Proc. Fla. State Hort. Soc. 93:258-260. 1980.

GERMINATION OF PEPPER SEED AT LOW TEMPERATURES AFTER VARIOUS PRETREATMENTS[1]

M. SACHS,[2] D. J. CANTLIFFE, AND J. T. WATKINS
University of Florida, IFAS,
Vegetable Crops Department,
Gainesville, FL 32611

Additional index words. Capsicum annuum, seed priming.

Abstract. **Low soil temperature in the winter and early spring in Florida delays field emergence of pepper** (Capsicum annuum). **This results in erratic stands and plant development. Methods to bypass the slow germination of pepper seed at low temperatures were studied. Seed size had no effect on germination at low temperature. Water uptake by imbibing seed was very similar at optimal (25°C) and low (15°C) temperatures. Short-term immersion in organic solvents or soaking the seeds in unsaturated and saturated fatty acids had no effect on germination. Priming in organic solutions and with various fatty acids also did not hasten germination at low temperature. Imbibition at 30°C for 48 hr in water, or in aerated KNO_3 solutions for 6 or 8 days, enhanced the germination at 15°C when the seeds were not redried after treatment. Redrying after priming led to a slower germination than if the seeds were not redried.**

Sweet pepper is native to tropical America and is classified as a warm-season plant requiring relatively high temperatures for successful seed germination (4, 7, 8, 10). Germination and emergence of pepper seedlings in winter and early spring conditions in Florida requires up to 4 weeks and is not uniform compared to the rapid, somewhere between 7 and 10 days, and uniform emergence in the summer.

Various seed pretreatments have been suggested for low-temperature germination of thermophillic seeds (2, 5, 9, 11, 13, 14). Tomato and pepper seeds have been soaked in inorganic salts (5, 11) and cotton in fatty acids in order to improve germination rates under conditions of environmental stress. More recently, Heydecker (9) and others (14) reported increases in germination rate of many seeds after priming. This study was undertaken to compare various pretreatments which might enhance the rate of pepper seed germination at low temperature.

Materials and Methods

'Early Calwonder' pepper seeds were placed in 6 cm Petri dishes on Whatman #3 filter paper to which 2 ml of deionized water was added. The seeds were germinated in the dark at 15°, 20°, or 25°C. Radicle protrusion constituted germination. All experiments, were replicated 4 times, with each replicate consisting of 25 seeds. All experiments were repeated at least twice.

In a second experiment, imbibition rates at 15° and 25°C were determined. Seeds were removed at various times for a period of up to 12 days, damp-dried, and then weighed. Seed dry weights were then determined after drying at 70°C for 48 hr.

In a third experiment, pepper seeds were size graded using sieves ranging from 2.4 to 4.4 mm. The graded seeds were germinated as previously described at 15° and 25°C.

In the fourth series of experiments, pepper seeds were soaked for 48 hr in 100 μM of various saturated and unsaturated fatty acids dissolved in acetone. After treatment the seeds were vacuum dried for 1 hr, then imbibed (primed) in distilled water at 30°C for 48 hr before germinating at 15°C. The controls consisted of an acetone presoak, a non-presoaked water imbibed treatment and dry seed. Only the first 2 controls were primed at 30°C for 48 hr. 'Early Calwonder' seeds were also imbibed in deionized water at 30°C for 0, 12, 24, or 48 hr or primed in 3% KNO_3 at 20°C for 0, 3, 6, or 9 days then germinated at 15°C. Seeds were primed in KNO_3 were washed in distilled water before germinating. In the final experiment, pepper seeds were primed at 30°C for 48 hr then dried in room conditions for 0, 48, or 96 hr before germinating.

Results and Discussion

The start of germination of 'Early Calwonder' pepper seeds was delayed as temperature decreased from 25° to 20° to 15° (3.0, 4.9 and 11.2 days, respectively). The rate of germination was only slightly reduced at 15° whereas total germination was unaffected by temperature in the range tested (Fig. 1). Water uptake during imbibition was similar at 15° and 25° and did not increase appreciably until most seed germinated (Fig. 2). It was assumed that the 10% difference in water uptake during the first 24 hr of imbibition at 25° or 15° did not account for the significant delay (8 days and more) of the germination at the lower temperature.

Seed size has no effect on germination rate at 25° or 15°, although total germination of the small seed, which represented less than 1% of the total seed lot, was reduced at both temperatures (Fig. 3).

Scanning electron micrographs of the external surface of the seed coat revealed that pepper seed appeared to be encased in a wax-like substance. If so, this layer might be removed by organic solvents, and thus allow more rapid germination. The germination pattern (start, rate and total

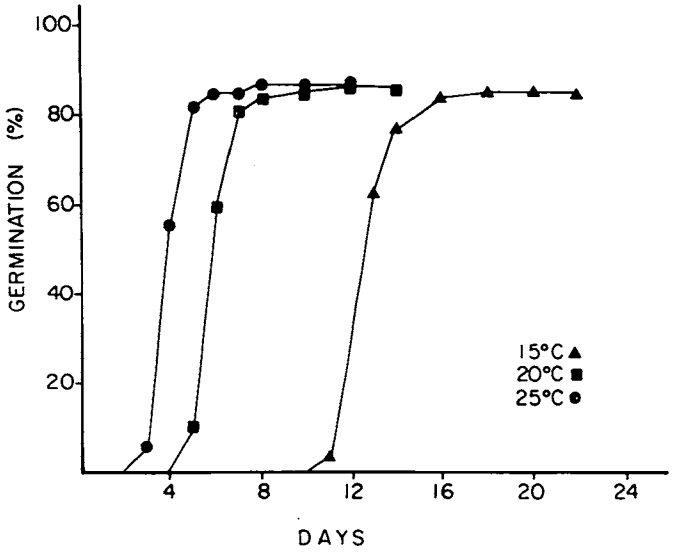

Fig. 1. The germination of 'Early Calwonder' pepper seed under various temperatures.

[1]Florida Agricultural Experiment Station Journal Series No. 2753.
This work was supported, in part, by Speedling Inc., Sun City, FL. 33586.

[2]On a sabbatical leave from the Agricultural Research Organization, The Volcani Center, Bet Dagan, Israel.

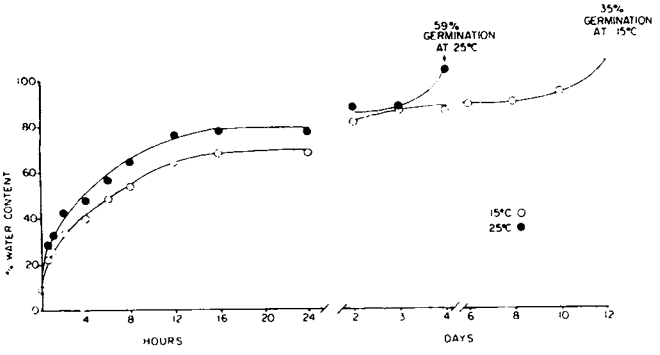

Fig. 2. The rate of water uptake of 'Early Calwonder' pepper seed during imbibition at 15° and 25°C.

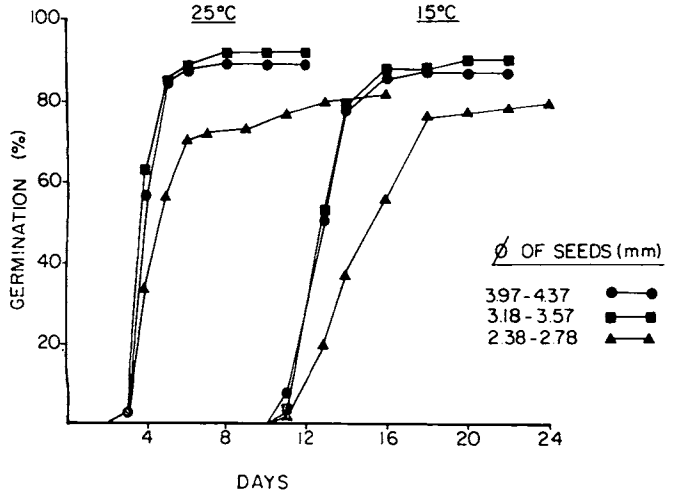

Fig. 3. The effect of seed size of 'Early Calwonder' pepper seed on germination at 15° and 25°C.

germination) at 15° of seeds soaked in various organic solvents (acetone, dimethylsulfoxide, dichloromethane and chloroform) was not affected by soaking up to 8 hr (data not shown).

Soaking of seeds in acetone for up to 3 months generally did not reduce germination or early seedling growth (12). Tomato and wheat seeds germinated better after the acetone treatment, whereas barley seed was damaged. This procedure was also suggested as a method to dissolve and introduce various chemicals into dry seeds so that the compound would be maintained within the seed during germination.

Various fatty acids have been incorporated into cotton seeds in order to overcome low temperature chilling injury (1). Clay et al. (3) found that cotton seeds with high unsaturated to saturated fatty acid ratios maintained higher physiological and biochemical functions than seeds with low ratios. These seeds also germinated better at low temperatures. In our work, soaking pepper seeds for 8 hr in saturated and unsaturated fatty acids dissolved in acetone did not improve germination rate, nor did they alter the total germination percentage (data not shown).

Soaking pepper seeds for 8 hr in solutions of acetone and palmitic acid or stearic acid dissolved in acetone increased the germination rate of pepper seeds at 15° after they had been primed at 30° for 48 hr (Table 1). Unsaturated fatty acids (oleic, linolenic and linoleic) decrease the rate of germination compare to saturated fatty acids. These differences are unresolved. Possibly the acetone or acetone and saturated fatty acids promoted more rapid germination during the subsequent 30° priming period.

Seed priming or bringing the seed to the brink of radicle emergence improves germination rates of many seeds which have been placed under stress (9). Pregerminating pepper seed at 30° for 12, 24, or 48 hr enhanced the start of germination at 15° by 3-4, 4-5 and 8-9 days, respectively compared to unprimed controls (Fig. 4). The seeds were not redried after imbibing at 30°. Woodstock (15) and Fieldhouse and Sasser (6) increased germination rates of pepper seeds primed in 2% KNO_3 and 2% KH_2PO_4, that were redried to 6% moisture. Germination rates of pepper increased at 25° in laboratory and greenhouse experiments by priming the seed in −8 bar polyethleneglycol (PEG) for 5 days at 15° but not in the field (16).

When 'Early Calwonder' seeds were primed in 3% KNO_3 at 20° for 3 to 9 days germination rate was increased, but the treatment did not affect the total germination percentage

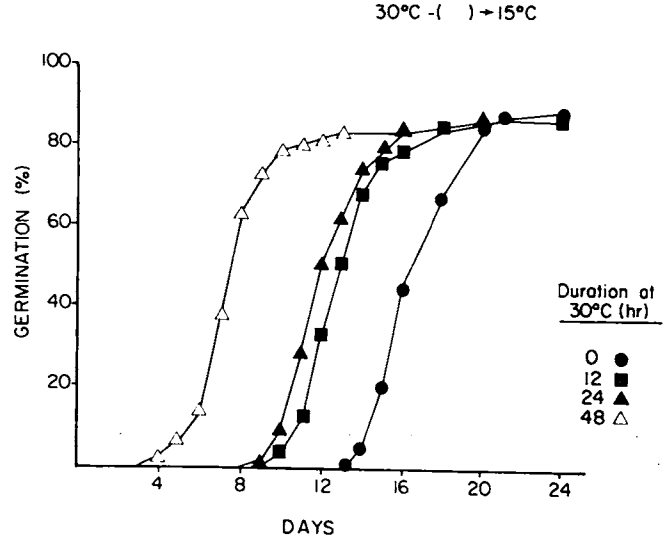

Fig. 4. Germination of 'Early Calwonder' pepper seed at 15°C after priming for 0 to 48 hr at 30°C.

Table 1. The effect of 8 hr soaking of dry 'Early Calwonder' pepper seed in 100 μM fatty acids dissolved in acetone before priming at 30°C for 48 hr. The seeds were then germinated.

Soak solutions	Days at 15°C					
	2	4	6	8	10	12
	Germination (%)					
Acetone	27c[z]	48d	63d	87d	95c	97a
Palmitric acid	23c	46d	57d	77d	92bc	97a
Stearic acid	38d	58e	69e	83d	92bc	94a
Oleic acid	1a	12c	29b	68c	91b	96a
Linoleic acid	4ab	15b	39c	71c	92bc	95a
Linolenic acid	5b	14b	31b	62b	88b	96a
Water primed only	1a	13b	30b	68c	91bc	91a
Unprimed	0a	0a	0a	11a	58a	89a

[z]Mean separation in columns by Duncan's multiple range test, 5% level.

at 15° (Fig. 5). The 9-day treatment appeared to speed up germination the most after removal of the seed from the priming conditions, some seeds germinated directly in the 9-day treatment, thus this duration of priming was excessive. Other salt solutions tested (2% KNO_3, 1% KNO_3 and 1% KH_2PO_4, 1.5% KNO_3 and 1.5% KH_2PO_4) gave similar results in enhancing the germination of the primed seeds at 15°.

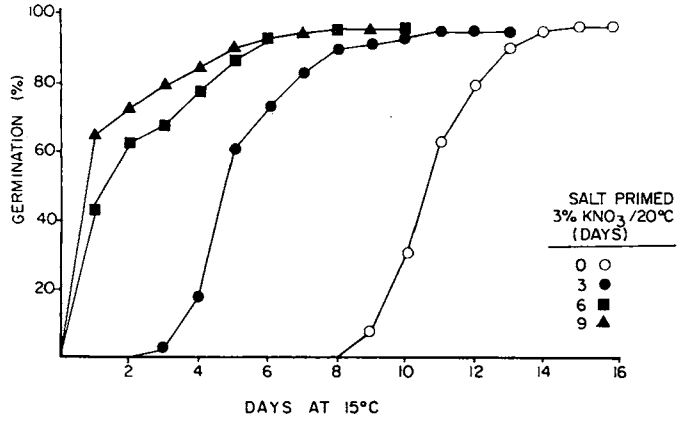

Fig. 5. Germination of 'Early Calwonder' pepper seed at 15°C after priming in KNO_3 solution at 20°C for 0 to 9 days. Seeds were not dried before germinating.

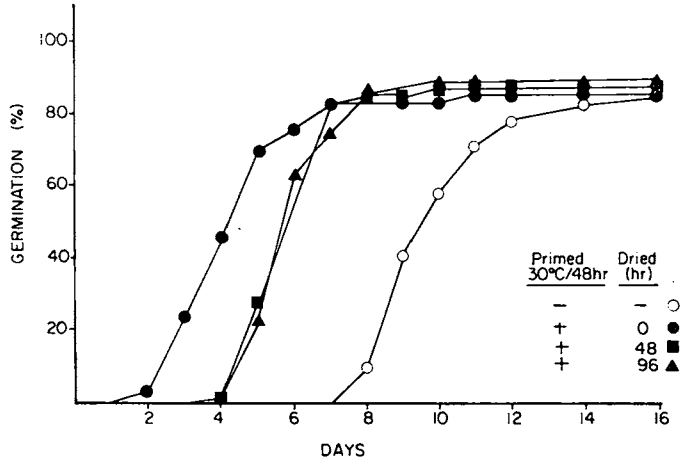

Fig. 6. The effect of drying primed 'Early Calwonder' pepper seeds for 48 or 96 hr on germination at 15°C.

If pepper seeds are to be sown by conventional methods after priming, then they must be redried. When 'Early Calwonder' seeds were primed at 30° for 48 hr, germination at low temperature was 6 days earlier compared to unprimed seeds. The effect of seed priming on germination rate was greater when the seeds were not redried (Fig. 6). Priming then redrying for 48 to 96 hr speeded germination, but by only 4 days. Hence, it would appear that pepper seed germination can be enhanced at 15° by seed priming. The reason for the delay in germination when seeds were redried cannot be explained. This point warrants additional research.

Literature Cited

1. Bartkowski, E. J., D. R. Buxton, F. R. H. Katterman and H. W. Kircher. 1977. Dry seed fatty acid composition and seedling emergence of pima cotton at low soil temperatures. *Agron. J.* 69:37-40.
2. ————, F. R. H. Katterman and D. R. Buxton. 1978. Influence of exogenous fatty acids on cottonseed germination. *Physiol. Plant.* 44:153-156.
3. Clay, W. F., E. J. Bartkowski and F. R. H. Katterman. 1976. Nuclear deoxynibonucleic acid metabolism and membrane fatty acid content related to chilling resistance in germinating cotton (Gossypium barbadense). *Physiol. Plant.* 38:171-175.
4. Cochran, H. L. 1935. Some factors which influence the germination of pepper seeds. *Proc. Amer. Soc. Hort. Sci.* 33:477-480.
5. Ells, J. E. 1963. The influence of treating tomato seed with nutrient solutions on emergence rate and seedling growth. *Proc. Amer. Soc. Hort. Sci.* 83:684-687.
6. Fieldhouse, D. J. and M. Sasser. 1978. Stimulation of pepper seed germination. *HortScience* 13:343 (Abstr.).
7. Gerson, R. and S. Honma. 1978. Emergence response of the pepper to low soil temperature. *Euphytica* 27:151-156.
8. Harrington, J. F. and G. M. Kihara. 1960. Chilling injury of germinating muskmelon and pepper seed. *Proc. Amer. Soc. Hort. Sci.* 75:485-489.
9. Heydecker, W., 1974. Germination of an idea: the priming of seeds. *University of Nottingham School of Agriculture Report*, 1973/1974: 50-57.
10. Kotowski, F. 1926. Temperature relations to germination of vegetable seed. *Proc. Amer. Soc. Hort. Sci.* 24:176-184.
11. Malnassy, P. G. 1971. Physiological and biochemical studies on a treatment hastening the germination of seeds at low temperatures. Ph.D. Thesis. Rutgers University, N.J.
12. Milborrow, B. V. 1965. Penetration of seeds by acetone solvents. Nature, London 199:716-717.
13. Pollock, B. M. 1969. Imbibition temperature sensitivity of lima bean seeds controlled by initial seed moisture. *Plant Physiol.* 44:907-911.
14. Sachs, M. 1977. Priming of watermelon seed for low-temperature germination. *J. Amer. Soc. Hort. Sci.* 102:175-178.
15. Woodstock, L. W. 1969. Biochemical tests for seed vigor. *Proc. Int. Seed Test Assoc.* 34:253-263.
16. Yaklich, R. W. and M. D. Orzolek. 1977. Effect of polyethelene glycol-6000 on pepper seed. *HortScience* 12:263-264.