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The Influence of NaCl Priming on Seed Germination and Seedling Growth of Canola (*Brassica napus* L.) Under Salinity Conditions

G.R. Mohammadi

Department of Crop Production and Breeding, Faculty of Agriculture,
Razi University, Postal code: 6715685438, Kermanshah, Iran

Abstract: A laboratorial study was carried out to investigate the effect of NaCl priming on seed germination and seedling growth of canola. Canola seeds were primed with 1% NaCl solution for 24 hours, at 20°C. Then primed and non-primed seeds were irrigated with seven different saline solutions consisted of 0 (control), 0.25, 0.50, 0.75, 1.00, 1.25 and 1.50% concentrations of NaCl. Results indicated that NaCl priming increased germination percentage, germination rate and seedling dry weight 25.57, 34.67 and 36.67 %, respectively, as compared with non-primed seeds. Overall increased NaCl level, led to the reductions in the traits under study but these reductions were higher for non-primed compared to primed seeds. At the 1.25% level of salinity, the reductions for germination percentage, germination rate and seedling dry weight were 36.30, 39.52 and 50% for primed and 69.47, 89.92 and 87.5% for non-primed seeds respectively, as compared with control. However, at 1.50% level of salinity non-primed seeds failed to germinate, while, germination percentage was 45% for primed seeds. The present study revealed that under salinity condition, seed priming with NaCl could be used as a method for improving seed performance in canola. However, further studies are needed to investigate the effects of NaCl priming on later growth and development stages of this crop.

Key words: Canola · NaCl priming · Germination · Seedling growth

INTRODUCTION

Canola *(Brassica napus* L.*)* is one of the most important oil seed crops in Iran that its production has been notably extended in recent years. A major constraint to seed germination and seedling establishment of canola is soil salinity that is a common problem in irrigated areas of Iran with low rainfall. This problem adversely affects growth and development of crop and results into low agricultural production. Soil salinity may influence the germination of seeds either by creating an osmotic potential external to the seed preventing water uptake, or the toxic effects of Na^+ and Cl^- ions on the germinating seeds [1]. Salt and osmotic stresses are responsible for both inhibition or delayed seed germination and seedling establishment [2]. Under these stresses there is a decrease in water uptake during imbibitions and furthermore salt stress may cause excessive uptake of ions [3]. Seed priming has been successfully demonstrated to improve germination and emergence in seeds of many crops [4, 5].

This method has been shown to enhance stand establishment in saline areas [6, 7]. Wiebe and Muhyaddin [8], Cano *et al.* [9] and Cayuela *et al.* [10] working with tomatoes, Pill *et al.* [11] working with asparagus and tomatoes, Passam and Kakouriotis [12] working with cucumber have concluded that seed priming improves seed germination, seedling emergence and growth under saline conditions. Sivritepe *et al.* [13] reported that NaCl priming of melon seeds increase total and rate of emergence and seedling dry weight under salinity conditions. They concluded that NaCl priming could be used as an adaptation method to improve salt tolerance of seeds.

The present study was conducted to evaluate the effect of NaCl priming on seed germination and seedling growth of canola under salinity conditions.

MATERIALS AND METHODS

The experiment was carried out at the Seed Research Laboratory of Faculty of Agriculture of Razi University, Kermanshah, West Iran. The canola cultivar used was Okapi (a canola cultivar that is widely planted in the region). Canola seeds were primed with 1% NaCl solution for twenty four hours, at 20°C. After priming, seeds

Corresponding Auhtor: G.R. Mohammadi, Department of Crop Production and Breeding, Faculty of Agriculture, Razi University, Kermanshah, Iran, Postal code: 6715685438

were put in a wire mesh strainer and washed with tap water for 5 minutes and then rinsed with distilled water. Following this, seeds were dried between two filter papers. Primed and non-primed seeds were placed in 9 cm glass petri dishes on a layer of filter paper (Whatman # 41). Twenty five seeds, were placed in each petri dish. The petri dishes were irrigated with seven different saline solutions consisted of 0 (control), 0.25, 0.50, 0.75, 1.00, 1.25 and 1.50% concentrations of NaCl. The petri dishes were placed in a germinator at 20°±1 C. The papers belong to each petri dish were replaced every two days to prevent accumulation of salt [14]. The experiment was a factorial with two factors (priming and salinity level) on the basis of a completely randomized design with four replicates.

Seed germination was recorded daily up to day 14 after the start of the experiment. A seed was considered germinated when radicle emerged by about 2 mm in length. Then the mean germination rate was calculated according to the following equation [15]:

$$R = \Sigma n / \Sigma Dn$$

Where R is the mean germination rate, n is the number of seeds germinated on day and D is the number of days from the start of test.

Moreover, germination percentage was determined in the end of test. To determine the seedling dry weight, after the 14^{th} day, seedlings produced in each petri dish were separated from the seeds, dried at 70°C to a constant weight and then weighed. Data analyses were carried out using SAS [16].

RESULTS AND DISCUSSION

Analysis of variance (Table 1) indicated that both priming and salinity level have the significant effects on the traits under study. Moreover, priming x salinity level interaction was significant at the 1% level of probability. Overall, NaCl priming increased germination percentage, germination rate and seedling dry weight 25.57, 34.67 and 36.67 %, respectively, as compared with non-primed seeds (Table 2). Cayuela *et al.* [10] observed that under salt stress the seedlings of tomato emerged earlier from seeds primed with NaCl than from non-primed seeds. Esmaielpour *et al.* [17] also reported that seed priming by NaCl led to increasing of total emergence and emergence rate in cucumber. These results are similar to the results obtained in the present study.

In general, increased NaCl level, led to the reductions in germination percentage, germination rate and seedling dry weight (Table 3). This can be attributed to prevent of water uptake created by salinity condition. This can be also due to the toxic effects of Na^+ and Cl^- ions on the germination process [1]. However, the reductions in the

Table 1: Analysis of variance of the traits under study

Source of Variance	Mean of Square		
	Germination percentage	Germination rate	Seedling dry weight
priming	3905.36 **	0.131 **	0.00001227 **
Salinity level	4383.21 **	0.095 **	0.00000869 **
Priming*salinity level	410.19 **	0.011 **	0.00000057 **
Error	114.40	0.002	0.00000013

**: Significant at the 0.01 level of probability

Table 2: Means comparison of the traits for primed and non-primed seeds of canola

Treatments	Germination percentage	Germination rate(per day)	Seedling dry weight (g)
Primed	75.43 a	0.323 a	0.0030 a
Non-primed	56.14 b	0.211 b	0.0019 b
LSD (0.05)	6.76	0.0265	0.0002

Means with the same letters in each column are not significantly different at the 0.05 level of probability

Table 3: Means comparison of the traits under different salinity level

Salinity level(%)	Germination percentage	Germination rate(per day)	Seedling dry weight (g)
0 (control)	96.17 a	0.405 a	0.0040 a
0.25	92.83 ab	0.387 a	0.0035 b
0.50	82.83 b	0.357 a	0.0033 b
0.75	67.17 c	0.257 b	0.0023 c
1.00	53.50 d	0.252 b	0.0022 c
1.25	45.50 d	0.145 c	0.0013 d
1.50	22.50 e	0.070 d	0.0007 e
LSD (0.05)	12.65	0.049	0.0004

Means with the same letters in each column are not significantly different at the 0.05 level of probability

Table 4: Means comparison of the traits under different salinity level for primed and non-primed canola seeds

	Primed			Non-primed		
Salinity level(%)	Germination percentage	Germination rate (per day)	Seedling dry weight (g)	Germination percentage	Germination rate (per day)	Seedling dry weight (g)
0 (control)	97.33 a	0.41333 a	0.0040 a	95.00 a	0.39667 a	0.0040 a
0.25	96.00 ab	0.41000 a	0.0037 ab	89.67 ab	0.36333 ab	0.0032 b
0.50	85.00 abc	0.39000 a	0.0038 ab	80.67 b	0.32333 b	0.0027 b
0.75	74.67 bcd	0.37333 a	0.0032 bc	59.67 c	0.22667 c	0.0014 c
1.00	68.00 cd	0.28667 b	0.0028 c	39.00 d	0.13000 d	0.0016 c
1.25	62.00 de	0.25000 b	0.0020 d	29.00 d	0.04000 e	0.0005 d
1.50	45.00 e	0.14000 c	0.0014 d	00.00 e	0.00000 e	0.0000 d
LSD (0.05)	22.29	0.08	0.0006	14.32	0.066	0.0006

Means with the same letters in each column are not significantly different at the 0.05 level of probability

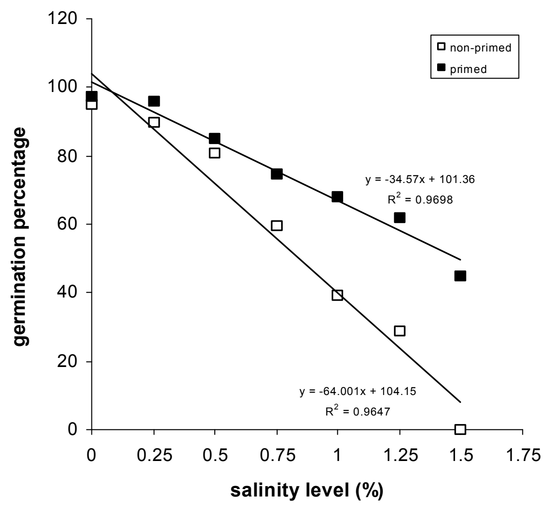

Fig. 1: The effect of different salinity levels on germination percentage of primed and non-primed seeds of canola

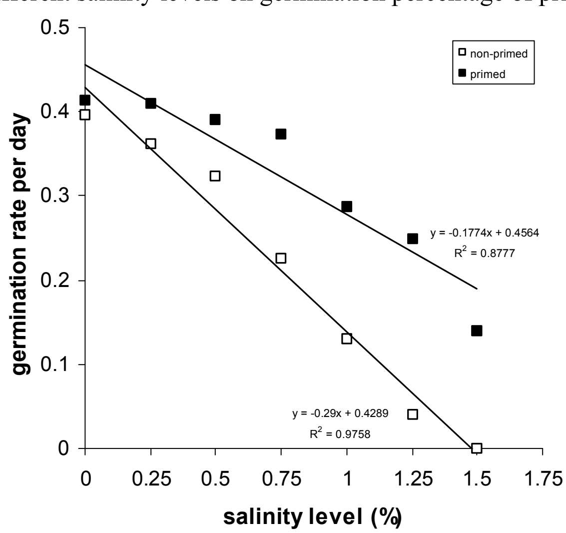

Fig. 2: The effect of different salinity levels on germination rate of primed and non-primed seeds of canola

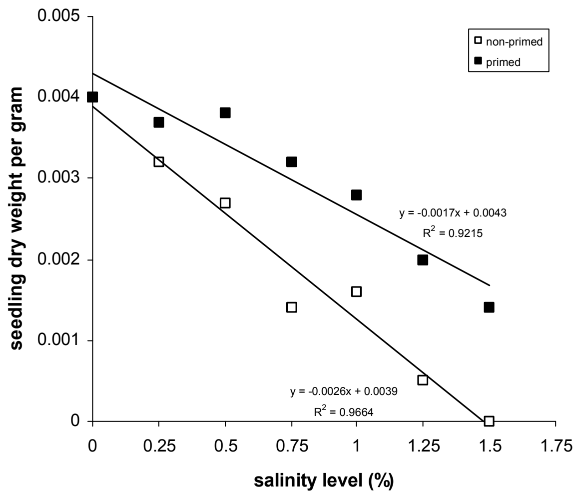

Fig. 3: The effect of different salinity levels on seedling dry weight of primed and non-primed seeds of canola

traits under study due to increased NaCl level were higher for non-primed compared to primed seeds (Fig. 1-3). For primed seeds significant reduction in germination percentage, germination rate and seedling dry weight occurred only when salinity levels were increased more than 0.5, 0.75 and 0.50%, respectively, while germination percentage, germination rate and seedling dry weight of non-primed seeds significantly reduced when salinity levels were increased more than 0.25, 0.25 and 0%, respectively (Table 4).

At the lowest levels of salinity, there were no notable differences between primed and non-primed seeds for the traits under study, but, with increasing salinity levels, primed seeds showed the better performance than non-primed seeds (Fig. 1-3). For primed seeds the NaCl concentration of 0.25 % reduced germination percentage, germination rate and seedling dry weight, 1.37, 0.81 and 7.50%, respectively as compared to control. At this level of salinity, the reduction for non-primed seeds were 5.61, 8.40 and 20%, respectively (Table 4). However, at 1.25% level of salinity, the reduction for germination percentage, germination rate and seedling dry weight were 36.30, 39.52 and 50% for primed and 69.47, 89.92 and 87.5% for non-primed seeds, respectively, as compared with control (Table 4).

In other words, the beneficial effect of priming on the traits under study enhanced when the salinity level increased. Similar results were reported by Sivritepe *et al.* [13] in study on melon seeds. At 1.50% level of salinity non-primed seeds failed to germinate, while, germination percentage was 45% for primed seeds (Table 4), indicating the positive effect of priming on seed germination under high salinity stress. Iqbal *et al.* [18] suggested that seed priming of wheat cultivars by NaCl is an effective method in alleviating the adverse effects of salt stress. Similarly, Katembe *et al.* [19] investigated the effect of NaCl as priming agent on germination and seedling growth of two *Atriplex* species under salt stress. They found that priming with NaCl improved the seed performance under high salinity condition.

According to Bewley and Black [20], the pre-sowing treatments cause initiation of the early metabolic processes and re-drying of seeds arrest, but do not reverse, the initial stages of germination so that on the availability of suitable conditions, the time taken to germinate is reduced. Argerich and Bradford [21] also found that the occurrence of space inside primed tomato seeds may accelerate the rate of germination by facilitating water uptake. During priming, the embryo expands and compresses the endosperm [22]. The compression force of the embryo and hydrolytic activities on the endosperm cell walls may deform the tissues that have lost their flexibility upon dehydration [23], producing free space and facilitating root protrusion after rehydration.

Overall, the present study revealed that NaCl priming has a notable beneficial effect on seed performance of canola under salinity condition. Further studies are needed to investigate the effects of NaCl priming on later growth and development stages of this crop.

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