# Germination of Supersweets: Imbibitional Chilling Injury

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Germination can be divided into a number of distinct stages including imbibition, starch breakdown and energy mobilization, and cell differentiation and elongation. These stages involve very different biological mechanisms and are sensitive to different environmental stimuli. Normally, during imbibition, water and oxygen move slowly into the kernel through the tipcap region. Membranes rehydrate and hormones are activated. During starch breakdown and energy mobilization, hormones induce embryo and aleurone cells to release enzymes that break down starch and convert it to sugar. Energy contained in the sugar is moved into the embryo. Embryo cells use the sugars to fuel cellular process including cell division, elongation, and differentiation. As root cells elongate the radicle emerges from the kernel followed by the plumule. After the plumule emerges from the soil the seedling begins photosynthesis and the plant becomes independent of the food supply stored in the kernel

Supersweet (*shrunken2*) kernels are more susceptible to damage during imbibition than are sugary kernels. Because of the extreme shrinkage that sweet corn kernels undergo as they dry, the pericarp often develops many tiny cracks. When kernels with cracked pericarp are planted in moist soil, water rushes in from all directions. This results in disruption of membrane reorganization. If membranes are disrupted cellular contents including sugars and salts leak out of the kernel and provide a food supply for potential seed pathogens. Cold soil temperatures greatly aggravate this situation. This syndrome is called imbibitional chilling injury.

We wanted to determine when supersweet seed is most sensitive to imbibitional chilling injury. We carried out a number of experiments to pin down the time.

## Materials and Methods

Experiment 1:

- Untreated seed of six supersweet hybrids.
- Six imbibition treatments
    - Each treatment consisted of one 24-hour period at 40$^{o}$F and five days at 75$^{o}$F. Treatment one consisted of the first 24 hours at 40$^{o}$F and the following 5 days at 75$^{o}$F. For treatment two, the seeds were exposed to 24 hours at 75$^{o}$F followed by 24 hours at 40$^{o}$F and then four days at 75$^{o}$F and so on.

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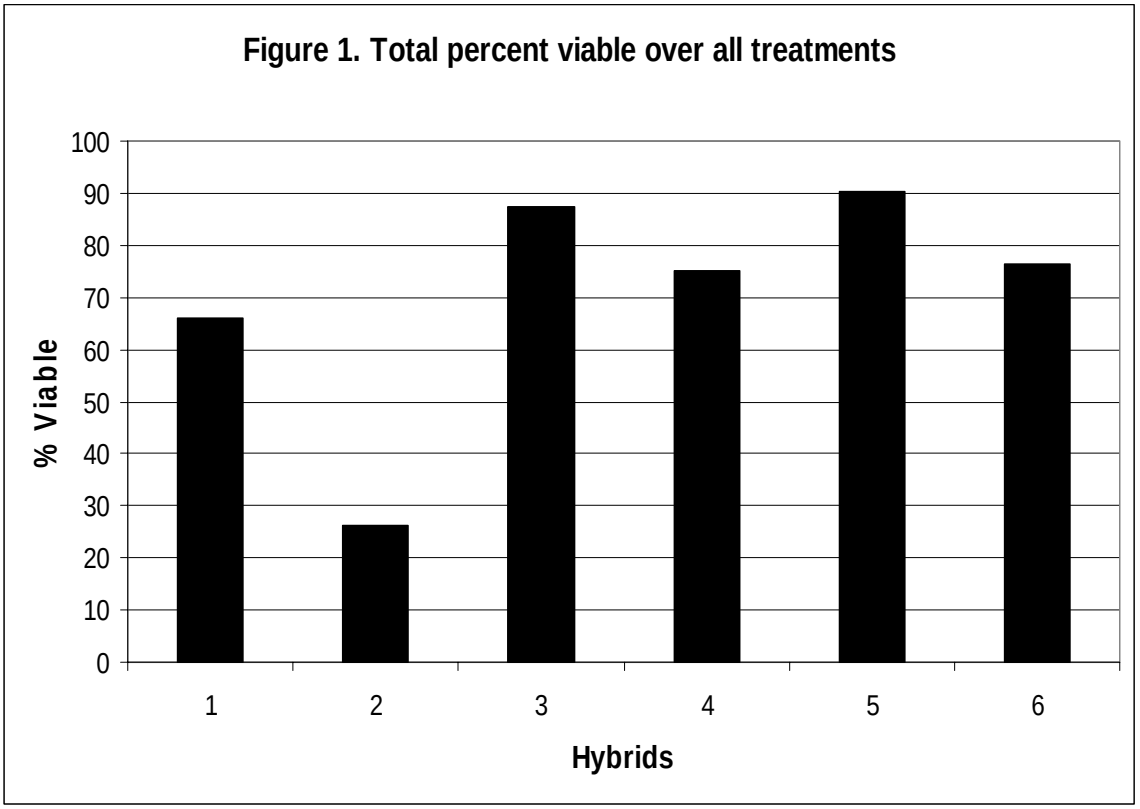
- The treatment number corresponds to the 24-hour cold period.
- We used rag dolls with no soil.
- Eight replications 25 seeds per replication

## Results

As expected the hybrids performed differently when averaged over all six treatments (Fig. 1). Hybrids 3 and 5 had nearly 90% germination, while only about 25% of the seeds in hybrid 2 germinated.




For every hybrid, treatment one resulted in significant reductions in viability (Figures 2 & 3). None of the other treatments had any significant effects on viability (Figure 2 & 3). Thus all the damage due to chilling imbibition occurred in the first 24 hours after planting. The reductions in some of the hybrids were large. In hybrid four 50% of the kernels were killed by chilling imbibition in the first 24 hours. Only about 5% of kernels in hybrid four were killed by treatment 2 (warm on day 1 and cold on day 2) and this was not significantly different from the control. Hybrids one, two and six all had greater than 30% damage due to treatment 1. On the other hand only 18% of the kernels of hybrid 5 were killed by imbibitional chilling injury on day 1. This was still a significant number.

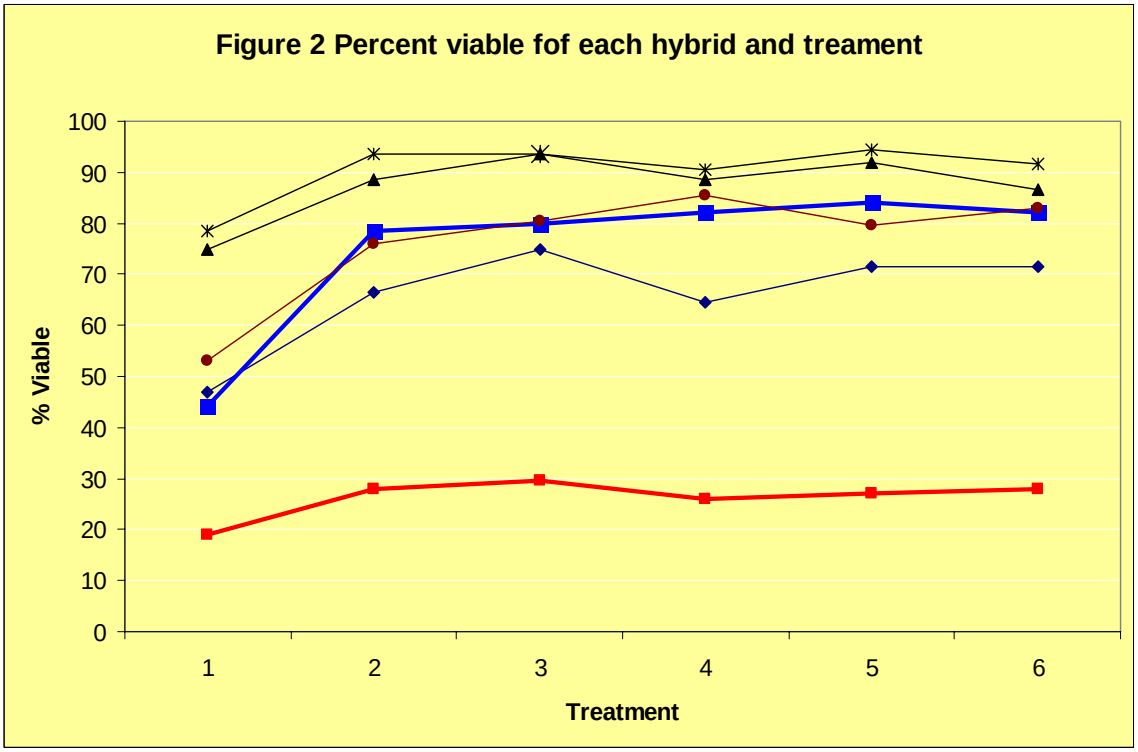


Figure 2 Percent viable fof each hybrid and treament
100
90
80
70
60
50
40
30
20
10
0
% Viable
1
2
3
4
5
6
Treatment

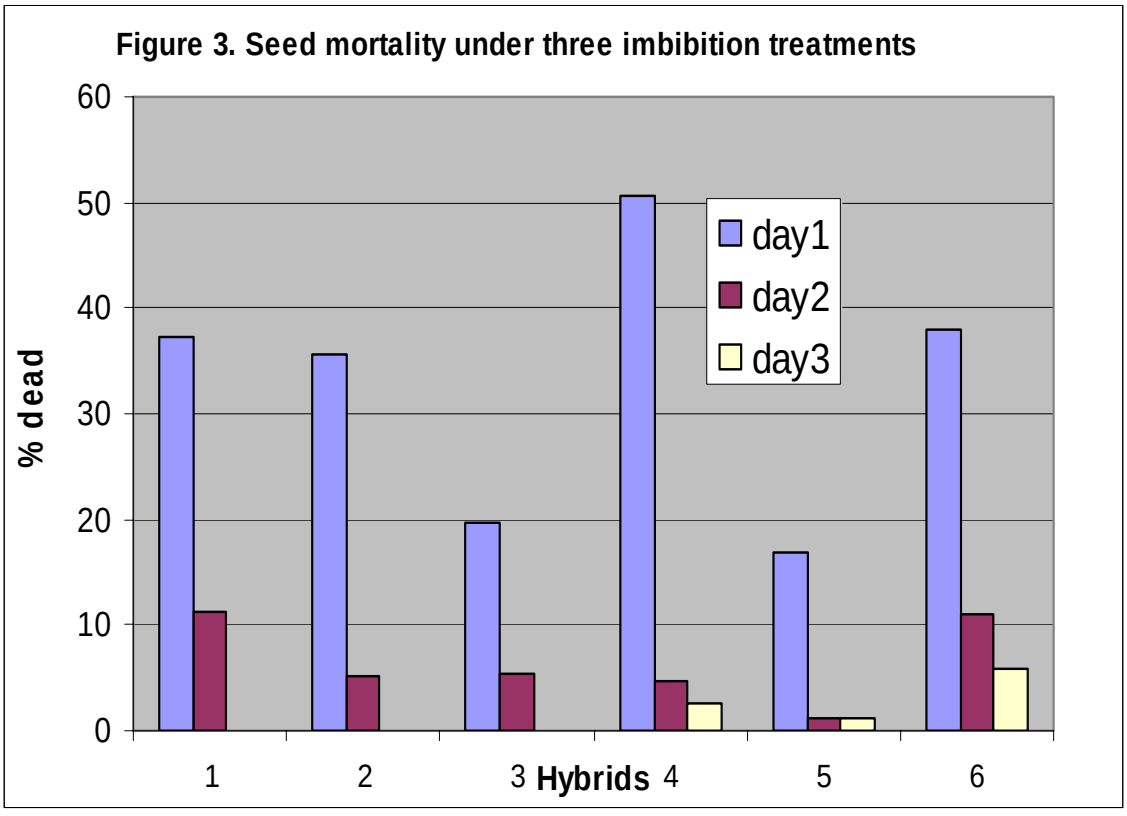
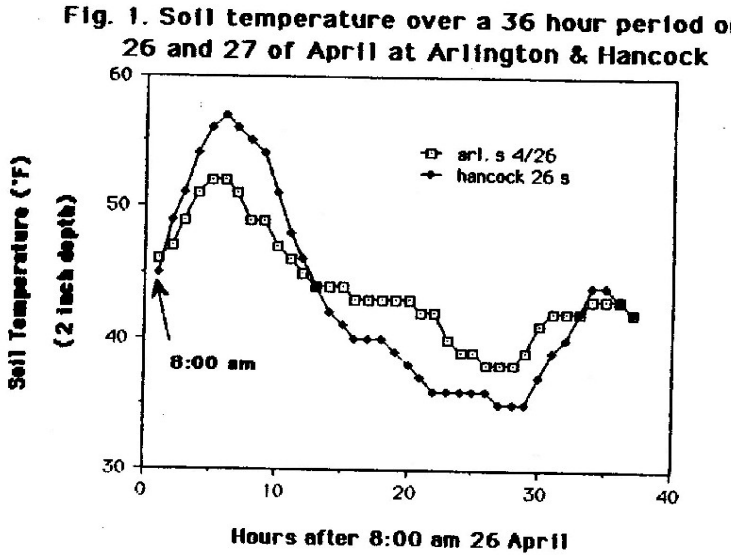


Figure 3. Seed mortality under three imbibition treatments
60
50
40
30
20
10
0
% dead
day1
day2
day3
1
2
3
Hybrids
4
5
6

To avoid imbibitional chilling injury supersweets should be planted in warmer soils. Sandy soils warm more quickly than do other soils, however they also cool more quickly. The figure below comes from a MWFPA Proceedings of a number of years ago. It shows the actual temperature fluctuations at planting depth for a 36 hour period starting at 8:00AM on 26 at Arlington and Hancock. If 40$^{o}$F was the critical temperature the Hancock seed would have spent more time below this temperature.




We did additional experiments attempting to narrow the critical period further and we did not find any significant differences within the first 24 hours.

## Conclusion

- Supersweet corn seeds are sensitive to imbibitional chilling damage.
- The critical time for imbibitional chilling damage occurs is the first 24 hours after planting.
- We could not narrow the critical time down further.
- While sandy soils warm more quickly they cool more quickly as well.