# EFFECTS OF WATER AVAILABILITY DURING SEED DEVELOPMENT IN LETTUCE (*Lactuca sativa* L.)

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## INTRODUCTION

Among the factors affecting germinability of a seed lot are the environmental conditions under which the seeds are produced. Several reports indicate that differences in temperature, water availability and daylength during seed development affect seed quality, especially dormancy and germinability. In general, the consensus is that water deficiency during seed development reduces dormancy and improves germination (Fenner 1991, Hilhorst and Toorop 1997, Gutterman 2000). The objective of this study was to determine how water availability of the mother plant during seed development affects seed germinability in lettuce.

## MATERIAL AND METHODS

Lettuce seeds (*Lactuca sativa* L. cv. Tango) were produced in a greenhouse under two treatments: i) wet (watering volume equivalent to evapotranspiration volume), and ii) dry (watering volume ~ 54% of wet treatment). The treatments were applied from bolting until the end of the experiment. Plants were arranged in a randomised complete block design, with four replications and 6 plants per replication. Six flower heads per replication were sampled at 4, 6, 8, 10, 12, and 14 days after flowering (DAF); fresh and dry weight of seeds was determined. Three harvests of mature seed were carried out and, in each harvest, the number of seeds per flower head was calculated from a sample of 20 heads per replication. Water content of harvested seeds was uniformly reduced to 7.4%, by use of anhydrous $CaSO_4$, and seed weight (using a sample of 100 seeds per replication) and total seed weight per plant were calculated. At the last harvest, plant height and dry weight were determined.

Germination tests of 50 seeds per replication were performed in petri dishes with two blotter papers saturated with distilled water, PEG, or ABA solutions. For the germination in PEG and ABA solutions, the germination index (GI) was calculated by the algebraic sum of the ratio of germinated seeds and days after sowing at the count moment (last count 14 days after sowing).

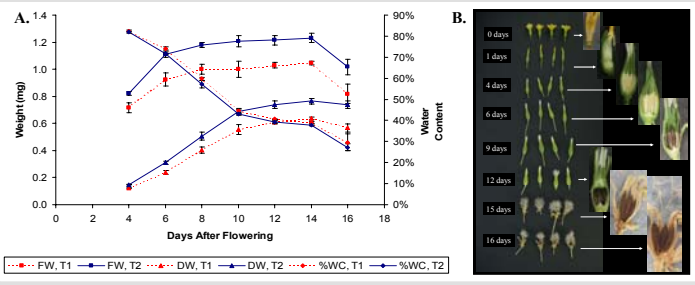


**Figure 1**. **A.** Weight and water content of lettuce seed during development. T1: wet treatment, T2: dry treatment, FW: fresh weight, DW: dry weight. Data are means +/- SE calculated from seeds of six flower heads per replication. **B**. Flower head and seed appearance at different moments of seed development. Samples from wet treatment.

## RESULTS AND DISCUSION

Both watering treatments presented similar patterns of lettuce seed development although the dry treatment had higher fresh and dry seed weight. For both watering treatments seed weight peaked around 12 DAF which indicates that water availability during seed development had no effect on physiological maturity (Fig. 1). However, the dry treatment produced heavier seeds than the wet one, which could be explained by the lower number of seeds per flower head and per plant of the dry treatment (Table 1). Plants from the dry treatment were smaller in terms of both dry weight and height. There were no differences in seed germination with light at 20, 25, and 30°C and in all cases it was close to 100%. However, a drastic reduction in germination was observed when seeds were germinated in dark conditions, which was more severe in seeds from the wet treatment (Table 1). In both treatments germination decreased at increased levels of exogenous ABA concentration, however seeds from the dry treatments were more sensitive to this compound (Figure 2). Germination percentage and GI for seeds from both treatments where reduced with reduction in water potential (PEG solutions), although seeds from the wet treatment were less affected (Figure 3).

**Table 1**. Parameters of growth, seed yield and seed quality for lettuce plants from both wet and dry treatments.

| Parameter | Treatment | | *p*- value[1] | % dry respect to wet |
|---|---|---|---|---|
| | Wet | Dry | | |
| **Growth** | | | | |
| Plant height (cm) | 121.4 | 109.7 | 0.021 | 90.4 |
| Plant dry weight (g) | 92.4 | 70.6 | 0.010 | 76.4 |
| **Seed Yield** | | | | |
| Seeds per flower head | 19.4 | 17.7 | 0.052 | 91.2 |
| Seeds per plant | 8211 | 5587 | 0.010 | 68.0 |
| Seed weight (mg) | 0.695 | 0.828 | 0.000 | 119.1 |
| Total seeds per plant (g) | 5.70 | 4.62 | 0.051 | 81.1 |
| **Seed Germination[2]** | | | | |
| At 20°C- light (%) | 100.0 | 99.5 | 0.391 | 99.5 |
| At 25°C- light (%) | 99.0 | 99.5 | 0.391 | 100.5 |
| At 30°C- light (%) | 98.5 | 97.5 | 0.664 | 99.0 |
| At 20°C- dark (%) | 12.0 | 23.3 | 0.050 | 194.2 |

[1]: *p*-value from analysis of variance.
[2]: germination counted as radicle appearance 7 days after sowing.

Izzeldin et al. (1980) studied the influence of water stress on yield and quality of lettuce seeds and reported that plants under water stress produced fewer and heavier seeds, which is in agreement with our results. However, these authors found that lettuce seeds from stressed plants had higher vigor and less abnormal seedlings, and concluded that water availability conducive to higher yields generally produced lower quality seeds. This observation is contrary with our results, which could be due to the differences in cultivar and/or methodologies.

In conclusion, restriction in water availability during lettuce seed development decreased seed yield and, in general, did not improve seed quality. Seeds produced under restricted water availability were heavier and showed a marginal increase in dark germination. However, final germination of lettuce seed exposed to increased concentrations of external ABA was more affected for seed from restricted water availability than for lettuce seeds from plants without water restrictions.

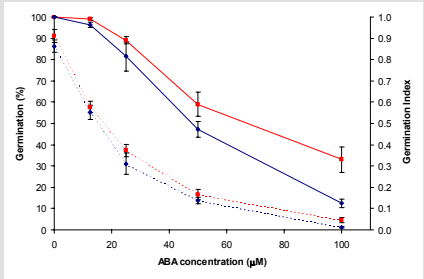


**Figure 2**. Germination (solid line) and germination index (broken line) of lettuce seeds from wet (red) and dry (blue) treatments at different ABA concentrations (20°C - constant light). Data are means ± SE of four replications of 50 seeds.

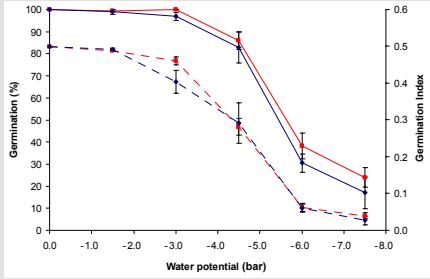


**Figure 3**. Germination (solid line) and germination index (broken line) of lettuce seeds from wet (red) and dry (blue) treatments at different water potentials (PEG solutions; 20°C - constant light). Data are means ± SE of four replications of 50 seeds.

## REFERENCES

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