TREATMENT FOR CONTROL OF SEED-BORNE PATHOGENS OF ZINNIA

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The general objective of this research work is to find effective methods of controlling seed borne fungi while maintaining high levels of seed germination and vigour. The material being tested at present is alternaria-infected zinnia seed.

The transmission of fungi by seed is important because it provides an efficient means of dissemination from one place to another and it allows carryover of the fungus in time. Because there is a close assocation of the fungus and seed there is maximum opportunity for progeny infection and the seed may help protect the fungus from unfavourable environmental conditions. The planting of fungus-carrying seed introduces the disease at random through an area producing well-distributed foci for primary infection (3).

Alternaria zinniae transmission in zinnia seeds occurs when senescent flowers on the plant absorb dew at night and remain wet the next day slowly becoming mouldy from a mixed microflora of fungi including *Alternaria zinniae*. This *Alternaria zinniae* has survived in the soil from the previous season's infected seedlings. *Alternaria zinniae* grows through the petals into the attached seeds. These infected seeds then give rise to diseased seedlings on which a great number of spores are produced. Air-borne spores then infect leaves, stems and flowers of other plants.

Methods for the control of seed transmission of fungi can be either preventive, such as crop rotation and selection and breeding of resistant plants, or curative in nature. This work involves the study of physical curative measures, that is, the application of heat.

Heat treatments have been used by many workers to significantly decrease or eliminate seed-borne diseases (5,7). The two most commonly used methods are hot water and steam-air treatment. Hot water was the first method used, one of the earliest reports being that of J.L. Jensen in 1888 who used hot water to kill the mycelia of *Ustilago nuda* infecting barley (3). It is still the most commonly used method today. Usually seed is soaked at temperatures ranging from 40°C to 60°C for time periods of 15 minutes to 24 hours, dried back, then stored or germinated.

L.A. Hawkins in 1929 first devised a "vapour heat" chamber for killing disease in which steam was injected into an air

stream and the temperature maintained by a mechanical device (4). Baker in the early 1960's developed a much more efficient apparatus suitable for seeds in which the aerated steam is passed downward through the seeds so that churning is minimized and condensate can drain out (2). Treatment temperatures are usually from 50° to 60°C and time periods range up to 30 minutes.

One of the major problems associated with the use of moist-heat treatments has been the severe decrease in seed viability that sometimes occurs. For example, for good control of some pathogens on lettuce Maude (6) found that a severe decrease in germination occurred. Moist-heat treatments may also produce a delay or reduction in germination vigour.

In this work attempts were made to overcome these problems by applying various chemicals to the seed either pre, during or after the heat treatment.

Several introductory experiments showed that about 55°C was the appropriate temperature for killing the alternaria in hot water and about 58°C for steam-air. Thirty minutes was the time period used. Germination percentages were very low, 5 to 30% depending on the temperature; however lower temperatures failed to kill the fungus.

Many different combination of treatments were used. Soaking in polyethyleneglycol for a week after heat treatment was found to increase the germination percentage but not sufficiently to warrant the amount of time and effort involved. Any type of soaking prior to heating resulted in extremely low germination rates.

Two of the major disadvantages described by Baker (1) of using hot water treatment for disease eradication are, firstly, that the seeds absorb a large amount of water resulting in the leakage of soluble materials. Secondly, it has been found that the higher the moisture content the greater the susceptibility of living organisms to thermal killing. The use of steam-air overcomes these problems to an extent but from the experiments carried out using a machine similar to that described by Baker, we found that the germination was still too low for practical purposes.

In an attempt to overcome these problems of imbibition and leaching we heated the seeds in concentrated salt solutions to see if these would, perhaps, by acting as osmotic agents protect the seeds.

Several salts were tried initially to determine if different salts were likely to yield different results and also to determine the approximate concentration needed for beneficial effect.

The method involved placing the seeds in the salt solution and heating at the desired temperature for ½ hour. After this treatment, the seeds were thoroughly washed and set to germinate on moist blotters.

Of the salts initially tried $CaCl_2 \cdot 2H_2O$ appeared to be the most effective, taking into account cost and ease of use. Using a concentration of 1 Molar, germination percentages of up to 50%, a great improvement on the use of hot water alone, could be achieved at 54°C. After seven days the seedlings appeared healthy and had good strong root development.

More detailed experiments were then carried out using $CaCl_2 \cdot 2H_2O$. Firstly, the temperature was kept constant and the salt concentration varied from 0 to 3.5 Molar. It was found that the 7 day germination markedly increased with increasing salt concentration up to 2 Molar. There appeared to be no benefit in further increasing salt strength. However, as the germination percentage increased so did the infection percentage (Table 1).

Table 1 Germination and infection of zinnia seeds heated at 54°C for ½ hour in $CaCl_2$ $2H_2O$

Molarity	7 day germination, percent healthy	10 day Infection, percent
0	8	2
0 1	6	2
0 5	19	3
1 0	45	10
2 0	60	15
2 5	61	23
3 2	58	18
3 7	56	21

In order to decrease the infection levels, experiments involving varying the temperature but keeping a constant salt concentration were carried out.

The results of these trials showed that at a temperature of 56° to 57°C the infecton levels could be kept below 5% and the germination above 50% (Table 2).

Further experiments have been carried out using a wider variety of salts but it appears that $CaCl_2 \cdot 2H_2O$ is as successful as any of those tried and much better than some salts which have proved highly toxic. We are extending this treatment to safflower seed infected with *Alternaria cartharmi* to see if the method can be used on other fungal infections and experimenting using shorter time periods with higher temperatures and longer soaks at lower temperatures to try and increase the germination percentage further.

Table 2. Germination and infection of zinnia seeds with a constant concentration of $CaCl_2$ $2H_2O$, and with varying temperatures

Temperature, degrees C	$CaCl_2$ $2H_2O$ 1.5M	7 day germination, percent healthy	10 day Infection, percent
Cool water	+	58[1]	23
soak	–	51[1]	19
54	+	57	9
	–	5	3
56	+	54	4
	–	1	not read
58	+	43	2
	–	0	not read
60	+	30	0
	–	0	not read

[1] Many others rotted

Thus from the work so far it appears that satisfactory control of *Alternaria zinniae* can be achieved and germination greatly increased by incorporation of a concentrated salt into the hot water treatment.

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PROPAGATION OF ORNAMENTAL *GREVILLEA*

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Abstract. *Grevillea* species and cultivars were propagated by four different techniques The results were heavily dependent on the condition of the plant material and on the species or cultivar used Cuttings of G. × 'Robyn Gordon' are best taken from wood 10 to 20 cm from the shoot apex, i e not