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Germination Response of *Eruca sativa* to Different Concentration of KCl

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Abstract

The germination responses of *Eruca sativa* Mill. seeds to saline stress caused by different concentration of potassium chloride was studied. For this purpose, 100 seeds of mentioned species were placed on filter paper in each replicate of Petri dish containing distilled water (control), 1 ppm, 2 ppm, 3 ppm, 4 ppm and 5 ppm of KCl. The results indicated that saline levels effects were significant ($P < 0.05$) for seed germination percentage, seed germination velocity, mean time to germination and seed vigor. Seed germination decreased significantly by increasing salinity levels. Also, the results showed that *Eruca sativa* Mill. is very sensitive to potassium chloride as salt causing salinity.

Keywords

Salinity Stress, KCl, Germination, Seed Vigor, *Eruca sativa* Mill

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1. Introduction

Salinity stress negatively impacts agricultural yields throughout the world, affecting production, whether for subsistence or economic gain. At present, about 20% of the world's cultivated land and approximately half of all irrigated land and 2.1% of the dry agriculture land is affected by salinity (FAO, 2000). Salinization is spreading more rapidly in irrigated lands because of inappropriate management of irrigation and drainage. Moreover, rain, cyclones and wind add NaCl to coastal agricultural lands (FAO, 2008). The rapid increase in the world's population requires an expansion of crop areas to raise food production. Salinity imposes serious environmental problems that affect grassland cover and the availability of animal feed in arid and semiarid regions (El-Kharbotly *et al.*, 2003). Salt stress unfavorably affected by plant growth and productivity during all developmental stages. For example Epstein *et al.* (1980) reported that salinity decreases seed germination, retards plant development and reduces crop yield. Shokohifard *et al.* (1989) reported that salt stress negatively affected seed germination; either osmotically through reduced water absorption or ionically through the accumulation of Na and Cl causing in imbalance in nutrient uptake and toxicity affect saline soils contain multiple types of soluble salt components, each of which has a different effect on the initial growth of plant (Redmann, 1974; Hardegree and Emmerich, 1990; Tobe *et al.*, 2002) and the composition of soluble salts in saline soils differ greatly among locations (Tobe *et al*., 2002). Although most of these reports are based on experiments with NaCl, it is hypothesized that other salts have similar effects on cellular function, but to different degrees, depending on the salt. Studies to examine salinity effects on the initial growth of plants have usually been carried out with individual salts (especially NaCl).

Eruca sativa Miller (Brassicaceae, synonym *Eruca vesicaria* Rocket), commonly known as "Jierjier", "Rocket salad" or "Garden salad" is a diploid annual herbaceous plant growing up to 80cm. It is in leaf all year, in flower from May to August and the seeds ripen from July to September. (Hedrick, 1972; Larkcom, 1980). It is a leafy vegetable suitable for growing in plug trays as a fresh-cut vegetable (Nicola et al.,

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2004). Interest in rocket has been increasing in recent years because of the spicy taste of its leaves. It is mainly used to garnish and flavour salads and a large variety of meals. According to D'Antuono et al. (2009), rocket is a new potential health promoting vegetable owing to the glucosinolates content.

Eruca sativa has been known since antiquity and has widely been consumed in various Mediterranean countries for the spicy-pungent flavour of the leaves (Padulosi, 1995; Padulosi and Pignone, 1997). Rocket is eaten as a vegetable (leaves) and as a spice (leaves, seeds, flowers) (Nuez and Hernández Bermejo, 1994). It is consumed as a raw green, as a part of salad mixes, as a cooked green, and is now very popular as a pizza topping (Padulosi, 1995; Padulosi and Pignone, 1997). Rocket is used in many ways other than a food. On the Indian subcontinent, special ecotypes of *E. sativa* are cultivated for seed production and subsequent oil extraction (Bhandari and Chandel, 1997). Rocket is believed to have aphrodisiac properties (Padulosi, 1995). It contains glucosides, mineral salts and vitamin C and is therefore considered to be an excellent stomachic, stimulant, and is also used as a diuretic and antiscorbutic (Nuez and Hernández Bermejo, 1994).

In the present study, we study the effects of different concentration of potassium chloride (KCl) on seed germination of *Eruca sativa*.

2. Materials and Methods

2.1. Study Species

Eruca sativa Miller which belong to (Brassicaceae, synonym *Eruca vesicaria* Rocket), commonly known as "Jierjier", "Rocket salad. *Eruca sativa* is grown in a wide range of soils and different climatic zones.

2.2. Effects of Salinity on Germination

To evaluate the effect of this salt on germination, 100 seeds of *Eruca sativa* were placed on filter paper in 9 cm petri dishes and submerged in 5 ml of potassium chloride. Solution of the KCl was used at concentrations of 0 (control), 1, 2, 3, 4, and 5 ppm. Experiment was performed in a completely randomized design with 4 replicates in the seed laboratory of the Department of Horticulture, Faculty of Agriculture, University of Zalingei. Germination counts were made daily and were considered to have germinated when the radicle emerged.

At the end of the germination period, the germination percentage, germination velocity, the mean time to germination and length of the stem and radicle under salinity were calculated. Germination percentage was calculated using the equation

$$\text{Final germination percentage:} = \frac{\text{Number of germinated seeds}}{\text{total number of seeds planted}}$$

Also, germination velocity and the mean time to germination were calculated using the following equations:

$$\text{Germination Velocity} = \sum \frac{\text{number of germinated seeds}}{\text{day of count}}$$

2.3. Statiscal Analysis

A multivariate ANOVA was used to evaluate the effects of salinity on seed germination. Data were analyzed using Statistix 8 for windows. When significant main effects existed, differences were tested by a multiple comparison LSD test at 0.05% confidence.

3. Result and Discussion

3.1. Germination Percentage

Results showed that increase in salinity causes significantly reduction in the germination percentage of *Eruca stiva* seeds (Table 1). This reduction in germination percentage is in agreement of earlier findings on cereals (Ben et al, 2001), sunflower (Turhan and Ayaz, 2004), spinach (Keshavarzi, 2011), hickpea (Al-Mutawa, 2003) and barley (Kardi et al, 2009). Ayers and Hayward (1948) reported that higher salinity levels aggravate delay in emergence of seedlings and finally reduced germination percentage. Similar results were also studied in mustard, by Das *et al.*, (2004).

Analyses of variance showed a wide range and highly significant effects of KCl concentrations on the parameters of seed germination. The effects of the KCl concentrations accounted for a high proportion of the variance in all analyses include full.

Table 1. The effect of different concentration of KCl on germination of *Eruca sativa*.

treatment	second day	third day	forth day	Fifth day
0ppm	50.25a	71.25a	77.27a	75.25a
1ppm	42.25ab	62.25ab	64.25ab	66.50ab
2ppm	33.00ab	50.00bc	56.50bc	59.25bc
3ppm	31.00ab	47.25bc	55.00bc	57.50.bc
4ppm	2450b	42.75bc	52.00bc	54.00bc
5ppm	24.00b	40.25c	41.75c	54.00c
cv	23.28	9.58	7.68	7.67
Alpha	0.05	0.05	0.05	0.05

Reduction in germination by an increase of salinity levels has been described by numerous authors (Othman *et al.*, 2006; El-Tayeb, 2005; Breen *et al.*, 1997; Ungar, 1982). Considerable variations were observed between two species especially at higher salinity levels in response to salinity for germination percentage. These results were in agreement with Basalah (1991) who found that high levels of salinity can significantly inhibit seed germination. Further, Waisel

(1972) found that increasing salinity concentration in germination often cause osmotic and/or specific toxicity which may reduce or retard germination percentage. Significant difference was obtained for salts regarding seed germination. The behavior (reduction or increase in seed germination by increase of salinity levels) of three salts which studied in this research, was different and partially intricate.

It has been shown that soil salinity increases P, Mn, and Zn and decreases K and Fe concentrations in plant tissues (Turan et al., 2010).

Potassium regulates plant water management, transpiration as well as the development of root pressure; it also participates in transport, photosynthesis, respiration, and the synthesis of different substances in other plant life processes. Disturbances of nitrogen metabolism can also result from potassium deficiency. The application of a double rate of phosphorus and potassium contributed to a reduction in nitrate concentration in rocket plants, even at high rates of nitrogen (Hanafy Ahmed et al. 2000). Likewise in other vegetables, increased potassium fertilization had an effect on the decrease in nitrate accumulation in yield (Ali et al. 1985, Wu and Wang 1995, Hanafy Achmed et al. 1997, Zhong et al. 1997). the presence of potassium enhances the process of nitrate reduction; moreover, potassium is a necessary activator of the enzymes catalyzing the biosynthesis of peptide bonds. In addition to the rate of potassium, its form is also important. In horticultural crops, potassium is most frequently applied as KCl and K_2SO_4, but potassium chloride arouses more controversy due to the opinion about the harmfulness of chlorine to plants.

Table 2. Effect of KCl concentrations on *Eruca sativa* seed vigor.

treatment	second day	third day	forth day	Fifth day
0ppm	21.25a	33.53a	38.30a	39.33a
1ppm	23.20a	30.30a	31.05a	32.33a
2ppm	18.50a	24.78a	28.58a	30.25a
3ppm	11.88a	21.95a	26.25a	28.45a
4ppm	15.50a	21.28a	26.03a	26.25a
5ppm	18.50a	19.95a	24.88a	25.00a
cv	19.38	19.46	24.53	25.50
Alpha	0.05	0.05	0.05	0.05

3.2. Seed Vigor

Data present in Table 2 showed non – significant differences in all different concentrations of potassium chloride among seed vigor. Results showed that increasing the KCl concentration decreasing seed vigor of *Eruca sativa*. In all of salts in different levels 0-5 ppm, the general trend is associated with seed vigor decrease. Therefore, low and non-uniform seed vigor as well as salinity stress, if not properly managed might become limiting factors for synchronized stand seedling establishment in various vegetables seed. Seed deterioration is a major problem in agricultural production. It has been estimated that 25% of the annual value of seeds in inventories might be lost because of poor seed quality (Schwember and Bradford, 2010). The rate of aging is strongly influenced by several environ-mental and genetic factors such as storage temperature, storage time, storage fungi, seed moisture content and seed quality (Harman and Mattick, 1976; Walters, 1998; Rajjou and Debeaujon, 2008).

4. Conclusions

The study involving KCl with different concentrations indicated that *Eruca sativa* seed germination are sensitive to salt stress. In general, there are significant decrease at 1 ppm, 2 ppm, 3ppm, 4 ppm and 5 ppm Potassium chloride concentrations for the studied plant compared with distilled water. KCl affecting seed vigor positively with increasing salt concentration. Seed vigor tests provide valuable seed quality information not identified by the standard germination test.

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