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# Seed Priming Enhances Germination of Annual Caraway (*Carum carvi* L.) at Low Temperatures

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## Introduction

Caraway (*Carum carvi* L.), a spice crop of the family Umbelliferae (Apiaceae), is grown on a small scale in Western Canada. Currently, it is one of the major spice crops in Saskatchewan and there is a large demand for the seed. The whole and ground seeds of caraway are used as a spice for food preparations and for extraction of essential oil. Caraway is a biennial or short-lived perennial plant, but annual forms are available. Generally, caraway seeds germinate slowly and show non-uniform germination. Thus, slow, erratic seedling emergence and uneven seedling growth are common problems in commercial production of caraway.

Seed priming is a pre-sowing treatment for improving the rate, uniformity and percentage of germination in many species (Heydecker and Coolbear, 1977; Bradford, 1984, Alvarado et al., 1987). In seed priming, the seeds are hydrated for a prescribed time in either water or an osmotic solution and then dried to their original moisture content. During seed priming, metabolic activities associated with germination are initiated, but the final phase of germination or radicle emergence does not occur. The length of imbibition period or concentration of osmotic solution (Heydecker et al., 1975) limits the water available for the radicle growth. The natural plant hormone abscisic acid (ABA), is also used to prevent radicle growth (Finch-Savage and McQuistan 1991).

The objective of this paper is to present the effect of seed priming treatments on germination of annual caraway at different temperatures.

## Materials and Methods

### *Seed priming*

Seeds of annual caraway cultivar Karzo were primed with aerated either distilled water, ABA ( $10^{-7}$ ,  $10^{-6}$ ,  $5 \times 10^{-6}$ ,  $10^{-5}$  or  $10^{-4}$  M),  $\text{KNO}_3$  (0.3, 0.3 or 0.5 M) or NaCl (0.5, 1.0 or 2.0 M) for 8, 16, 24, 36 or 48 hours at  $22 \pm 1$  °C. Following the priming treatments, the seeds were thoroughly rinsed with running distilled water and air dried at approximately 22 °C for 48 hours.

### Germination Experiments

Germination tests were conducted at 5, 10, 15 and 22 °C in the dark. Each replication of each seed priming treatment consisted of 50 primed seeds which were placed on two layers of Whatman #1 filter paper in a 9 cm plastic petri dish moistened with 3.5 ml of distilled water. The dishes were sealed in polyethylene bags to minimize the evaporation. The treatments were arranged in a randomized complete block design with four replications at each temperature. Germination was recorded at 12-hour intervals until germination ceased. Time to 50% germination ( $TG_{50}$ ) (Coolbear et al., 1984) and final percentage germination were determined.

### Results and Discussion

Seed priming decreased time to 50% germination of annual caraway at 5, 10, 15 and 22 °C (Figure 1). The decrease in  $TG_{50}$  was large when seeds were germinated at low temperatures, e.g., 5 °C. Seeds primed with distilled water, ABA and  $KNO_3$  reduced  $TG_{50}$  compared to NaCl at all four temperatures (Figure 1). Among the priming treatments, seeds primed with distilled water, low concentrations of ABA and low concentrations of  $KNO_3$  for 36 or 48 hours had the lowest  $TG_{50}$  at all four temperatures (Table 1).

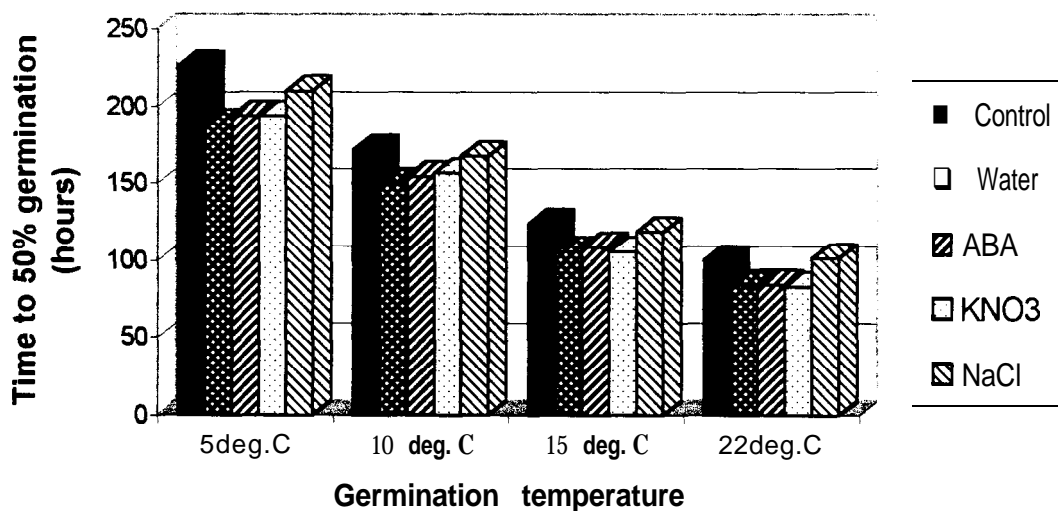


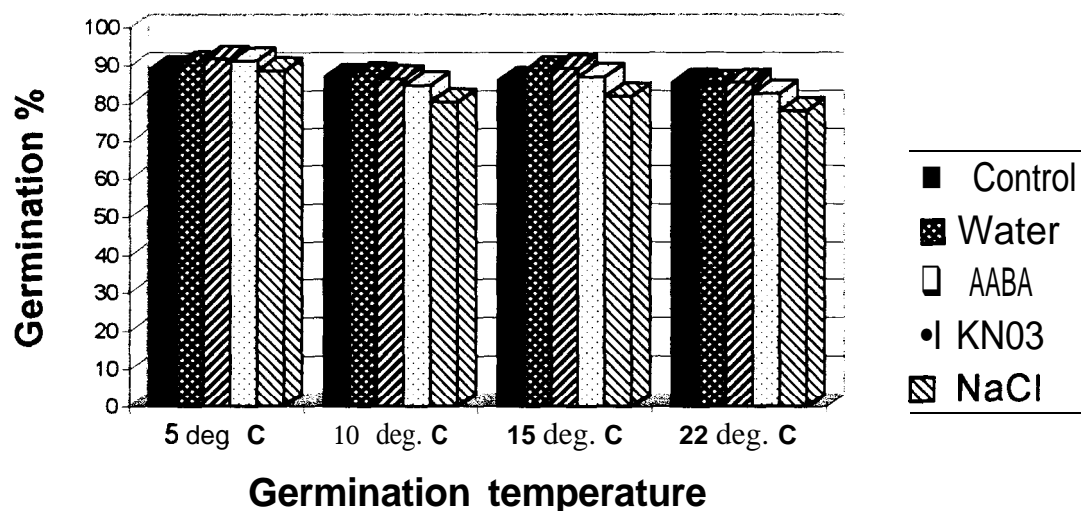
Figure 1. Effect of seed priming with different solutions on  $TG_{50}$  of annual caraway at different temperatures.

**Table 1. Effect of seed priming treatments on TG<sub>50</sub> at different temperatures.**

Temperature	Priming solution	Concentration (M)	Duration of priming (hours)				
			8	16	24	36	48
			TG <sub>50</sub> (hours)				
5 °C	Water		218.6	205.6	176.9	169.6	171.1
	ADA	10 <sup>-7</sup>	212.0	206.2	198.4	166.7	169.4
		10 <sup>-6</sup>	210.4	205.7	199.9	168.8	163.0
		5 x 10 <sup>-6</sup>	216.3	210.5	197.4	171.5	171.3
		10 <sup>-5</sup>	214.1	213.4	204.7	166.0	170.7
		10 <sup>-4</sup>	222.7	217.2	209.8	178.0	175.4
	KNO <sub>3</sub>	0.2	212.2	209.0	195.9	164.1	162.5
		0.3	214.4	213.7	205.9	166.3	163.5
		0.5	220.3	219.0	210.5	175.9	173.4
	TG <sub>50</sub> for non-primed seeds = 226.1 hours						
10 °C	Water		166.8	157.7	160.0	135.0	130.9
	ADA	10 <sup>-7</sup>	168.2	155.2	153.4	138.4	137.5
		10 <sup>-6</sup>	166.9	158.4	158.3	137.5	137.7
		5 x 10 <sup>-6</sup>	171.8	163.5	160.9	138.9	136.8
		10 <sup>-5</sup>	168.3	167.5	165.3	137.6	138.9
		10 <sup>-4</sup>	172.6	166.8	165.1	152.6	141.8
	KNO <sub>3</sub>	0.2	165.9	160.5	157.6	141.3	136.0
		0.3	164.6	159.6	161.5	149.5	138.3
		0.5	167.4	171.4	165.8	159.9	156.1
	TG <sub>50</sub> for non-primed seeds = 172.0 hours						
15 °C	Water		115.8	114.0	103.0	100.7	94.4
	ADA	10 <sup>-7</sup>	122.9	106.1	101.7	104.4	97.5
		10 <sup>-6</sup>	122.6	110.0	105.2	103.1	97.9
		5 x 10 <sup>-6</sup>	117.7	110.1	108.1	98.1	96.6
		10 <sup>-5</sup>	124.7	111.6	105.6	97.0	99.5
		10 <sup>-4</sup>	121.0	121.8	111.8	106.8	108.1
	KNO <sub>3</sub>	0.2	116.4	102.9	101.4	92.8	90.8
		0.3	116.3	109.8	104.0	100.3	99.6
		0.5	117.3	108.3	112.6	108.2	102.5
	TG <sub>50</sub> for non-primed seeds = 124.4 hours						
22 °C	Water		94.1	91.0	85.8	72.8	76.5
	ADA	10 <sup>-7</sup>	95.8	89.8	85.3	69.5	71.6
		10 <sup>-6</sup>	97.2	92.3	81.9	70.5	72.5
		5 x 10 <sup>-6</sup>	96.2	87.3	84.8	68.7	71.4
		10 <sup>-5</sup>	95.8	88.3	87.0	83.6	73.1
		10 <sup>-4</sup>	98.2	97.3	90.1	81.3	78.5
	KNO <sub>3</sub>	0.2	90.6	82.1	84.6	70.7	67.9
		0.3	85.9	87.8	83.4	81.7	72.2
		0.5	90.8	85.3	83.9	86.0	90.6
	TG <sub>50</sub> for non-primed seeds = 100.1 hours						

LSD<sub>(0.05)</sub> for treatment means at 5 °C = 13.6; LSD<sub>(0.05)</sub> for treatment means at 10 °C = 10.8; LSD<sub>(0.05)</sub> for treatment means at 15 °C = 7.3; LSD<sub>(0.05)</sub> for treatment means at 22 °C = 10.0.

Seed priming treatments did not improve final percentage germination, however, the NaCl priming treatment reduced final percentage germination at all four temperatures (Figure 2).



**Figure 2. Effect of seed priming treatments on final percentage germination at different temperatures.**

### Conclusions

Seed priming enhanced germination rate of annual caraway at low and high temperatures. The effect was more pronounced when seeds were germinated at low temperatures. Distilled water, ABA and  $KNO_3$  can be used as priming solutions. Seeds primed with distilled water, low concentrations of ABA, low concentrations of  $KNO_3$  for longer periods (36 or 48 h) resulted in the most rapid germination at all four temperatures. Seed priming had no effect on enhancement of the final percentage germination at any of the temperature. Seed primed with NaCl, however, reduced final percentage germination.

### References

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