

# EFFECTS OF MOISTURE AND SALT STRESS ON GERMINATION OF COMMON WATERHEMP (*Amaranthus tuberculatus*)

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**ABSTRACT:** Common waterhemp is generally not a major weed in cropping systems in California. It is an annual dioecious species and one of the most problematic weeds in the US and is known to be resistant to many herbicides. In recent years, this species has been observed in Roundup Ready corn fields in Merced County and its prevalence seems to be increasing. Very little information is available on seed germination biology and ecology of this species in the local context. Therefore, two experiments were conducted to assess: a) the effect of water stress, and b) salt stress on germination of locally collected seeds. Water stress was simulated by preparing polyethylene glycol solutions ranging from 0 to -4.12 MPa. Salt stress was assessed under sodium chloride solutions ranging from 0 to 25 dS m<sup>-1</sup> electrical conductivity. Germination tests were conducted in petri dishes lined with germination paper and placed in a controlled environment chamber set at 21 °C. The experiment was arranged as a completely randomized design and data were analyzed using analysis of variance and non-linear regressions. Results indicated that this species was not very tolerant to drought because germination was reduced by 50% at -0.35 MPa. However, it was moderately tolerant to salinity because approximately 50% of the seeds germinated at 5 dS m<sup>-1</sup>. These findings suggest that common waterhemp can invade moderately saline soils provided adequate moisture is available for germination.

**INTRODUCTION:** Common waterhemp (*Amaranthus tuberculatus*) is being observed more frequently in some of the central CA agricultural areas (Fig. 1). This weed is native to central North America and is a major weed in the Midwestern US. The Weed Science Society of America recently ranked it as among the top ten worst weeds in the nation. Prior to 2010, this weed was only occasionally observed in CA, primarily in the northern part of the Central Valley. However, in recent years, it has been observed to be invading corn fields and is often confused with other *Amaranthus* species. It is not known if this species can thrive under drought and salt stress conditions, which occurs in the Central Valley of CA. If so, it can become problematic and widespread. About 0.32 million ha of the southwestern part of the Central Valley are salt affected and have electrical conductivity (EC) levels > 4 dS m<sup>-1</sup>. Secondly, there have been frequent droughts in recent years in this semi-arid, irrigated region of CA. Therefore, seed germination under drought and salinity conditions need to be studied to predict its adaptive abilities.

**OBJECTIVE:** The objective of this project was to study the germination ability of common waterhemp seeds under different levels of moisture and salinity stress to predict their ability to adapt in the Central Valley of California.

**MATERIALS AND METHODS:** Germination of locally-collected Common waterhemp seeds were tested under simulated moisture and salinity stress conditions. Polyethylene glycol (PEG) was used to create solutions of different water potential (0, -0.149, -0.51, -1.09, -1.88, -2.89, and -4.12 MPa). In a separate study, solutions of different salinity levels (25, 50, 100, 150, 200, 250 mM) were prepared by dissolving 0.146, 0.242, 0.584, 0.877, 1.169, and 1.461g, respectively of sodium chloride (NaCl) in 0.1 L water. A 0 mM (control, de-ionized water) treatment was also included. Twenty seeds of common waterhemp were placed in 9-cm diameter petri dishes containing germination paper (Anchor Paper Co.). In each petri dish, 10 ml of the respective solutions were placed with a pipette. The petri dishes were then sealed with parafilm and placed in a growth chamber programmed for a constant temperature of 21 °C seed with 12 hr daylight (Fig. 2). The petri dishes were examined every 3-4 days up to 21 days for germination. The seeds were considered as germinated when a radicle and plumule emerged. The number of germinated seeds were counted and then removed. The experiment was a completely randomized design with five replications. The number of seeds germinated in each treatment were expressed in terms of percent of control (no PEG or salt). Data for the two experiments were analyzed separately using ANOVA and non-linear regression models.



Fig. 1. A common waterhemp plant growing in Merced County.

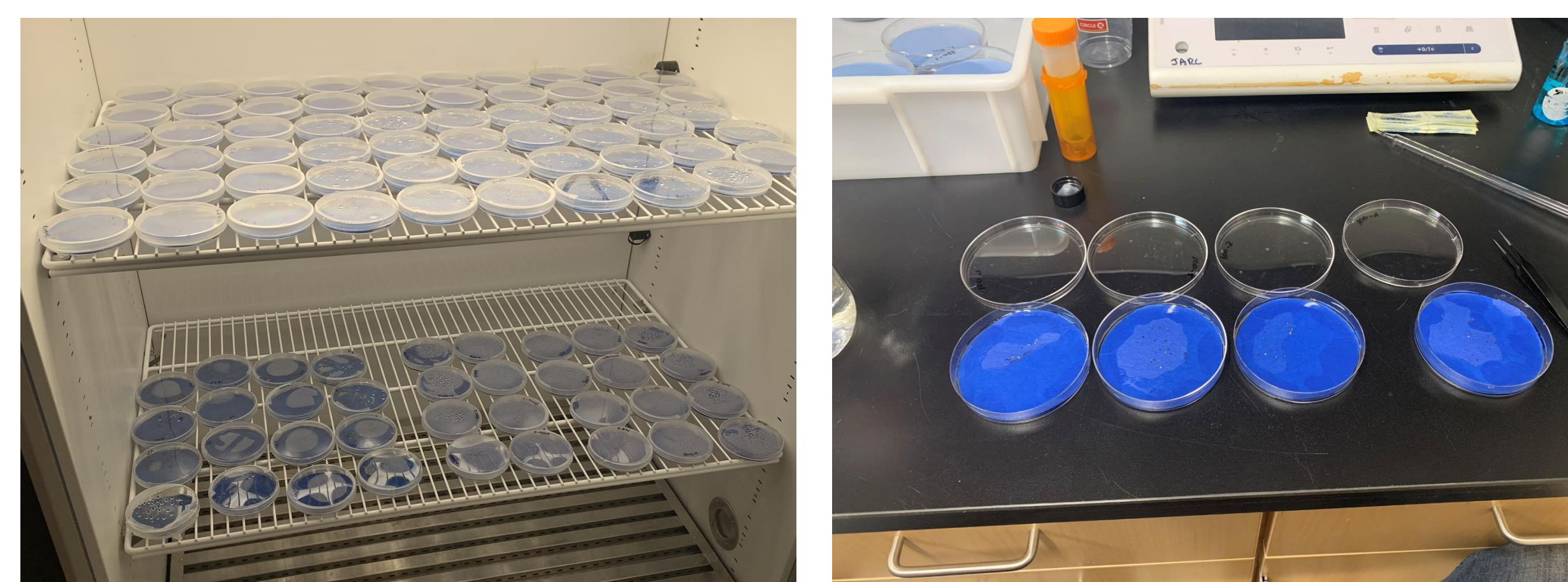


Fig. 2. Common Waterhemp seeds in petri dishes with different moisture and salinity levels placed in a growth chamber programmed for constant temperature of 21 C.

## RESULTS:

**Moisture Stress:** Common waterhemp was not very tolerant to drought stress during germination (Fig. 3). Few seeds germinated at -0.5 MPa and none of the seeds germinated at the lower potential levels. Germination was reduced by 50% at approximately -0.35 MPa.

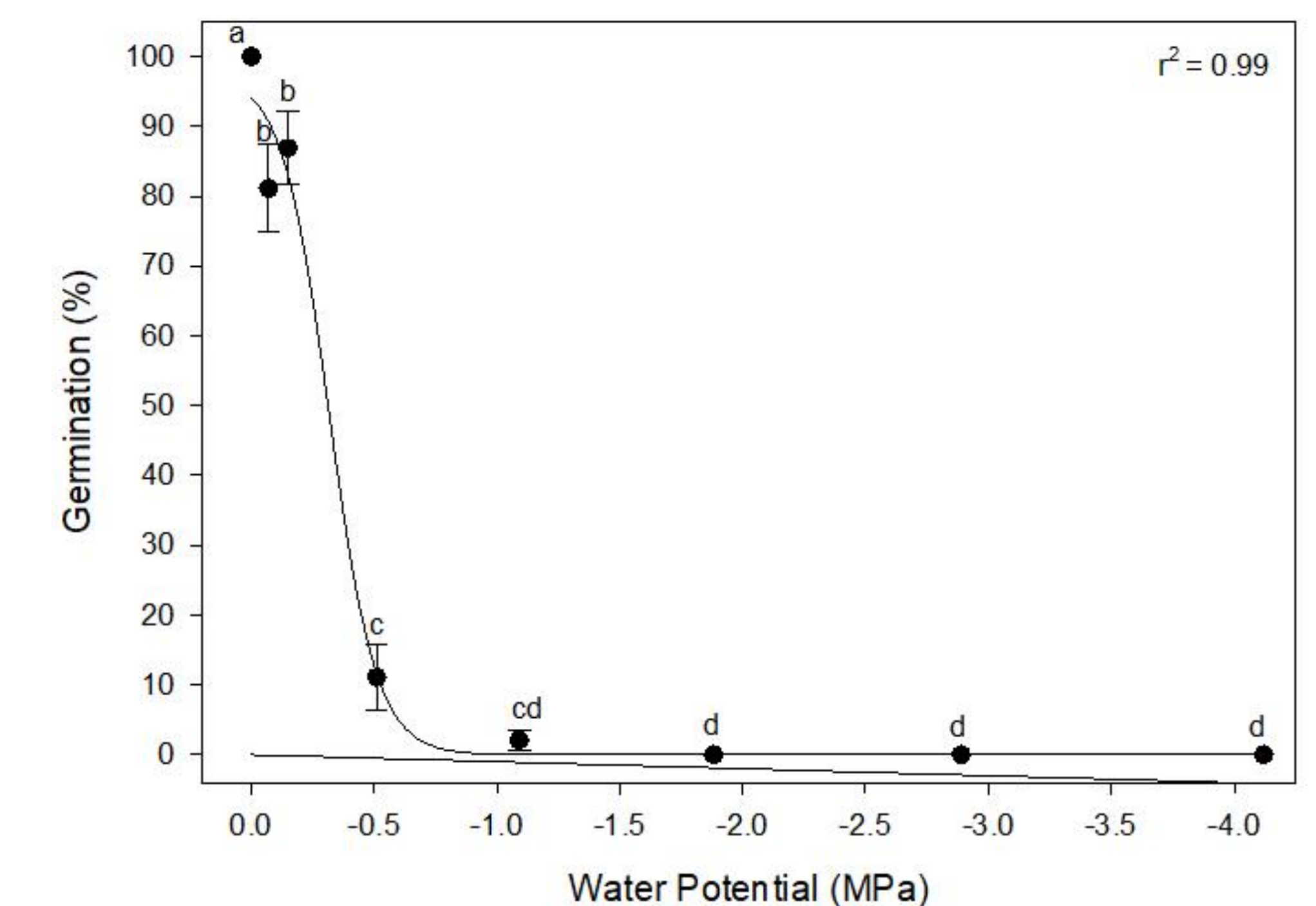


Fig. 3. Effect of moisture stress (water potential) on germination of common waterhemp seeds.

**Salinity Stress:** Common waterhemp was moderately-tolerant to salinity stress during germination (Fig. 4). Germination was reduced by 50% at an EC of 5 dS m<sup>-1</sup>. However, almost 10% of the seeds germinated 15 dS m<sup>-1</sup>.

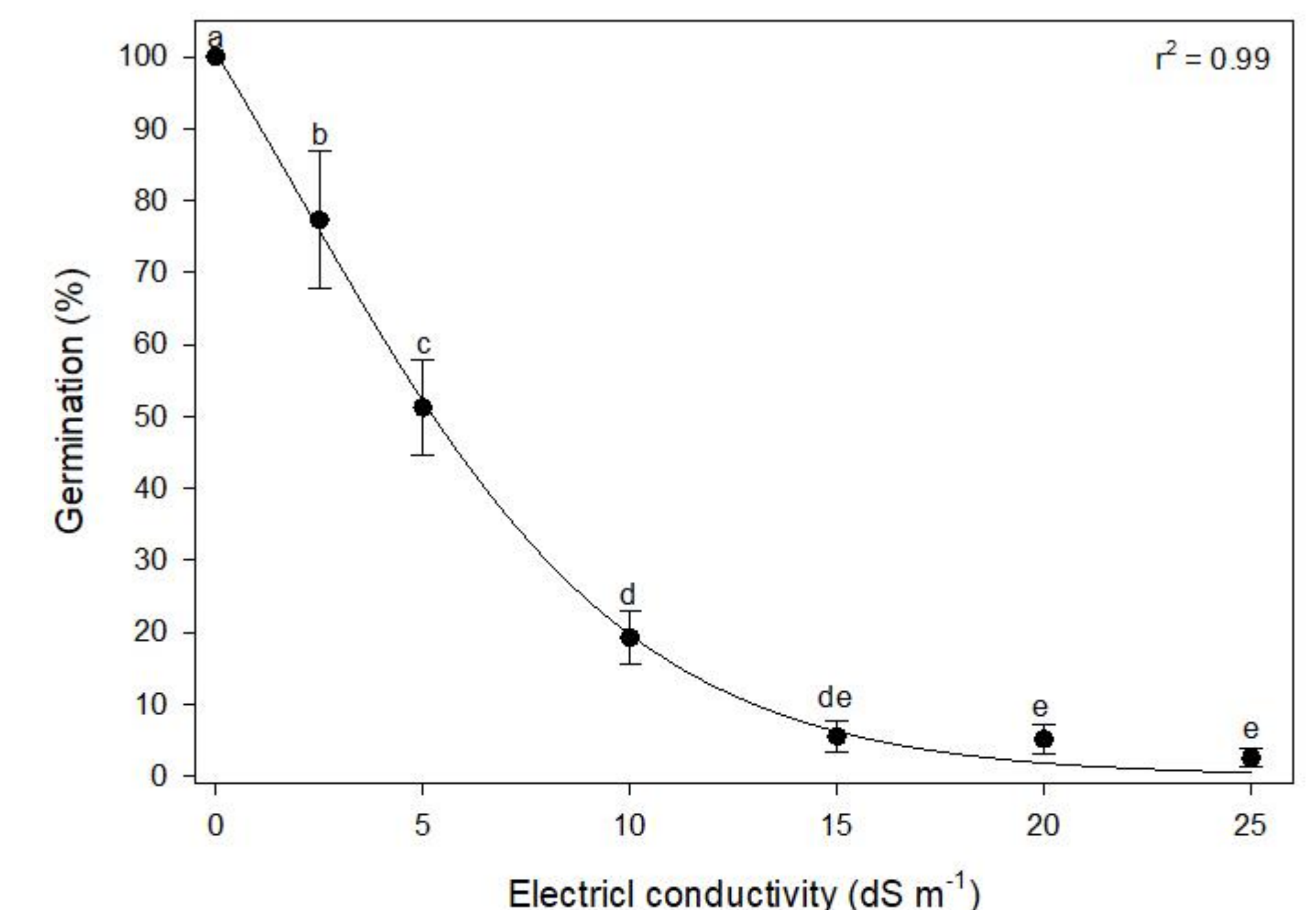


Fig. 4. Effect of salt stress (electrical conductivity) on germination of common waterhemp seeds.

**CONCLUSION:** This study showed that common waterhemp was not very tolerant to drought stress but moderately tolerant to salinity. Therefore, this species will likely invade irrigated field with moderately saline soils and can grow certain areas in the western part of the San Joaquin Valley provided that adequate moisture is available during its germination.

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