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GERMINATION STUDIES ON *ACACIA POLYACANTHA* SEEDS

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Summary

Of the many seeds produced by *Acacia polyacantha* very few are well filled, and of these even fewer germinate. The low germination rate is due to secondary dormancy of the seeds. In a lot of preselected, well filled seeds tested for germination, only about seven percent of the seeds germinated. Various treatments which included chilling and boiling for varying periods of time and pretreatment with acid significantly improved seed germination rate over control values. Pretreatment with gibberellic acid did not affect the germination rate at all, but chipping the testa in the hilum area of the seed achieved the best results. When a similar chipping in the testa was administered on the back side of the seeds, germination was similarly improved, although a large number of seeds had not germinated on the first day.

Introduction

The genus *Acacia* is the largest in the sub-family Mimosoideae and the second largest in the family Leguminosae. Its species are dominant over extensive tracts of land, in tropical and subtropical areas. In Southern Africa the genus is of economic significance from the aspect of enchroachment into grassland grazing areas (Carr, 1976). *A. polyacantha* Wild. sub-species *campylacantha* (Hochst. ex A. Rich.) Brenan, (Synonym: *A. campylacantha*) is indigenous to Zambia and grows wildly in wetland areas like dambos and along river lines in valleys. *Acacia polyacantha* being a leguminous plant fixes nitrogen in the soil. Consequently it has a lot of potential in agroforestry as a fallow tree for the improvement of soil fertility and provision of cattle feed (Chidumayo, 1988).

Efforts are being made to develop *Acacia* fallow agricultural systems in Zambia (Chidumayo, 1988). Trees of this plant grow to a height of 25 m with a stratified, flattened and spreading crown (Timberlake, 1980). The tree makes good firewood. Its edible gum is used as an adhesive in the confectionery industry. Its roots are known for medicinal value in treating snakebite, gonorrhea, leprosy and pneumonia (Timberlake, 1980).

However, in some areas of Zambia the species is heavily infected with witches' broom which is regularly associated with the fungus *Phoma sorghina* (Sacc.) Boerema (Zulu & Banage, unpublished). The disease is restricted to the branches only and in its advanced state causes death of the whole plant.

The plant flowers from September to December and produces mature pods from July to August the following year. The seeds are ellipsoid in outline and flattened in shape with dark olive green to brown colour (Carr, 1976). Each plant produces large quantities of fruit and their dispersal occurs mainly by mechanical thrust of the drying pods.

Preliminary laboratory seed germination trials indicated low germination rates of about 7 per cent of freshly collected as well as stored seeds. The seeds exhibited some kind of dormancy, which needed to be broken in order to stimulate the seeds to germinate. Experiments were designed to investigage the phenomenon.

Experimental

Seeds were collected in August 1985 and stored in transparent polythene bags at 25 ± 2°C. One year old seeds were either chilled and boiled for 1-15 min; immersed in concentrated sulphuric acid for 1-10 min and rinsed in distilled water; immersed in varying concentrations of gibberellic acid (100 - 1000 p.p.m.), or had their seed coats chipped in the hilum area or the back-side.

For each treatment, triplicate sets of 35 seeds were maintained. Following their respective treatments the seeds were sown in 10 cm bottomed petri-plates on moistened cotton wool, and kept in an incubator at 25°C for 7 days, to allow them to germinate.

For the pod and seed data, a total of 1200 pods from 10 randomly selected trees were examined. Pod length and width were measured and the number of seeds in each pod recorded, noting the number of insect damaged seeds and the undeveloped ones.

Results

Acacia polyacantha produces a lot of fruit. The pods are linear measuring 7.83 - 13.53 cm long and 1.38 - 1.70 cm wide. The fruit is a dehiscent pod, containing commonly 2 - 11 seeds with an average of 6 seeds per pod. Similar observations were made by Timberlake (1980). A pod produces an average of two well filled seeds which are free from insect attack with the rest being either aborted embryos or developed seed which has been infested with insect larvae. The results are summarized in Table 1.

Germination experiments

Since the data are not continuous, an analysis of frequencies using the G statistic was deemed to be most appropriate (Sokal & Rohlf, 1969). Results of the experiments were first lumped and

TABLE 1

Acacia polyacantha *pod and seed data*

Number of trees sampled	10
Number of pods examined	1,200
Maximum seed number per pod	11
Minimum seed number per pod	2
Mean seed number per pod	6
Mean healthy seed per pod	2
Mean unhealthy seed per pod	4
Intact (without insect damage) seed	32%
Germination potential of well filled seed	7%

when overall significance between treatments and between days of incubation had been demonstrated, individual treatments were tested. The overall germination percentages are presented in Table 2.

Differences after 7 days incubation

The germination rates of most of the treatments were highly significant ($P < 0.01$) with the exception of freezing and boiling treatments. In Table 2 where the level of significance is indicated for the day 7 results, the different times during which acid scarification occurred had no influence on the germination of the seeds.

Differences between days

There was an overall highly significant difference between the germination success for the different days. The most striking effect was the acceleration of germination achieved by chipping the seed, especially on the front, in the hilum area directly opposite the embryo. For most treatments it was not until the third or fourth day that most of the seeds germinated; with chipping, a large number had germinated on the first day. Treatment with gibberellic acid had no effect on germination rate.

Discussion

A seed is said to be dormant if it is viable but cannot germinate despite the presence of favourable conditions for germination, such as water supply, temperature and the normal composition of the atmospheric air (Mayer & Poljakoff-Mayber, 1982). Primary dormancy is shown by seeds whose ability to germinate is interrupted by a period of ripening (Mayer & Poljakoff-Mayber, 1982). *A. polyacantha* seeds, on the other hand, exhibit secondary dormancy in which seed germination is inhibited by lack of a suitable environmental requirement. Seed dormancy of *A. polyacantha* is induced by the presence of a hard seed coat, which stops water supply to the embryo. This phenomenon is widespread in the Leguminosae, where the seed coat is very hard, resistant to abrasion and is covered with a wax-

TABLE 2

Percent germination of A. polyacantha *seed with various seed treatments*

Treatment		*Incubation period* 1	2	3	4	5	6	7
Chilled + boiled	1 min	0.0	9.5	20.0	32.4	32.4	35.2	37.1*
Chilled + boiled	5 min	0.0	3.8	15.2	18.1	19.0	19.0	19.0 *
Chilled + boiled	10 min	0.0	4.8	8.6	8.6	9.5	9.5	9.5
Chilled + boiled	15 min	0.0	0.0	1.0	1.0	1.0	1.0	1.0 *
Frozen only		1.0	4.8	6.7	7.6	7.6	7.6	8.6
Control		0.0	5.7	5.7	7.6	7.6	8.6	8.6
Chipped front		81.9	83.8	84.8	86.7	87.6	87.6	87.6 *
Chipped on the back		14.8	62.0	66.7	67.6	76.9	76.9	76.9 *
Frozen, boiled for 3 min		0.0	21.9	28.6	29.5	30.5	32.4	32.4 *
Boiled for 3 min		1.0	22.9	28.6	28.6	28.6	29.5	31.4 *
Control		2.9	8.6	9.5	9.5	9.5	9.5	10.5
Chipped front		68.5	69.4	71.3	72.2	72.2	72.2	72.2 *
Acid scarification (min)	1	16.2	43.8	59.0	68.6	72.4	75.2	76.2 *
" "	2	10.5	45.7	60.0	70.5	72.4	78.1	78.1 *
" "	3	12.4	39.0	56.2	67.6	73.3	78.1	81.0 *
" "	4	14.3	51.4	63.8	67.6	70.5	71.4	75.2 *
" "	5	14.3	45.7	59.0	63.8	67.6	69.5	73.3 *
" "	10	8.6	40.0	59.0	66.7	71.4	75.2	77.1*
Control		0.0	3.8	5.7	5.7	5.7	5.7	5.7
Gibberellic acid (p.p.m.)								
100		6.5	6.5	6.5	6.5	6.5	6.5	6.5
300		1.2	1.2	1.2	3.8	3.8	3.8	3.8
500		1.2	1.2	3.8	3.8	3.8	3.8	3.8
1000		2.5	2.5	5.1	6.5	7.6	7.6	7.6
Control		3.8	5.1	6.5	7.6	7.6	7.6	7.6

* Numbers are significantly different from the control at $P \leq 0.01$.

like layer (Bhat, 1968; Mayer & Poljakoff-Maber, 1982).

Two possible ways in which water can be experimentally supplied to the embryo is either by cracking the seed coat, or by unplugging the strophiolar cleft. The cleft is lined with suberized cells which prevent the entry of water (Cavanagh, 1980). The quickest way of supplying the embryo with moisture is by cracking the testa on the side of the embryo.

Germination is delayed by more than 24 h if the opening is made on the back side of the seeds. This might be due to the time lag it takes the moisture to diffuse from the back of the seed past the endosperm to the embryo. It has been recommended that *Acacia* seeds can be induced to germinate if the seeds are filed on the one edge, followed by boiling the seeds briefly and soaking then before sowing (Carr, 1976).

The present study shows that fracturing the testa in the hilum area followed by sowing is enough to induce satisfactory germination of the seeds. Alternatively, the strophiolar cleft can be unplugged by acid scarification. But germination of seeds by this method lags behind that of testa fracturing by about 5 days.

Other methods such as boiling, chilling and treatment with gibberellic acid were also tried but proved ineffective in promoting the germination of *A. polyacantha* seeds. This is inspite of the fact that gibberellic acid has been shown to stimulate germination of various seed types (Mayer & Poljakoff-Mayber, 1982).

It is stressed that dormancy of seeds is an important adaptive property of plants and that it affects the distribution of plant species (Nikolaeva, 1958). Of the seeds produced per plant of *A. polyacantha* only about 32 per cent have the potential to germinate because the others are either damaged by insects or they are not properly filled. Only about 7 per cent of the properly filled seeds germinate given sufficient water supply. However, dormancy of seeds enable a species to exist under unfavourable conditions, with the consequence of spreading germination over a period of time, which can have survival value for the plant species (Mayer & Poljakoff-Mayber, 1982).

A method now exists which can be used to grow a large number of seedlings of *A. polyacantha* from a limited number of pre-selected, well filled and uninfested seeds. The only disadvantage with the method is that seed fracturing in the hilum area is a delicate operation and, therefore, needs care to avoid wastage through embryo damage. Acid scarification, on the other hand, is quicker and just as good over a longer period of time and, therefore, provides a useful alternative.

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