumable that chances for growth and appreciable establishment of *L. perfoliatum* to establish in high saline soils would be somewhat low. With increasing burial depth from 0.5 to 4 cm, length and dry matter of the emerged seedlings were reduced constantly. No seedlings were emerged from the seeds buried at 6 cm depth. This suggests that *L. perfoliatum* would not become trouble to growers at minimum or reduced-tillage cropping systems.**

Keywords – **Burial Depth, Dry Matter, Pepperweed (*Lepidium Perfoliatum* L.), Salinity, Seedling Growth.**

I. Introduction

The genus *Lepidium* is an invasive species and belongs to the genera of the Brassicaceae consisting of about 175 species. It is distributed worldwide, primarily in temperate and subtropical regions; the genus is poorly represented in arctic climates and in tropical areas it grows in the mountains (Al- Shehbaz, 1986 a,b). Pepperweed (*Lepidium perfoliatum* L.) is a biennial or annual invasive species that distinct in the genus and the family morphologically on account of the nodal swellings (Rechinger, 1968).

Germination and seedling stage are the most critical periods for the establishment of plant species (Bani-Aameur and Sipple-Michmerhuizen, 2001), includes many reactions with different phases affected by environmental factors. The influence of these factors varies between species (Riemens *et al.,* 2004). The arid and semi-arid regions of the world are characterized by drought and commonly by saline soils; thus plants from these regions must be adapted to the adverse situations of these habitats (Epstein, 1972). The ability of seeds of some populations to germinate more rapidly or a greater percentage of the seeds to germinate under stressful environmental conditions provides an early competitive advantage to the more tolerant species (Harper, 1977). Most invasive plants primarily rely on seed dispersal and seedling recruitment for population establishment and persistence.

Ecophysiological studies of seed germination have suggested that light, temperature, pH, osmotic potential, salinity and planting depth can be the most reliable environmental signals to indicate the appropriate timing for seeds germination and subsequent seedlings emergence (Demirezen and Aksoy, 2007). A better understanding of how germination and initial growth of *L. perfoliatum* seedlings responds to major soil and/or environmental factors and depth of burial will provide us with valuable information about its aggressive spread in East Azerbaijan, could ultimately help in devising an integrated management plan for this troublesome weed. Hence, in the present work seedlings emergence and growth of *L. perfoliatum* in relation to its adaptability to different temperatures, salt concentrations and burial depths were explored.

II. Materials and Methods

Plant materials and preparing

Experiments were carried out at the Seed Technology Laboratory of the University of Tabriz in 2013. Seeds of *L. perfoliatum* were collected during August in 2012, the time for ripening of the seeds of species studied. Early observations showed the seeds were not dormant. The seeds were obtained from a naturally occurring population in fields belonging to Faculty of Agriculture, University of Tabriz (latitude 38.05^0 N, longitude 46.170 E, Altitude 1360 m above sea level) which is located in the North-west of East Azerbaijan province, Iran. The climate of the location is characterized by mean annual precipitation of 245.75 mm, mean annual temperature of 10°C, mean annual maximum temperature of 16.6°C, and mean annual minimum temperature of 4.2°C. The seeds were cleaned and dried for a few days at room temperature and then stored under such conditions in paper bags until used in the experiments. Prior to the each experiment, smaller and yellowish seeds of *L. perfoliatum*, considered as immature seeds were omitted.

Salt stress

Sodium chloride solutions of 0 (as control), 6, 12, 18, 24, and 30 dS m^{-1} were prepared to induce five levels of salinity stress. Thereafter, fifty selected seeds were surface sterilized in 2% sodium hypochlorite solution for 15 min, and then were rinsed with distilled water thoroughly. Seeds were placed equidistant in covered Petri dishes (9 cm diameter) containing sterilized filter paper in the bottom which was moistened with either distilled water or NaCl solution. The treatment solutions were drained off from the germination media and replaced with 5 ml fresh solutions at 2-day intervals to avoid the effect of seed leachates. Seeds were incubated under 20/10 °C temperature and 12 h light/dark conditions for 8 days (Amini *et al.,* unpublished).

Burial depth

To determine the effect of burial depth on seedling emergence of *L. perfoliatum,* fifty seeds were buried in 0.5, 1, 2, 3, 4, and 6 cm emergence depths of sand in plastic pots measuring 70 mm diameter×90 mm deep. Containers were watered as needed to maintain adequate soil moisture. Emerged seedlings were counted daily for 2 weeks. Temperature and light/dark conditions were as used to salinity experiment.

At the end of each experiment period dry weight and length of normal seedlings were quantified. The data of the experiments were pooled for analysis of variance (ANOVA), as there was no time × treatment interaction. All experiments were carried out twice as a completely randomized design with four replications per treatment. The SAS Version 9.0.3 was used for ANOVA. The data that were used in ANOVA met the assumptions such as normality and homogeneity of variance and did not require transformation.

III. Results and Discussion

Salt stress

Analysis of variance of the data for length and dry weight of *L. perfoliatum* seedlings (Table 1) showed that both of growth parameters were significantly affected by salinity at 1% probability level. According to comparison of mean values, similar patterns were detectable for both seedlings length and dry matter changes in different salt solutions. Seedlings growth was hampered remarkably proportionally to increased salinity level up to 18 dS m^{-1} in growing medium. Beyond this point, the effects were negligible and seedling produced by the seeds exposed made very poor growth (Figs. 1 & 2). Soil salinity suppresses shoot growth more than the root growth (Ramoliya *et al.,* 2004). The mechanism by which salt reduces growth is probably via an osmotic stress or ion toxicity. NaCl salinity also affects water and ion transport processes in plants, which may change the nutritional status and ion balance (Hasni *et al.,* 2009). Reduced shoot dry matter of seedlings (Fig. 2) is the consequence of impaired radical and hypocotyl extension due to prevent cellular division and elongation (Boureima *et al.,* 2011) under low water potentials under saline conditions (Fig. 1). Conforming our observations, Analiza *et al.,* (2012) considered common beggar's (*Bidens alba*) as a moderately-tolerant weed species to salt stress. They observed that it is able to germinate and produce seedlings over a wide range of salt concentrations (10 to 160 mM NaCl). Similarly, germination of hairy beggar's-tick (Reddy and Singh, 1992) and tall morning glory [*Ipomoea purpurea* (L.) Roth] (Singh *et al.,* 2011) were also inhibited at salt concentrations ≥200 mM; however a small proportion of seeds still germinated at salt concentrations ≥100 mM. Considering these results, sharp reduction in *L. perfoliatum* vegetative shoot emergence experiencing salinities up to 12 dS m^{-1} shows that this species is fairly sensitive to salt stress at seedling stage. Nevertheless, it is able to geminate and produce seedlings, which may ensure its survival under moderately-saline soils.

Burial depths

Table 2 represents the effect of burial depths on growth had a significant. Soil burial depth is one of the factors having a major role in emergence of weed seeds. The emergence of *L. perfoliatum* severely controlled by burial depth, as with increasing the depth of seeds placement growth of seedlings was reduced (Figs. 3 & 4). None of seeds buried at 6 cm were able to emerge and reach soil surface. This response could be due to a light trigger (Benvenuti, 1995). However, *L. perfoliatum* do not require light to germinate (Amini *et al.,* unpublished). Several researchers have suggested that seedling emergence might be limited by an induction of seed dormancy because of hypoxia, production of anaerobic metabolites (Benvenuti and Macchia, 1995; Boyd and Acker, 2004), and reduction in diurnal temperature fluctuations as planting depth increases (Thompson and Grime, 1983). Furthermore, physical limitations in carbohydrate reserves in small seeds similar to those of *L. perfoliatum* might not be sufficient to support seedling emergence as burial depth increases (Bewley and Black, 1994). This could explain why vigorous seedlings was produced of the seeds placed near the soil surfaces, compared with those have not enough energy reserves to emerge from deeper locations in the soil. With increasing time to start emergence after sowing depth of 0.5 cm, growth reduction of *L. perfoliatum* seedlings is rational. Similar results have been reported for a number of species (Chauhan and Johnson, 2010; Bolfrey-Arku *et al.,* 2011).

IV. Conclusion

Our results suggest that *L. perfoliatum* is moderately tolerant to salt stress. Also shallow plowing to bury *L. perfoliatum* seeds below 4 cm in the soil would be effective enough to reduce or control the emergence and population of this weed species. Therefore at reduced-tillage and conventional cropping systems with burial depth>4cm, the seeds of this weed species will not be able to emerge in the field.

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Table 1: Analysis of variance of on growth parameters for *L. perfoliatum* seedlings under different salt concentrations.

SOV	df	Seedling length	Seedling dry weight
Replication	3	0.0121	0.000
Salinity	5	18.074**	0.0002**
Error	15	0.0115	0.000
CV (%)		10.14	8.14

** and * significant at p≤ 0.01 and p≤0.05, respectively.

Table 2: Analysis of variance of on growth parameters for *L. perfoliatum* seedlings under different burial depths.

SOV	df	Seedling length	Seedling dry weight
Replication	3	0.054	0.00033
Burial depth	5	4.854**	0.0000066**
Error	15	0.081	0.00018
CV (%)		13.14	10.14

** and * significant at p≤ 0.01 and p≤0.05, respectively.

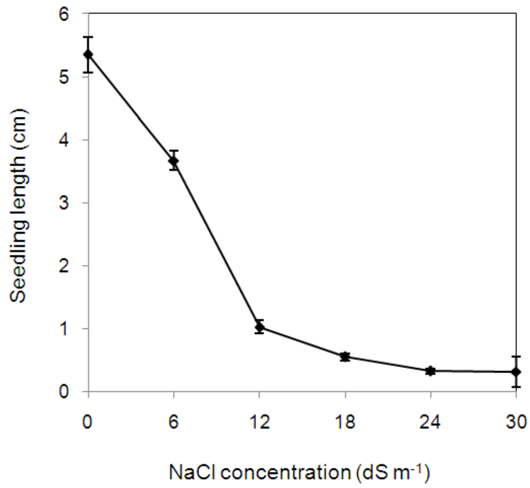

Fig.1. Length of *L. perfoliatum* seedlings as affected by different salt concentrations in 20/10 °C day/night temperatures and 12 h photoperiod. Vertical bars represent standard error (±SE).

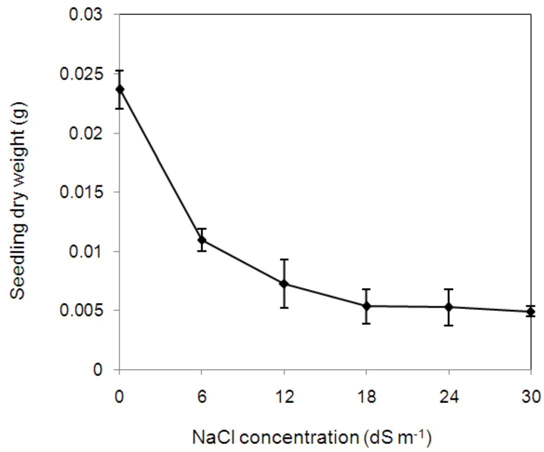

Fig.2. Dry weight of *L. perfoliatum* seedlings as affected by different salt concentrations in 20/10 °C day/night temperatures and 12 h photoperiod. Vertical bars represent standard error (±SE).

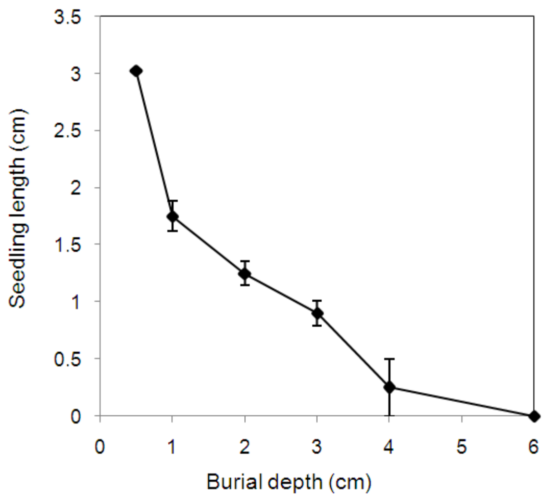

Fig.3. Length *L. perfoliatum* seedlings as affected by burial depths in 20/10 °C day/night temperatures and 12 h photoperiod. Vertical bars represent standard error (±SE).

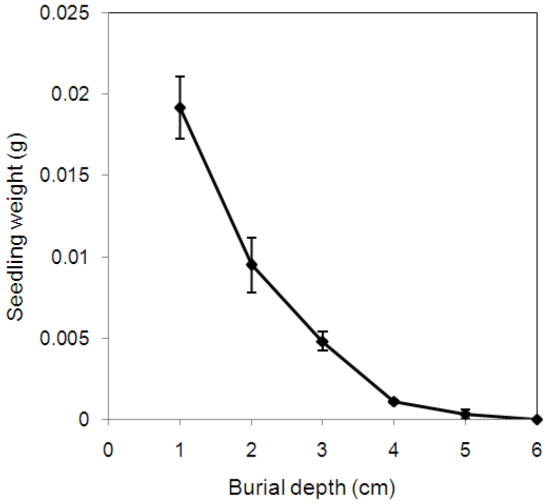

Fig.4. Dry weight of *L. perfoliatum* seedlings as affected by burial depths in 20/10 °C day/night temperatures and 12 h photoperiod. Vertical bars represent standard error (±SE).