Effects of irrigation with domestic wastewater on germination characteristics of cress (*Lepidium sativum* L.) as an important medicinal plant

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Abstract

The main objective of the present study was to investigate the effects of irrigation with domestic wastewater on seed germination traits of cress (*Lepidium sativum* L.). Reuse of the treated wastewater for irrigation of green space, agricultural and other purposes, considered as one of the main objectives especially in arid and semi-dry areas such as Iran, due to water resources deficit. This experiment was carried out as a completely randomized block design with three replications at Islamic Azad University, Shahr-e-Qods Branch of Tehran in 2011. Treatment of the experiment was sewage water with different pollution indexes. In each replication there was a treatment that irrigated with agronomical water as a control. The results show that effects of treatments on germination percentage, mean time to germination and coefficient of velocity of germination was quite significant at 1% level of probability. Therefore, domestic wastewater could be used as irrigation water in farming of cress.

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Introduction
Seed priming is one of the useful approaches to improve germination and seedling establishment under low humidity and low temperature conditions. Seed priming is a technique which the seeds before placing in their bed and faced with ecological situation of the environment, obtain the physiological and biochemical preparation for germination. This may be caused several biological and physiological reactions in primed seed and derived plant (Farooq et al., 2006). So that, these can be seen in the germination manner, early plant establishment, exploitation of environmental inputs, earliness, increasing in quantity and quality of the product (Feigin et al., 1991; Ghassemi-Golezani et al., 2008).

Major effects of seed priming can be studied and evaluated as follows: Effect of seed priming on germination and primary seedling establishment. A lot of reports indicated that improvement in germination and related indexes such as average time of germination, seed vigority, root length, shoot length, germination rate and primary establishment in the primed seeds. Garden cress is an annual herbaceous plant native to Mediterranean and West Asia and Central Europe. The roots of this plant are tapered and sink directly in the soil. Nowadays, this plant is cultivated as a medicinal plant due to a lot of ingredients. It used as diaphoretic, blood purifier, salver, tonic, anti-seizure and disposal of vomit.

Exclusive of wastewater application in crops irrigation and conservation in water resources, also it is applied as a source of fertilizer (Rattan et al., 2005; Feiginet al., 1991). So that the use of wastewater for irrigation as a rich source of nutritional elements required by plants, has a long history in different countries (Feiginet al., 1991; Akpor and Muchie, 2011). In some medicinal plants, water resources induced changes in antioxidants which were suggested to be involved in prevention of plant tissues damage (Aliabadi Farahani et al., 2008; Bernstein et al., 2009). The objective of this study was to evaluate the effects of irrigation with domestic wastewater on some characteristics of the seed germination including seed germination percentage, seed germination rate, mean duration of seed germination and coefficient of seed germination rate in cress.

Materials and methods

Plant materials and experimental conditions
This experiment was carried out as a completely randomized block design with three replications at Islamic Azad University, Shahr-e-Qods Branch of Tehran in 2011. Domestic wastewater with various pollution indices [S1B (BOD5=50 mg/l), S2B (BOD5=75 mg/l), S3B (BOD5=100 mg/l) and (BOD5=125 mg/l (S4B))] were used to evaluate the effect of different treatments of irrigation. In each replication there was a treatment that irrigated with agronomical water as a control.

To determine the germination percentage or germination ability, 100 seeds were selected and cultivated in Petri-dishes in the germinator for 21 days at 25 °C. Finally, the total number of germinated seeds were counted and considered as the final seed germination percentage. The grown seedlings were counted daily, then normal and abnormal seedlings identified and 10 normal seedlings were selected. After measuring the length of seedlings, they were placed in an oven at 75 °C temperature for 48 hours. Then, the seedlings were weighed and dry weight was calculated. Seedling vigor index was calculated as follow:

Seedling vigor index = seedling dry weight × germination ability.

The mean time to germination (MTG), which is considered an index of the germination rate, was calculated according to following equation:

$$MTG = \frac{\sum (n \times d)}{\sum n}$$

Where MTG is mean time to germination, n is number of germinated seeds during d days, d is number of days and Σn is the total number of germinated seeds.

Coefficient of velocity of germination (CVG), which is speed and acceleration characteristic of seed germination, was calculated according to following formula:
\[ CVG = \frac{G_1 + G_2 + ... + G_n}{(1 \times G_1) + (2 \times G_2) + ... + (n \times G_n)} \]

Where \( CVG \) is coefficient of velocity of germination and \( G_1, G_2, \ldots, G_n \) are number of germinated seeds during first day \( (G_1) \) to final day \( (G_n) \) of experiment.

The mean of daily germination \( (MDG) \), which is considered an index of the germination rate, was calculated according to following formula:

\[ MDG = \frac{FGP}{d} \]

Where \( MDG \) is the mean of daily germination, \( FGP \) is germination percentage and \( d \) is the number of days to achieve the maximum germination.

Daily germination speed \( (DGS) \), that is reversing the average daily germination, calculated according to following equation:

\[ DGS = \frac{1}{MDG} \]

Where \( DGS \) means daily germination speed (Number of germinated seed(s) per day).

Statistical analyses were done using Excel 2013, SPSS Ver. 22 and MSTATC software. Mean separation was performed using Duncan’s Multiple Range test at 0.05 probability level after ANOVA.

**Results and discussion**

**Statistical analysis of the studied traits**

Seed germination of garden cress under wastewater irrigation conditions is presented in Table 1. The effect of treatments on germination percentage, germination rate, mean time to germination and germination rate was significant at 1% and 5% level of probability (figures 1, 2, 3 and 4).

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<tr>
<th>Treatment</th>
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<th>MGT</th>
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**Table 1. Different traits of germination of *Lepidium sativum* L. in three replications.**

The highest germination percentage, germination rate and coefficient of velocity of germination observed in S1 B \( (\text{BOD}_5=25 \text{ mg/l}) \) with an average of germination percentage 63.3, 1.97 and 12.66 percent, respectively. The maximum mean time to germination obtained in S4 B \( (\text{BOD}_5=100 \text{ mg/l}) \) with an average of 14.3 percent (Figures 1 to 4). Thus, it can be concluded that the domestic wastewater had a significant effect on the behavior of garden cress germination.

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**Fig. 1.** Germination percentage in different treatments.

**Fig. 2.** Germination rate in different treatments.

Accelerate germination in primed seeds could be due to an increase in degrading enzymes such as alpha-amylase, increasing activity of surface charge of...
bioenergy in the form of increase in the amount of ATP, increasing synthesis of RNA and DNA and promote the number and function of mitochondria. In primed seeds, cell membrane structure and function are in better situation in comparison with control seeds. This can be investigated through study on electrical conductivity of seed extract. So that, seepage intracellular metabolites was lower in primed seeds, and also, consequently membrane conductivity of seed extract was lower. This has been proved confirmed seeds of sweet corn, sugar beets, plums, radish, wheat and barley. This will also be the reason for better germination in treated seeds. Some metabolic and biochemical changes in primed seeds is benefit to seed germination. For example, a part of the proteins and carbohydrates in this seeds are broken due to enzymes and hydrolysis reactions and are ready to participate in the process of germination. So, this can be the justification for acceleration of germination and reduce mean time to germination (Casenave and Toselli, 2007). Ghassemi-Golezani et al. (2008) reported that Alpha-amylase enzyme activity in primed seeds of chickpea useful to improve the vigor germination and this was more obviously in old seeds. In the standard germination tests based on static rules, time to 50% germination, mean germination rate and uniformity of germination in primed seeds of canola, wheat, pea, soybean, alfalfa, corn, sorghum, watermelon, rice, lettuce and improved significantly. This represents the acceleration of germination and seed vigor enhancement affected through seed treatments before sowing (Farooq et al., 2006). In seedling derived from germination of primed seed, the radicle and shoot length were increased. This increase was more and impressive in the radicles.

**Fig. 3.** The mean of daily germination in different treatments.

**Fig. 4.** Coefficient of velocity of germination in different treatments.

**Conclusion**

The Results showed that the effects of treatments on germination percentage, mean time to germination and coefficient of velocity of germination was quite significant at 1% level of probability. Therefore, domestic wastewater could be used as irrigation water in farming of cress.

**References**


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