

WHY DO TOMATO SEEDS PRIME?

Physiological Investigations into the Control  
of Tomato Seed Germination and Priming

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## Summary

It is the aim of this thesis to examine hypotheses regarding the prevention of radicle emergence during priming and of the enhancement of germination following priming. This work should identify the control sites in the processes of radicle emergence and their modification during priming.

For the most part these hypotheses are underlain by an analysis of germination as a special case of plant cell expansion. A study of cell expansion requires an understanding of the water relations of the tissues involved. Therefore, the sequence of events during the germination of tomato seeds was first examined through a water relations study then the changes caused by priming were examined.

The study of the water relations of germinating tomato seeds revealed that the seeds came into  $\Psi$  equilibrium with the imbibitional solution, whereas, the embryo was measured at much lower  $\Psi$ . There was no evidence of a lowering of embryo  $\Psi_{\pi}$  nor of an increase in embryo  $\Psi_p$  prior to radicle emergence. The embryo  $\Psi$  measurements need to be interpreted with caution for they are *ex situ* measurements and thus do not directly measure these properties in the seed. It is unlikely that a large  $\Delta\Psi$  could be maintained within the seed during imbibition. Thus the existence of a large seed to embryo  $\Psi_p$  can be inferred from these measurements. The moisture release isotherm of the excised embryo confirmed this inference. The endosperm tissue enclosing the embryo was found to restrict the hydration level of the embryo

prior to its emergence. As the embryo was capable of expansive growth prior to radicle emergence, it was concluded that the weakening of the endosperm controlled radicle emergence in tomato seeds.

During priming the tomato seeds were in  $\Psi$  equilibrium with the priming solution, but the embryo was not. As the embryo was capable of growth after 2 days of the 6 day priming treatment, it was concluded that radicle emergence was prevented by the maintenance of the endosperm restraint. Germinating primed seeds did not display a marked plateau during imbibition. Both seed and embryo water contents were higher than those of non-primed seeds. However, embryo  $\Psi$  and  $\Psi_{\pi}$  were lower than those of embryos from non-primed seeds, eventhough embryo  $\Psi_{\pi}$  measurements during priming had not revealed significant lowering. The relative growth rate of seedlings from primed seeds was higher than that of non-primed seeds for the first 12 h after radicle emergence.

The endosperm of tomato seeds consisted of two distinct cell types found in separate locations within the seed. At the micropylar end of the seed the endosperm cells had thin walls, whereas those in the rest of the seed had thickened walls. The outer walls of outermost endosperm cells in the rest of the seed had massively thickened walls whereas these were lacking from the outer cells of the micropylar region.

All cells, except those of the root cap, contained protein bodies. The protein bodies of the micropylar region endosperm cells were seen to breakdown to form vacuoles

prior to radicle emergence. The protein bodies in other cells did not appear to change prior to this time. During priming protein body breakdown was more extensive in the micropylar region endosperm cells and vacuole formation also occurred in the radicle. After radicle emergence the cells of the radicles from primed seeds were found to be about 50% larger than those of the radicles from non-primed seeds.

Endosperm weakening preceded radicle emergence in tomato seeds. Slower germinating seeds within the population had higher values for endosperm resistance. Endosperm weakening during priming resulted in values for endosperm resistance which were lower than those measured from a population of germinating non-primed seeds. Germinating primed seeds had resistances which were similar to those of priming seeds. It was concluded that a final rapid endosperm weakening step may be necessary for radicle emergence to occur.

These studies have shown that tomato seeds prime because the endosperm does not weaken sufficiently to permit expansion of the radicle. The mechanism by which some endosperm weakening was permitted, but the final weakening for radicle emergence was prevented was not identifiable. Priming advanced the timing of radicle emergence by improving the rate of water uptake by the seeds; by eliminating the time necessary for the loosening of embryo cell walls and by permitting the completion of the first step of the endosperm weakening process. Embryos from primed seeds had improved cell wall extensibilities which

permitted higher relative growth rates during the first 12 h after radicle emergence.

**Certificate**

I hereby declare that this work has not been  
submitted for a higher degree to any other  
university or institution.

A handwritten signature in cursive script, appearing to read "Anthony Mark Haigh". The signature is written in dark ink and is centered on the page.

**Anthony Mark Haigh**

Dedicated to my wife

Helen Jane Bailey

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