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EFFECT OF PRESOWING SEED TREATMENTS ON GERMINATION OF LETTUCE SEED AT HIGH TEMPERATURE¹

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Abstract. The potential use of presowing treatments to prevent high temperature induced dormancy in lettuce (*Lactuca sativa* L.) seed was evaluated. Seeds of the cultivar 'Minetto' were soaked in water or 1% sodium phosphate (Na_2HPO_4) soln at 2 temp (15 and 25°C) for 1, 3, 6 or 12 hours. Germination tests were done immediately after each treatment at 35°C on moist filter paper and after redrying the seed. When the seeds were redried, germination tests were done at 20°C and 35°C in petri dishes, and, in soil at 35°C. At 20°C seed germination was high (92 to 97%) regardless of treatment. However, at 35°C germination occurred only in presoaked seeds. Redrying the seed was necessary in order to obtain maximum germination. For the best soak treatments, soaking at 15°C was more effective than at 25°C. Sodium phosphate was only more effective than water when seeds were soaked at 15°C. The optimum duration of soak was 3 and 6 hours in petri dishes and 6 hours in soil.

In many plant species the optimum germination temp range coincides with the optimum temp range for plant growth (7). In lettuce, plant growth can continue above the upper temp for optimum growth (15 to 25°C), however, germination may be completely inhibited at temp only slightly above the optimum germination temp range (3). For most lettuce cultivars, the "cut-off point" for normal germination is about 27 to 30°C. According to Sharpless (14), the germination of even the most heat-tolerant cultivars is seriously reduced when the temp is held constant at

30°C during inhibition and is completely inhibited at 35°C. Evenari (2) described this phenomenon as "heat dormancy". McCoy and Harrington (10) suggested that older seeds were desirable for warm weather planting because they were less susceptible to high temp dormancy. However, vigor of seedlings from older seeds was reduced.

A number of growth regulators affect lettuce seed germination. Reynolds and Thompson (11) reported that the high temp "cut-off point" may be shifted upwards by applying kinetin or downwards by applying abscisic acid. Kinetin was not as effective in the absence of light (12). Heydecker and Joshua (5) reported good results by soaking the seeds for 15 min in a 70 to 100 mg/l⁻¹ solution of kinetin dissolved in dichloromethane. This system permitted kinetin to be absorbed by the seeds without initiation of germination. Treated seeds germinated at considerably higher temp than did untreated seeds up to one year after treatment. The use of dichloromethane, however, is dangerous since the chemical is flammable and the fumes are toxic when inhaled. Ells (1) and Koehler (8) used fairly strong salt solutions to "vigorize" seeds. More recently, seed treatments have been successfully used on a number of species, whereby seeds are brought to the brink of germination in water or an osmotic medium. This procedure called "seed priming" (4, 9, 13) allows seeds to germinate more rapidly under unfavorable environmental conditions. In the present work, the effect of presoak treatments in water or sodium phosphate solutions at different temp for various durations was evaluated to determine if high temp dormancy in lettuce seed could be circumvented.

Materials and Methods

Non-photosensitive lettuce seeds (*Lactuca sativa* L. cv. Minetto) were soaked in water or 1% sodium phosphate (Na_2HPO_3) soln at 15 and 25°C for 1, 3, 6 and 12 hours. Each treatment consisted of 0.5 g of seeds and was replicated twice. The expt was arranged as a split plot design with soak the main plot and temp and time the subplot treat-

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ments. No extra aeration was provided to the seeds during the treatments. In order to remove excess moisture at the termination of each treatment, the seeds were placed in a Buchner funnel connected to vacuum for one min. After removing some seeds for an immediate germination test at 35°C, each lot was set out to dry for about 4 days in open air at room temp (approximately 21°C, 40% RH). After drying back to the original moisture content, a second germination test was performed at 20 and 35°C in petri dishes and at 35°C in soil. In the petri dish test, 2 replications of 25 seeds each were placed in a single layer of Whatman 3 filter paper saturated with 4 ml of deionized-distilled water. Seeds were checked daily and counted as germinated when the radicle protruded at least 3 mm from the seed coat. For the soil test, the seeds were sown 1 cm deep in a peat-sand-soil mix in plastic flats. The temp of the moistened soil was equilibrated at 35°C before planting. Seeds were considered germinated when the seedlings emerged through the soil surface. Non-treated seeds were used with all tests as a control.

Results and Discussion

Soak soln, soak temp and duration of soak had no effect on lettuce seed germination at 20°C (Fig. 1). Fully imbibed seeds from the water soak treatment essentially did not germinate at 35°C, whereas seeds soaked in phosphate solution germinated very poorly (1 to 14%). Heydecker (6) suggests that this inhibition may be due to a lack of an ade-

quate supply of oxygen for respiration because of the very high moisture content of the seeds. The higher germination of seeds soaked in sodium phosphate may have been due to a reduced water uptake in the higher osmotic salt solution. Germination of redried seeds at 35°C in petri dishes or soil was slightly higher with the 15°C soak than with the 25°C soak, and was reduced as soak duration passed 6 hours.

In the petri dish germination test at 35°C, non-treated seeds did not germinate whereas the highest germination occurred when seeds were soaked in sodium phosphate for 3 or 6 hours then redried (Table 1). When the seeds were soaked in sodium phosphate for more than one hr, the 15°C soak temp was better than 25°C. Temp did not affect the water soak treatment except at the one-hr duration where the 25°C soak led to a twofold increase in germination over the 15°C soak. Thus, water soak or high soak temp (25°C) led to high germination percentages after only one hr. This may have been related to a faster initiation of the germination process over the lower temp (15°C) sodium phosphate (high osmotic) soak. If this 'pregermination' process was speeded-up by using water or a higher soak temp then time in the soak had to be decreased in order to obtain the highest radicle emergence at 35°C. Possibly, if the pregermination process was taken too far before redrying, then subsequent radicle emergence was adversely affected.

In the germination test performed in soil at 35°C the highest germination of redried seed generally occurred after 6 hr soak in either soak solution (Table 2). Temperature reduced emergence only with the 6 hour Na₂HPO₄ soak.

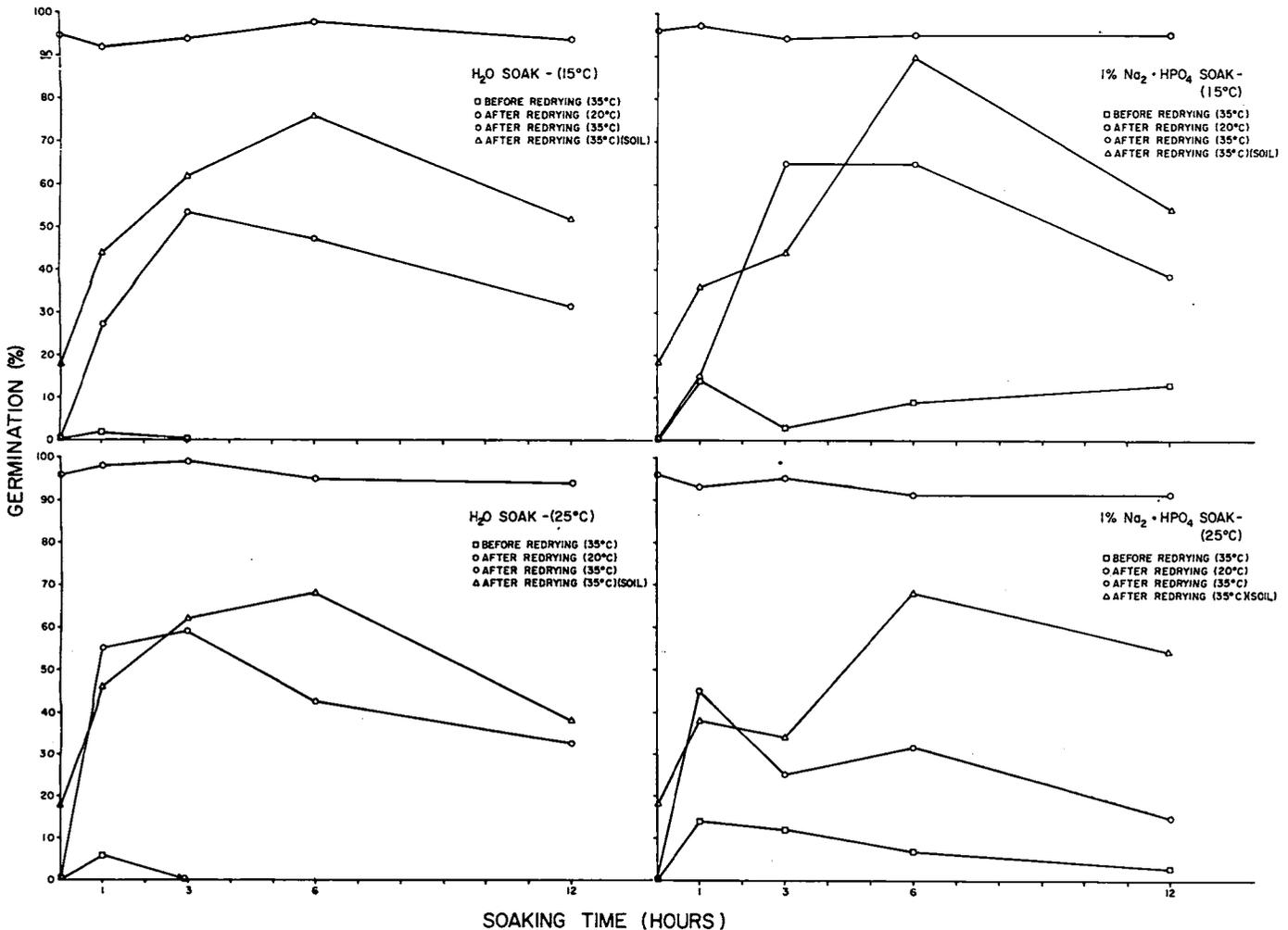


Fig. 1. The effect of water (H₂O) or sodium phosphate (Na₂HPO₄) soak at 15 and 25°C for 1, 3, 6 and 12 hours on the germination of lettuce seed at 20 and 35°C in petri dishes or soil.

Table 1. Effect of solution, temperature and duration of soak on the percentage germination of redried lettuce seed at 35°C in petri dishes.

Soak		Duration (hours)				Mean	
Solution	Temp	1	3	6	12	Soak Solution	Temp
Germination (%)							
H ₂ O	15°C	27.5b*	53.5a	47.5a	31.5b	43.6	
	25°C	55.0a	59.0a	42.5b	32.5b		
F value [†]		*	NS	NS	NS		
Na ₂ HPO ₄	15°C	15.0c	65.0a	65.0a	38.5b	37.5	
	25°C	45.0a	25.0bc	31.5b	15.0c		
F value		*	*	*	*		15°C 56.0 25°C 52.2
Mean		35.6b	50.6a	46.6a	29.4b		

*Mean separation within rows by Duncan's multiple range test, 5% level.

†Mean differences due to temp not significant (NS) or significant at the 5% (*) level.

Table 2. Effect of solution, temperature and duration of soak on the percentage germination of redried lettuce seed at 35°C in soil.

Soak		Duration (hours)				Mean	
Solution	Temp	1	3	6	12	Soak Solution	Temp
Germination (%)							
H ₂ O	15°C	44.0c*	62.0b	76.0a	52.0bc	56.0	
	25°C	46.0b	62.0a	68.0a	38.0b		
F value [†]		NS	NS	NS	NS		
Na ₂ HPO ₄	15°C	36.0c	44.0bc	90.0a	54.0b	52.2	
	25°C	38.0c	34.0c	68.0a	54.0b		
F value		NS	NS	*	NS		15°C 57.2 25°C 51.0
Mean		41.0b	50.5b	75.5a	49.5b		

*Mean separation within rows by Duncan's multiple range test, 5% level.

†Mean differences due to temp not significant (NS) or significant at 5% (*) level.

Although the soak treatments were not significantly different, the 6 hr soak in Na₂HPO₄ at 15°C led to the highest seedling emergence (90%). Regression equations were used to estimate maximum germination at each soak duration and are as follows:

Soak solution

Equation

$$\begin{aligned} \text{H}_2\text{O} & 34.40 + 11.75T - 0.91T^2 \\ \text{Na}_2\text{HPO}_4 & 50.62 - 19.69T + 6.48T^2 - 0.40T^3 \end{aligned}$$

The equation for water indicates that the germination in soil at 35°C would be maximized using a time of 6.5 hours.

The presowing treatments used in this experiment led to a 'priming' of the lettuce seeds which allowed radicle emergence at 35°C. Seeds soaked for 6 hr in water or sodium phosphate at 15°C and redried gave the highest germination in soil at 35°C (76 to 90%). This method presents distinct advantages over other methods used in that it is simple, safe and the treated seed can be redried, stored and planted using normal practices. Refinements of the treatment procedures are currently being researched. When further developed, this priming method will be field tested.

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