EFFECTS OF SALINITY AND pH on Common waterhemp (*Amaranthus tuberculatus*) germination

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ABSTRACT: Common waterhemp (*Amaranthus tuberculatus*) is a major weed in the Midwestern US agronomic cropping systems. In recent years, it has been observed in agricultural areas of the Central Valley of California. However, it is not known if this species will establish in soils of various salinity and acidity conditions. To gain better insight of the capabilities of common waterhemp germination potential under these conditions, two studies were conducted to evaluate the effect of salinity and pH levels on the germination. Salinity levels were prepared with sodium chloride solutions ranging from 0 to 25 dS m^{-1} electrical conductivity. The pH ranges were from 5 to 9. The germination tests were conducted in petri dishes with the seeds placed on seed germination paper in a controlled growth chamber at 20°C. The experiment was set up as a completely randomized design and data were analyzed using a non-linear regression for the salinity study and ANOVA for the pH study. Results indicated that this species was moderately tolerant to salinity and germination was reduced by 50% at 10dS m^{-1}. Results also indicated that this species was not very tolerant to pH extremes as maximum germination occurred at pH levels of 6 and 7 and declined rapidly at the other pH levels. These studies indicated that common waterhemp could germinate in soils with moderate salinity and an optimum pH level of 6 to 7. However, these are preliminary results, and the studies will be repeated to verify these results.

INTRODUCTION: Common waterhemp is a highly competitive, invasive weed species that has become a threat to agronomic production systems (Fig.1). The vast spread of this weed could have been through many dispersal mechanisms, but conservation tillage and the evolution of multiple herbicide resistances has caused the weed to proliferate. The level of this weed species adaptability to various stresses needs to be studied to predict its invasiveness in California.

Fig. 1. A mature common waterhemp plant.
Picture credit: Division of Plant Sciences, University of Missouri

OBJECTIVE: To determine the effect of salt stress and pH levels on the germination of common waterhemp seeds.

MATERIALS AND METHODS: Germination of locally-collected common waterhemp seeds were tested under simulated pH and salinity stress conditions. Three different buffers were used to create the pH levels (5, 6, 7, 8, and 9). A potassium phosphate buffer consisting of a mixture of monobasic dihydrogen phosphate and dibasic monohydrogen phosphate were used for pH levels 6, 7, and 8. The stock solutions citric acid and sodium citrate were mixed to create a citrate buffer for pH 5. A glycine-NaOH buffer for pH level 9 was a mixture of glycine and NaOH. In a separate study, solutions of different salinity levels (2.5, 5, 10, 15, 20, and 25 dS m^{-1} electrical conductivity) were prepared by dissolving 0.73g, 1.21g, 2.92g, 4.385g, 5.845g, and 7.305g, respectively of sodium chloride (NaCl) in 1000 ml of DI water. A 0 mM (control, de-ionized water) treatment was also included. Twenty scarified seeds of common waterhemp were placed in 9-cm diameter petri dishes containing germination paper (Fig. 2). In each petri dish, 10 ml of the respective solutions were placed with a pipette, after the solutions were calibrated with an EC meter. The petri dishes were then sealed with parafilm and placed in a growth chamber programmed for a constant temperature of 20°C with 8 hr daylight. The petri dishes were examined every three to four days up to 21 days for germination. The seeds were considered as germinated when a radicle and plumule had emerged (Fig. 3). The number of germinated seeds were counted and then removed. The study was arranged as a single factor completely randomized design. The number of seeds germinated in each treatment were expressed in terms of percent of control (neutral pH and no salt). Data for the two experiments were analyzed separately using non-linear regression models and ANOVA.

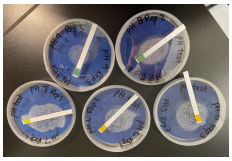

Fig. 2. Common waterhemp seeds in petri dishes with different pH levels and pH strips displaying the stability of the pH throughout the study.

Fig. 3. A common waterhemp seed showing the emergence of radicle and plumule

RESULTS:

pH: Common waterhemp was not very tolerant to extreme pH levels (Fig. 4). Maximum germination occurred only at pH 6 and 7. Less than 20% of the seeds germinated at the other pH levels.

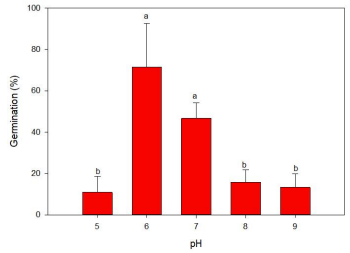

Fig. 4. Effect of pH levels on germination of common waterhemp seeds.

Salinity: Common waterhemp was moderately tolerant to salinity stress during germination (Fig. 5). Germination was reduced by 50% at 10 dS m^{-1}. However, approximately 15% of the seeds germinated at an EC level as high as 20 dS m^{-1}.

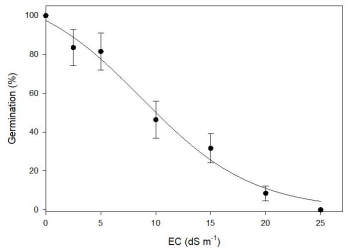

Fig. 5. Effect of salt stress (electrical conductivity) on germination of common waterhemp seeds.

CONCLUSION: This study showed that common waterhemp was not tolerant to pH extremes but was moderately tolerant to salinity. Therefore, this species may invade salt-affected soils of the Central Valley with neutral pH.

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