# THE LETTUCE (*LACTUCA SATIVA* L.) SEED STORABILITY AFTER HYDRATION TREATMENT*

**J. Pazdera**

*Czech University of Agriculture, Faculty of Agronomy, Prague, Czech Republic*

Storability of nine lettuce seed lots treated by hydration treatment was evaluated in this experiment. Two methods of hydration treatment: prehydration with duration 3, 6, 12 and 24 hours and osmotic priming in PEG 6000 solution (osmotic potential –1,5 MPa) with duration 24, 72 and 144 hours were used. Osmopriming 24 and 72 hours had positive effect on seed parameters after 300 days of storage. These seed lots had significantly higher germination percentage and germination energy and significantly shorter MTG (Mean Time of Germination) than untreated stored control. Prehydration treatment influenced the storability of treated seeds negatively. Longer durations of hydration had more negative influence on storability than shorter durations. Optimal hydration treatment is an important condition for next storage of treated seeds.

seed; lettuce; hydration treatment; storage

## INTRODUCTION

The storability of seed after hydration treatment is still incompletely resolved question. Seed hydration treatment is performed as pre-sowing treatment, with consequential sowing of treated seed lots. The storage of treated seeds is not presupposed or only shortly before sowing. Existing experiences with storage of treated seed are very different. Seeds after treatment can be stored shortly without loss of benefits acquired by hydration. But long-term storage can cause subsequent negative changes of vigour and viability in comparison with non-treated seeds.

For example Cantliffe (1981) found that the effect of prehydration and of osmotic priming in salt solution on seed germination and vigour was the same after 4 months storage in dry conditions as before storage. Dearman et al. (1986) said that the osmotic priming reduced the loss of vigour during the storage. Argerich et al. (1989) found that the tomato seed after priming treatment kept similar viability after 1 year storage at 4 °C. Oluoch and Welbaum (1996) studied the influence of priming treatment on storability of muskmelon seeds. They published that non-treated seeds germinated better at 30C than the treated ones, but the field emergence was lower in comparison with treated seeds after 9 years of storage.

The different results were presented by Alvarado and Bradford (1988) with tomato seed. Long-term storage can influence negatively vigour of treated seed. Similarly Tarquis and Bradford (1992) did not find any protective effect of short duration of prehydration treatment on lettuce seed tolerance against deterioration. Osmotic priming before storage also affected longevity of seeds negatively. Hacisalihoglu et al. (2000) found faster deterioration of lettuce seed after the priming. Treated seeds after accelerated ageing test had similar high germination, but germination rate decreased with deterioration.

The objective of this paper was evaluation of the possibilities of seed lots storage after hydration treatments and evaluation of influence of storage duration on changes of seed performance.

## MATERIAL AND METHODS

This experiment was done with nine standard seed lots of lettuce (*Lactuca sativa* L.), of three cultivars (Smaragd "S", Podřipan and Jupiter) appointed for commercial use, with purposely different declared initial seed germination (from 82 to 99%).

### Hydration methods

Seed lots were treated by two hydration methods: prehydration and osmotic priming, each method with different duration of the treatments (Table 1).

Prehydration was realized in distilled water, without aeration, at the temperature 20 °C. Osmotic priming was done in PEG 6000 solution at 20 °C, with osmotic potential –1.5 MPa, prepared according to Michel and Kaufmann (1973). The PEG solution was aerated by ambient air. After both hydration methods seed were dehydrated back on filter paper in two steps: at first free water was quickly drained off and then seeds were let open for 24 hours on filter paper at the temperature 22 °C and relative humidity (RH) 42%.

### Storage

All treated and untreated (control) seed lots were stored in closed plastic boxes at 25 °C and relative humidity (RH) 10% for 0, 60, 180 and 300 days (Table 1).

* This research was supported by Grant Agency of the Czech Republic (521/96/0616).

Table 1. The overview of hydration treatment variants

| Sample | Hydration treatment | Duration of hydration treatment (hours) | Storage duration (days) |
|---|---|---|---|
| 1–9 | control (untreated seed) | – | 0, 60, 180, 300 |
| 1–9 | prehydration | 3 | 0, 60, 180, 300 |
| 1–9 | prehydration | 6 | 0, 60, 180, 300 |
| 1–9 | prehydration | 12 | 0, 60, 180, 300 |
| 1–9 | prehydration | 24 | 0, 60, 180, 300 |
| 1–9 | osmopriming | 24 | 0, 60, 180, 300 |
| 1–9 | osmopriming | 72 | 0, 60, 180, 300 |
| 1–9 | osmopriming | 144 | 0, 60, 180, 300 |

Table 2. Statistical significance of differences among treatments after storage (average of 9 seed lots, $\alpha = 0.05$)

| Treatment | Duration (hours) | Storage (days) | Germination | Sign. | Mean time of germination | Sign. | Germination energy | Sign. |
|---|---|---|---|---|---|---|---|---|
| Control | – | 0 | 92.00 | A | 2.96 | N | 71.59 | AB |
| Control | – | 60 | 88.75 | ABCD | 3.36 | LM | 55.95 | FGH |
| Control | – | 180 | 83.92 | FGHI | 3.55 | IJK | 52.97 | GHIJ |
| Control | – | 300 | 80.81 | IJ | 3.60 | IJ | 54.94 | FGH |
| Prehydration | 3 h | 0 | 88.64 | ABCD | 3.40 | JKL | 59.03 | EF |
| Prehydration | 3 h | 60 | 89.42 | AB | 3.72 | GHI | 54.44 | FGHI |
| Prehydration | 3 h | 180 | 86.47 | BCDEFG | 3.90 | EFGHF | 44.08 | KL |
| Prehydration | 3 h | 300 | 83.19 | GHI | 3.56 | IJ | 51.49 | HIJ |
| Prehydration | 6 h | 0 | 88.98 | ABC | 3.71 | HI | 52.05 | HIJ |
| Prehydration | 6 h | 60 | 87.61 | BCDE | 3.92 | EF | 49.08 | JK |
| Prehydration | 6 h | 180 | 83.61 | FGHI | 4.29 | BC | 34.81 | MN |
| Prehydration | 6 h | 300 | 80.53 | IJ | 3.92 | EFG | 39.44 | LM |
| Prehydration | 12 h | 0 | 85.17 | DEFG | 3.74 | FGHI | 49.76 | IJ |
| Prehydration | 12 h | 60 | 86.03 | BCDEFG | 4.18 | CD | 41.67 | L |
| Prehydration | 12 h | 180 | 76.03 | KLM | 4.35 | BC | 31.64 | N |
| Prehydration | 12 h | 300 | 68.16 | N | 4.26 | BC | 31.91 | N |
| Prehydration | 24 h | 0 | 81.08 | HIJ | 4.04 | DE | 41.94 | L |
| Prehydration | 24 h | 60 | 78.11 | JKL | 4.28 | BC | 35.91 | MN |
| Prehydration | 24 h | 180 | 68.61 | N | 4.57 | A | 24.78 | O |
| Prehydration | 24 h | 300 | 59.74 | O | 4.39 | AB | 24.77 | O |
| Priming | 24 h | 0 | 86.94 | BCDEF | 2.73 | OP | 71.64 | AB |
| Priming | 24 h | 60 | 86.06 | BCDEFG | 3.20 | M | 62.50 | DE |
| Priming | 24 h | 180 | 85.58 | CDEFG | 2.81 | NOP | 71.75 | AB |
| Priming | 24 h | 300 | 84.64 | EFGH | 3.33 | LM | 62.82 | DE |
| Priming | 72 h | 0 | 88.03 | BCDE | 2.65 | P | 74.83 | A |
| Priming | 72 h | 60 | 86.97 | BCDEF | 2.91 | NO | 69.11 | BC |
| Priming | 72 h | 180 | 86.39 | BCDEFG | 2.67 | P | 76.37 | A |
| Priming | 72 h | 300 | 83.93 | FGHI | 2.87 | NO | 71.43 | AB |
| Priming | 144 h | 0 | 79.14 | JK | 3.24 | LM | 58.06 | EFG |
| Priming | 144 h | 60 | 79.54 | JK | 3.34 | LM | 56.49 | FGH |
| Priming | 144 h | 180 | 74.76 | LM | 2.94 | N | 64.93 | CD |
| Priming | 144 h | 300 | 72.42 | M | 3.33 | LM | 54.65 | FGHI |
| | | | Minimal significant difference = 3.61 | | Minimal significant difference = 0.20 | | Minimal significant difference = 5.11 | |

Values in columns marked by the same letter are not significantly different ($P < 0.05$)

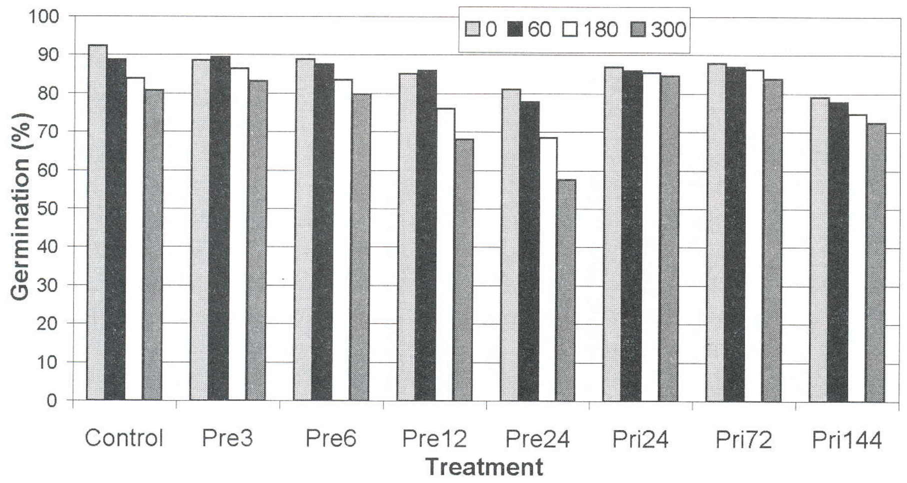


Fig. 1. Germination of treated seed lots after storage (average of 9 lots)
0, 60, 180, 300 means duration of storage in days

**Lots evaluation**

Seed germination percentage was determined and mean time of germination (MTG) and germination energy of all treated samples and the non-treated control were counted after testing.

**Seed germination** – was evaluated at 20 °C, in plastic boxes on filter paper (crepe, 120 g.m$^{-2}$), with underlying sand saturated with 60% of water, in four replications of 100 seeds each. Germination was counted in 24 hours intervals. Radicle protrusion of 3 mm was scored as germination.

**Mean time of germination (MTG)** – was calculated from daily germination values by equation of Nichols and Heydecker (1968):

$$\frac{\Sigma\, n_d\, d}{\Sigma\, n_d} \qquad (1)$$

where $n_d$ is number of seeds germinated on the day (d) and $d$ is serial number of the day.

**Germination energy** – was counted as cumulative germination after 3 days.

**Statistical analysis**

Experimental data were analysed with statistical packet SAS, version 6.12. (SAS Institute, Inc. Cary, NC USA). Analysis of variance was used for evaluation, exactly SAS GLM (General Linear Model) procedure. Means were compared by Tukey's test.

## RESULTS AND DISCUSSION

The results of this work confirm the positive influence of hydration treatment on seed germination, germination energy and MTG of treated lettuce seed after 300 days of storage. But this positive effect depends on the used hydration method. Decrease of germination percentage (in average of all seed lots) of stored lots after priming 24 and 72 hours was lower (2.30% or 4.10%, respectively) than that of stored control (11.19%) and the seed germination at the end of storage (300 days) was higher, even as germination energy. MTG of stored lots treated by priming (all variants) was significantly shorter in comparison with the stored control. It means that these samples germinate quickler than untreated control and have higher seed vigour. The prehydration treatment influenced seed parameters after storage negatively. Although the decrease of germination of seed lots treated by prehydration 3 and 6 hours after storage was lower (5.45% or 8.45%, respectively) than of stored control, germination at the end of storage (300 days) was only insignificantly different. MTG of seed lots after prehydration was significantly longer than untreated control.

The germination percentage of treated seed lots (in average) after storage decreases with treatment duration. Longer durations 12 and 24 hours of prehydration and 144 hours of priming were negatively related to storability of treated seed lots. These durations were evaluated as too long for successful hydration (Pazdera, Hosnedl, 2002). Successful hydration treatment is an important condition for further storage of treated seeds.

The detailed results of seed parameters of treated lettuce seed after storage are shown in Figures 1–3, statistical evaluation in Table 2.

## CONCLUSION

The storability of treated seeds after hydration depends on success of hydration treatment. The osmotic priming with duration 24 and 72 hours positively influenced storability of lettuce seeds. The prehydration treatment had negative influence on seed parameters after storage; lower germination percentage and longer MTG were found.

Even, if the storage of seed lots after hydration treatment is possible, the main use of the hydration treatment would be in pre-sowing seed treatment. Seed lots treated by hydration should be stored only shortly, with objective to save treated seeds of good quality before sowing. Meanwhile, I do not recommend the application of hy-

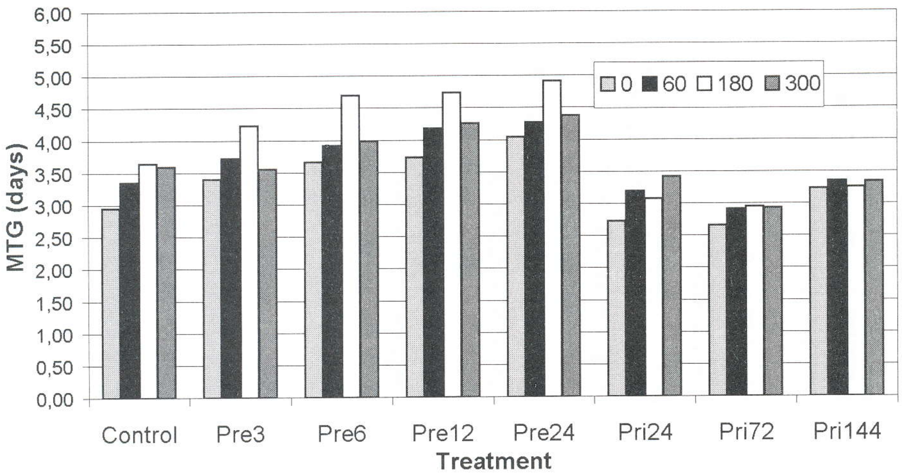


Fig. 2. Mean time of germination of treated seed lots after storage (average of 9 lots)
0, 60, 180, 300 means duration of storage in days

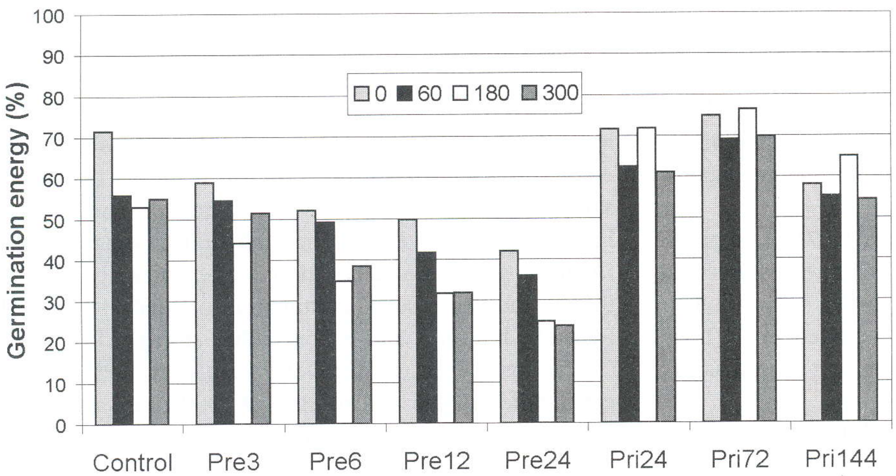


Fig. 3. Germination energy of treated seed lots after storage (average of 9 lots)
0, 60, 180, 300 means duration of storage in days

dration treatment with the objective to store the treated seeds after hydration, because questions of long-term storage of treated seeds are still not fully resolved and unexpected decrease of seed quality after storage is possible to appear.

## REFERENCES

ALVARADO, A. D. – BRADFORD, K. J.: Priming and storage of tomato (*Lycopersicon lycopersicum*) seeds. I. Effects of storage temperature on germination rate and viability. Seed Sci. Technol., *16*, 1998: 601–612.

ARGERICH, C. A. – BRADFORD, K. J. – TARQUIS, A. M.: The effects of priming and aging on resistance to deterioration of tomato seeds. J. Exp. Bot., *40*, 1989: 593–598.

CANTLIFFE, D. J. J.: Priming of lettuce seed for early and uniform emergence under conditions of environmental stress. Acta Horticulturae, *122*, 1981: 29–38.

DEARMAN, J. – BROCKERHURST, P. A. – DREW, R. L. K.: Effects of osmotic priming and ageing on onion seed germination. Ann. Appl. Biol., *108*, 1986: 639–648.

HACISALIHOGLU, G. – TAYLOR, A. G. – PAINE, D. H. – HILDEBRAND, M. B. – KHAN, A. A.: Embryo elongation and germination rates as sensitive indicators of lettuce seed quality: Priming and aging studies. Hortscience, *34*, 2000: 1240–1243.

MICHEL, B. E. – KAUFMANN, M. R.: The Osmotic potential of polyethylene glycol 6000. Plant Physiol., *51*, 1973: 914–916.

NICHOLS, M. A. – HEYDECKER, W.: Two approaches to the study of germination data. In: Proc. of the International Seed Testing Association, *33*, 1968: 531–540.

OLUOCH, M. O. – WELBAUM, G. E.: Viability and vigor of osmotically primed muskmelon seeds after nine years of storage. J. Amer. Soc. Hort. Sci., *121*, 1996: 408–413.

PAZDERA, J. – HOSNEDL, V.: Effect of hydration treatments on seed parameters of different lettuce (*Lactuca sativa* L.) seed lots. Zahradnictví (Horticultural Sci.), *29*, 2002: 12–16.

TARQUIS, A. M. – BRADFORD, K. J.: Prehydration and priming treatments that advance germination also increase the rate of deterioration of lettuce seeds., J. Exp. Bot., *43*, 1992: 307–317.

Received for publication on July 17, 2003
Accepted for publication on August 18, 2003

PAZDERA, J. (Česká zemědělská univerzita, Agronomická fakulta, katedra rostlinné výroby Praha, Česká republika):

**Skladovatelnost osiva salátu po hydratační úpravě.**

Scientia Agric. Bohem., *34*, 2003: 135–139.

Hydratační úpravy osiv jsou primárně prováděny jako předseťové ošetření semen, s předpokládaným následným výsevem těchto upravených semen. Skladovatelnost hydratačně upravených osiv je dosud ne zcela vyřešenou otázkou. Cílem této práce bylo zhodnocení možností skladování hydratačně upravených osiv a vliv skladování na změny kvality těchto osiv.

Byla hodnocena skladovatelnost devíti partií osiva salátu různé provenience s různými kvalitativními parametry, které byly upraveny pomocí hydratace. Byly použity dvě metody hydratace: prehydratace s expozicí 3, 6, 12 a 24 hodin a osmotický priming s expozicí 24, 72 a 144 hodin. Prehydratace byla prováděna v čisté vodě, osmotický priming v roztoku PEG 6000 s osmotickým potenciálem –1,5 MPa s aerací. Upravené partie osiv byly uskladněny v uzavřených boxech při teplotě 25 °C a nízké vzdušné vlhkosti 10 % a pravidelně hodnoceny po 0, 60, 180 a 300 dnech skladování.

Na semenářské parametry partií osiv po 300 dnech skladování měl pozitivní vliv osmopriming s expozicí 24 a 72 hodin. Tyto partie měly na konci skladování průkazně vyšší klíčivost a energii klíčení a průkazně nižší MTG (Mean Time of Germination) než neupravená kontrola. Vliv prehydratace na skladovatelnost osiv byl negativní. Obecně je možné říci, že delší trvání hydratace u obou metod mělo větší negativní vliv na skladovatelnost než kratší délky úprav (tab. 2).

Skladovatelnost upravených osiv výrazně ovlivňuje správné provedení vlastní hydratace. V takovém případě je delší skladování hydratačně upraveného osiva možné, nicméně tyto úpravy by měly sloužit hlavně jako předseťové, a nikoliv jako úpravy pro zlepšení skladovatelnosti osiv.

osivo; salát; hydratační úpravy; skladování

---

*Contact Address:*

Ing. Jiří P a z d e r a , Ph.D., Česká zemědělská univerzita v Praze, Agronomická fakulta, katedra rostlinné výroby, Kamýcká 957, 165 21 Praha 6-Suchdol, Česká republika, tel.: +420 224 382 540, fax: +420 224 382 535, e-mail: pazdera@af.czu.cz