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DELETERIOUS METABOLIC AND MORPHOLOGICAL CHANGES RESULTING FROM SEED SOAKING PRIOR TO SOWING

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For many years growers have soaked seeds prior to sowing in the belief that germination will often be improved. However in many cases exactly the opposite effect is achieved; that is, germination will be reduced or seedling growth will be abnormal. A further reason to study soaking injury is highlighted by new changes in cultural practices. Recent work has focussed more attention on seed soaking prior to sowing as a means of improving field or greenhouse seedling emergence and uniformity. Two striking examples highlight this:

1. The use of pre-germination chambers to prepare materials for fluid drilling. This interesting technique is now used by growers of high value vegetable crops in many countries and is the result of recent research work at The National Vegetable Research Station in England (12). The method is also suitable for small scale use (7). It seems highly likely that this technique will prove useful for woody ornamental plants as well as other ornamentals. Indeed, equipment is now being developed for the bedding plant industry for this purpose.
2. The use of osmotic priming techniques for seeds. Using this method seeds are partially hydrated in a controlled manner.

The degree of hydration may be controlled by immersion of the seed in solutions of varying strength (i.e. determines available water.) A biologically inert solution is used with a high molecular weight to avoid entry of its molecules into the seed. It is possible to induce early germinative stages with no apparent external changes to the seed (except perhaps a slight change in size). This results in more rapid and even germination after treatment with no requirement for specialized equipment (2,3).

A literature search reveals that seed injury on soaking can occur (1,13), although very few practical recommendations have been given for pre-soaking seeds to maximize germination. This difficulty is due to the fact that species, cultivars and even seed lots may vary in their response to injury after soaking. In order to quantify some of these effects I have conducted a series of experiments on soaking injury in seeds of a number of genera.

Evidence for soaking injury In a recent series of experiments metabolic injury of seeds has been studied after soaking (5,6,8,9,10). Seeds sensitive to injury demonstrate rapid alcohol fermentation and a gradual depletion of seed reserves (4). All of these experiments exposed the seeds to soaking periods from 0 to 96 hours only. This problem can be related to oxygen deficiency under water and may in part be alleviated by oxygenation of the water but the partial pressure of oxygen should preferably be below the partial pressure of oxygen (8).

To date almost all of this work has been conducted on herbaceous species. This is due to the requirement for rapid turnover of experimental material. However, we hope to be able to formulate general predictive behavioural patterns by seed type. At this stage it is possible to make an intuitive guess as to seed behavioural patterns under flooding but this has not yet been quantified. This is based largely on metabolic behaviour and germination tests.

Frequently when seeds suffer metabolic damage a secondary form of damage follows. It is known that alcohol fermentation in tissues frequently leads to membrane damage. In seeds this is often observed as damage to the seedling meristem and may sometimes be a lethal syndrome.

I have recently studied another type of secondary damage. After flooding, seeds may germinate apparently normally if the treatment was not too severe. However, my experiments have shown a reduction in height of the established seedling in a number of species, even though those species subjected to soaking had been soaked for up to 96 hours ahead of sowing time.

Avoidance of soaking injury 1. Seeds of herbaceous species might be injured after only 48 hours of soaking. Usually, howev-

er, a soaking period up to 8 hours will be advantageous (for example, *Pisum sativum* L).

2. Seeds of woody ornamental species may often be soaked for much longer periods without deleterious effects. Indeed in many instances this is desirable because some types of dormancy problems may be alleviated after this treatment. It is thought that germination inhibitors are leached out during this soaking period. In my laboratory we are currently working on the replacement of this treatment with growth regulator infusion into the seeds of woody ornamentals (11).

In summary we can say that both metabolic and morphological damage (which indirectly results from metabolic damage) may result from seed soaking prior to sowing but in the case of woody ornamental seeds this may not be the case during dormancy.

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