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BREAKING DORMANCY IN SEEDS OF COVER LEGUMES

BY

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SUMMARY

The common methods of scarification of seeds to break dormancy : acid, hot water and heat treatments, were re-appraised. Treatment with conc. sulphuric acid was the most effective method. It was possible to break dormancy equally effectively, but using far less acid than has been used hitherto. In the hot water treatment, control of temperature and duration of treatment are important to achieve best results.

INTRODUCTION

Improper seed treatment to break dormancy appears to be a prime cause for poor and often delayed establishment of leguminous ground covers in young plantations. This is surprising because methods of effective seed scarification have been adequately documented (Anon, 1960 ; Wycherley, 1960 ; Chandrasekera, 1964).

Most legumes used as covers in rubber have characteristic hard seed coats impervious to water, and the hilum, the normal passage for the entry of water, is usually closed, resulting in dormancy. Thus, unless the seeds are treated to open this fissure, or some other opening is made on the seed coat for the entry of water, they fail to germinate.

Hot water treatment is the popular method of breaking seed dormancy on estates. Chandrasekera (1964) observed that for *Pueraria*, the optimum temperature of water for breaking dormancy was 60 to 80°C. However, this method was clearly inferior to acid or mechanical scarification in regard to both germination and longevity of seeds after treatment (Chandrasekera, 1964 ; Anon, 1963). In other words, acid-treated seeds can be stored without appreciable loss of viability for a considerable length of time, after washing to remove acid and drying, whereas hot water-treated seeds cannot be stored and should be planted soon after treatment.

Mechanical scarification is as effective as acid and is used commercially in Malaysia (Wycherley, 1960 ; Anon, 1963). However, this method is not popular here probably because of the need to improvise suitable equipment and the attendant expenditure.

Acid scarification is not as popular as it should be perhaps because the potential health hazard involved in the handling of acid has been over-emphasised. Moreover, there also appears to be some uncertainty among planters on the amount of acid that should be used and the duration of treatment.

It is believed that dry heat causes opening of fissures, and therefore soaking seeds in cold water soon after drying could result in improved germination. Wycherley (1960) found that germination of *Pueraria phaseoloides* but not of *Flemingia congesta* seeds improved from about 10% to 50% after drying at 50°C for 1 — 8 h ; acid treatment was however superior.

The investigations reported in this paper were aimed at ascertaining :

(1) The highest seeds to acid ratio and treatment time giving maximum germination.

(2) Whether conc. HCl is as effective as conc. H_2SO_4 for seed scarification.

(3) Whether the period of treatment and temperature are critical in the hot water and dry heat treatments and whether these treatments can be manipulated to give better results than have been reported previously.

MATERIALS AND METHODS

Seeds and acids used in the experiments were purchased from commercial sources. Seeds after treatment were soaked in tap water overnight and germinated on moist filter paper (Whatman No. 1). Duplicate sets of one hundred seeds were used for each treatment. Experiments were usually repeated with seeds obtained from different sources and there was good agreement among repetitions.

Acid treatment

Seeds were placed in 100 ml beakers, acid was added and stirred thoroughly to ensure that all seeds were well-coated. At the end of the treatment period, excess acid when present was drained off and the seeds transferred to a large volume of tap water and rinsed thoroughly in several changes of fresh tap water.

Hot water treatment

Water, heated to the required temperature, was poured over the seeds. The water was drained off after specified treatment times or on cooling as the case may be, and seeds soaked overnight in fresh water. Where regulation of temperature was necessary, a thermostatic oven was used.

Heat treatment

Seeds were spread thinly in open petri dishes and placed in a thermostatic oven with temperature regulated as required.

RESULTS

Acid treatment

Volume of acid : Ten gramme lots of *Pueraria phaseoloides* seeds, contained in 100 ml beakers, were treated for 30 min with 0·25, 0·5, 1·0, 2·0 ml conc. sulphuric acid or sufficient acid to cover the seeds completely. Seeds were washed and germinated. The results are given in Table 1.

TABLE 1

GERMINATION OF *PUERARIA* SEEDS TREATED WITH DIFFERENT VOLUMES OF CONC. H_2SO_4 FOR 30 MIN. (10 G SEED PER BATCH)

Volume of acid (ml)	% Germination
0·25	28
0·50	46
1·0	56
2·0	52
Excess acid	56
Control (cold water)	4

The data suggest that 1 ml of acid per 10 g seed was as effective as excess acid in causing sufficient scarification for maximum germination.

Treatment time: Ten gramme lots of seeds of *Pueraria phaseoloides, Mimosa invisa, Desmodium ovalifolium, Calopogonium mucunoides* and *Centrosema puboscens* were treated with 0·25, 0·50, 1·0 or 2·0 ml of acid for 15, 30 or 60 min. The results (Fig. 1) show that maximum germination occurred when 10g of *Mimosa* seeds were treated with 1 ml of acid for 60 min ; but 2 ml acid in the same time depressed germination. The smaller volumes of acid tested were clearly insufficient to produce maximum germination irrespective of duration of treatment. *Pueraria* seeds (10 g) treated with a minimum of 0·5 ml acid for 30 min germinated best and the germination percentage decreased with increase or decrease in the treatment time ; 0·25 ml acid was insufficient for maximum germination. *Desmodium* seeds (10 g) treated with 2·0 ml of acid gave the highest germination percentage, treatment time not being critical. However, at 0·5, and 1·0 ml acid, germination improved with increased treatment time, but at 0·25 ml germination was very poor. *Calopogonium* seeds germinated best with no effect due to treatment time when 0·5 or 1 ml acid was used but there was a sharp decline in germination due to treatment time when the volume of acid was 2·0 ml ; treatment with 0·25 ml acid resulted in germination comparable with the higher levels, but only at 30 and 60 min. The percentage germination was maximum and nearly the same for *Centrosema* seeds treated with 0·25, 0·5 or 1·0 ml of acid for 30 min. There was some indication of a decrease in germination with increase in treatment time when 2·0 ml of acid was used.

Generally, when seed weight and treatment time are fixed, smaller seeds appear to require more acid for scarification. This obviously is because of the greater surface area to be wetted, with smaller seed.

Type of acid : The relative effectiveness of conc. H_2SO_4 and conc. HCl for scarification of *Pueraria, Calopogonium* and *Desmodium* was examined using 10g lots of seeds and 2·0 ml acid per lot at treatment times of 20 and 40 min.

The results (Table 2) show that for *Pueraria* and *Calopogonium* seeds HCl was only about half as effective as H_2SO_4 whereas for *Desmodium*, HCl was still less effective.

TABLE 2

EFFECT OF CONC. SULPHURIC ACID AND CONC. HYDROCHLORIC ACID TREATMENTS ON SEED GERMINATION

	% Germination			
	Conc. H_2SO_4		Conc. HCl	
	20 min	40 min	20 min	40 min
Pueraria phaseoloides	70	60	33	17
Calopogonium mucunoides	24	20	9	6
Desmodium ovalifolium	67	79	7	4

Hot water treatment

In the first experiment, using *Pueraria* and *Calopogonium* seeds, the effect of the ratio of the weight of seeds to the volume of water on germination was studied. Volumes of 100 ml of water heated to 80°C was added to varying quantities of seeds. The water was allowed to cool and the seeds germinated.

Results (Fig. 2) show that germination percentage varied with the ratio of seed to hot water, and the optima for *Calopogonium* and *Pueraria* were very different. Further the hot water treatment, as described, is clearly inferior to acid scarification.

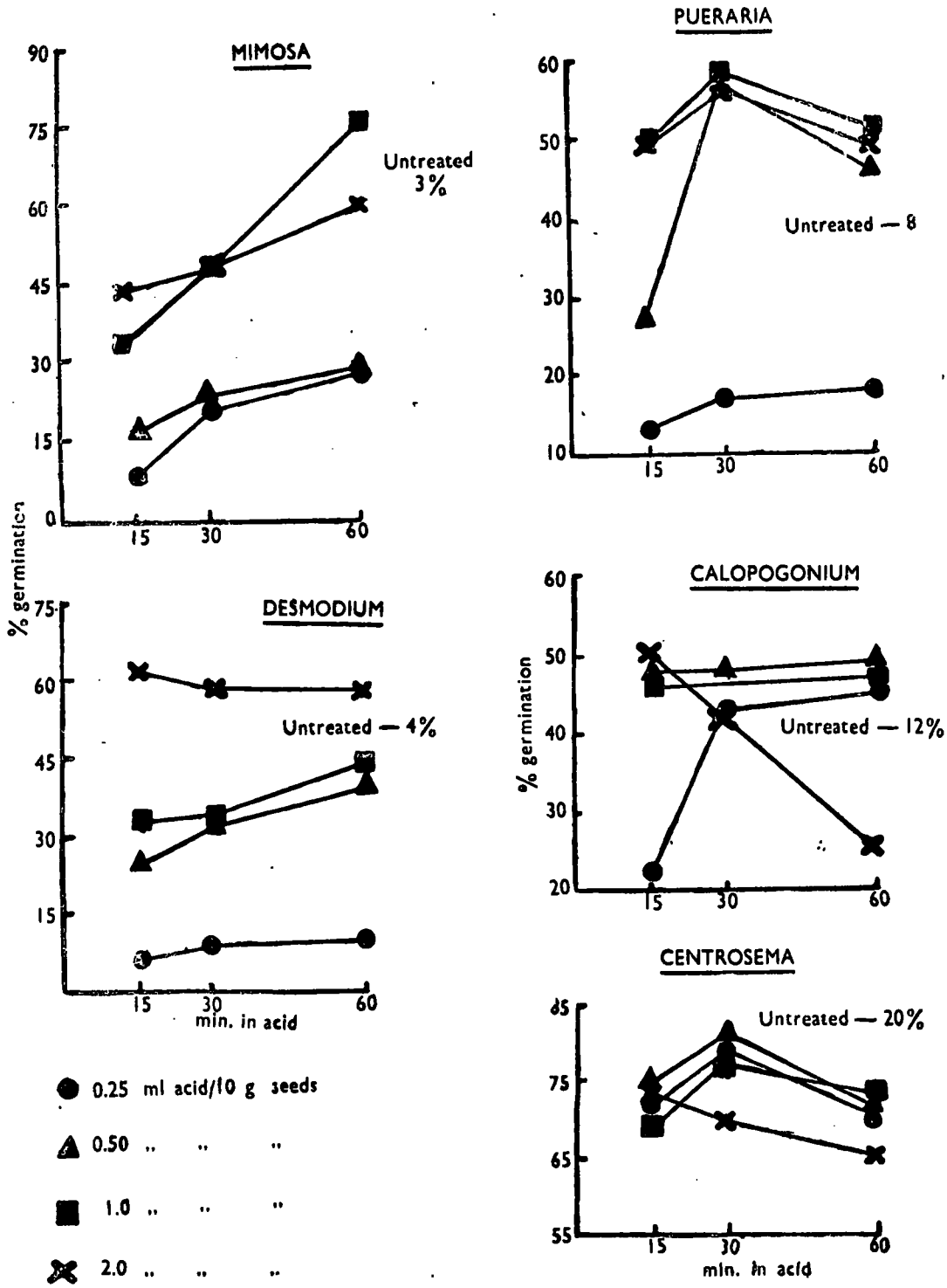

Fig. 1 — Effect of conc. sulphuric acid treatment on seed germination.

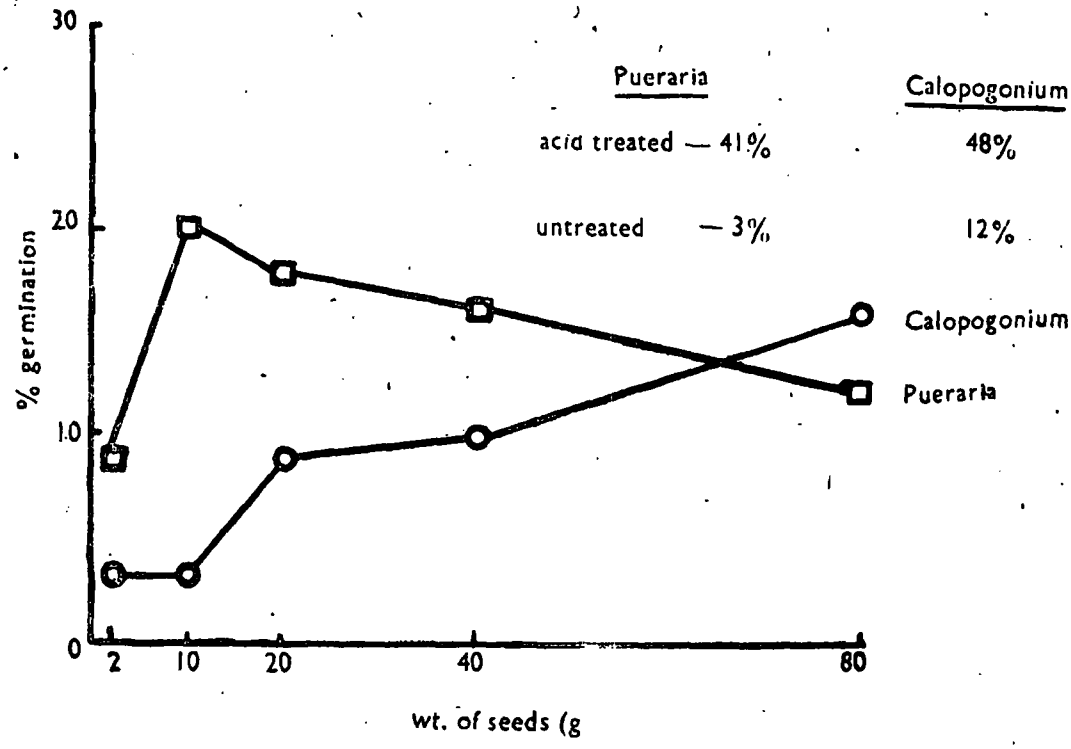

Fig. 2 — Effect of the weight of seeds used per 100 ml hot water (starting temp. 80°C) on seed germination.

The effect of seed treatment with hot water at controlled temperatures of 60° and 80°C for different times of treatment was examined (Fig. 3).

It is evident that for all the varieties of seeds, water at 80°C depressed germination and this effect increased with the length of treatment. Germination was relatively better at 60°C with optima varying with the seed species. Again, treatment with acid was distinctly superior to the hot water treatment which was ineffective for *Desmodium* and *Calopogonium*.

Dry heat treatment

Pueraria seeds were subjected to dry heat at 50°C for different periods of time (Fig. 4). Heating for 1 to 4h improved germination from 6% (untreated) to only about 19%. Prolonged heating appeared to be detrimental. Acid scarification was again far superior to dry heat treatment.

Germination was not much improved by treatment at higher temperatures at any of the durations tested (Fig. 5). It is interesting to note that whereas at 60°C, cooling seeds after treatment, before soaking, depressed germination, the opposite was true at 80°C. This is hard to explain.

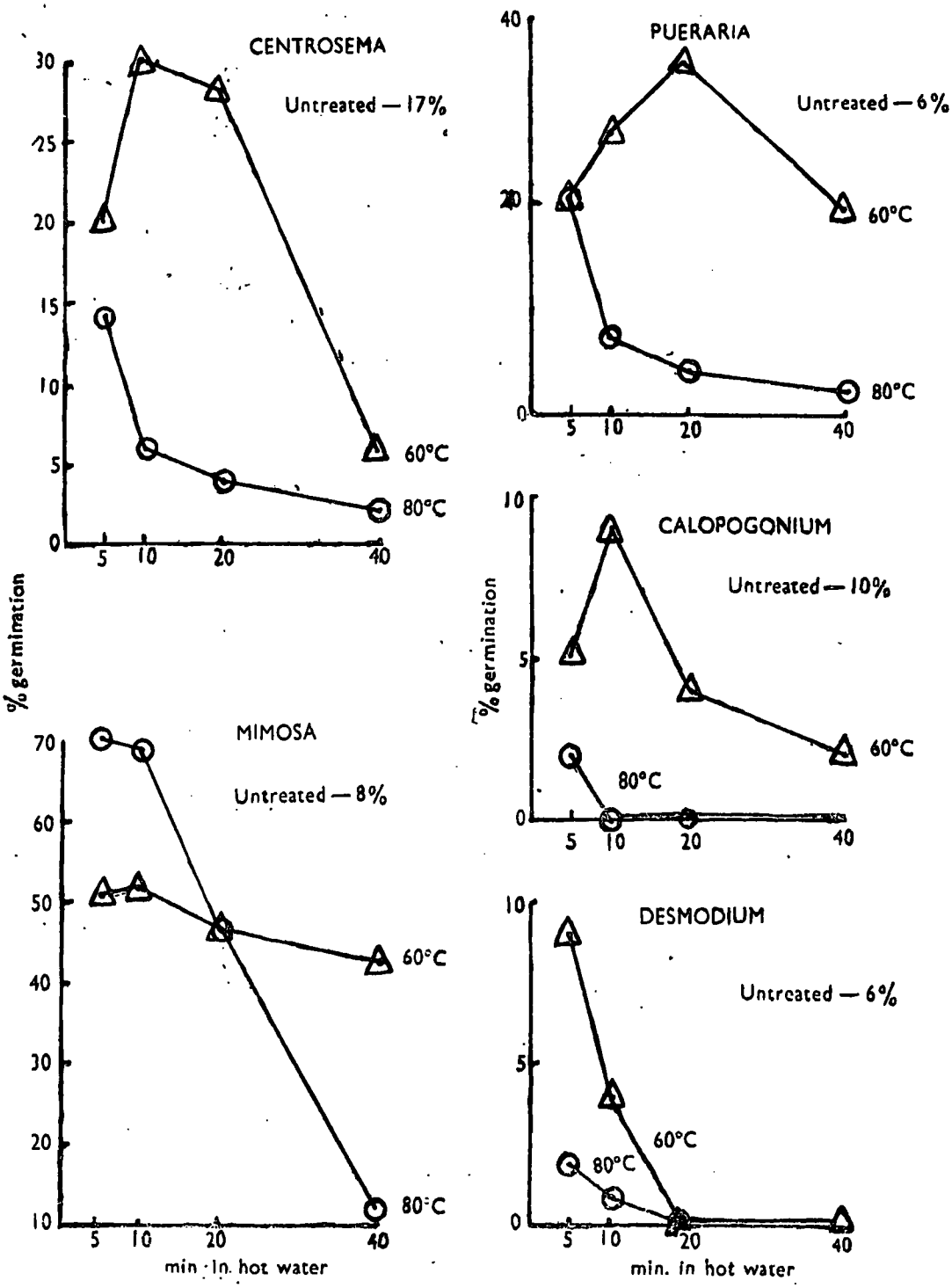

Fig. 3 — Effect of hot water treatment on seed germination.

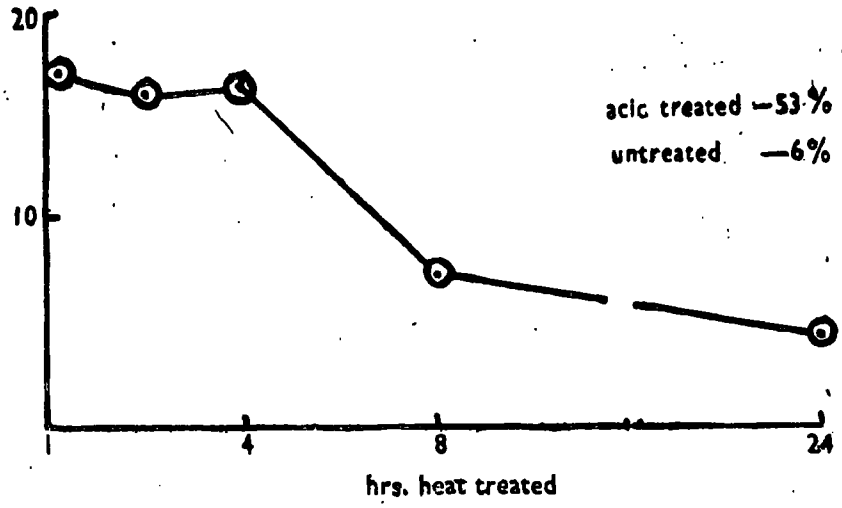

Fig. 4 — Duration of heat treatment at 50°C on seed germination.

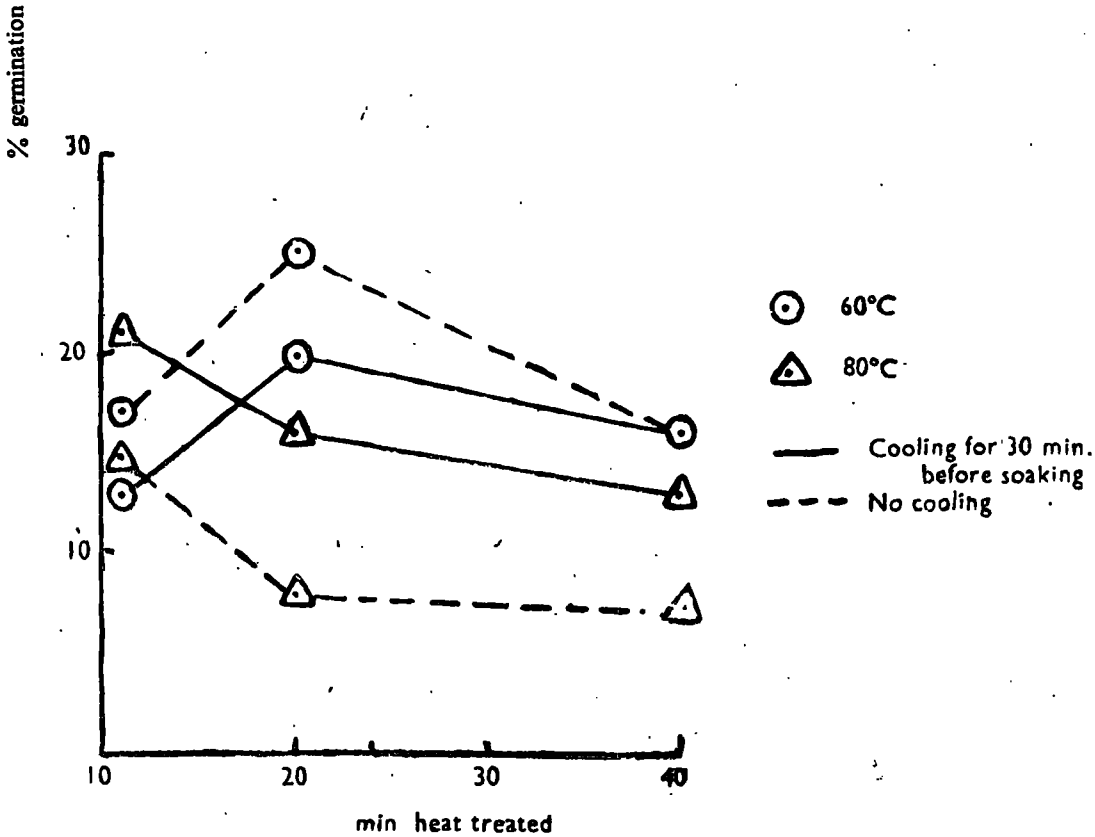

Fig. 5 — Temperature, duration of heat treatment, and cooling after heat treatment before soaking of seeds in water on seed germination.

DISCUSSION

Except in the case of *Mimosa invisa* seeds, sulphuric acid treatment was far superior to dry heat or hot water treatments for seed scarification. Hot water was nearly as effective as acid for *Mimosa*. However, the hot water and heat treatments have been reported elsewhere to be relatively more effective than has been noted here (Wycherley, 1960 ; Chandrasekera, 1964). This discrepancy is hard to explain.

The main finding in this study is that mere coating of seeds with concentrated sulphuric acid was as effective as treatment with a large excess of it. The significance of this is that not only can one save on the acid but also on the potential health hazard in handling acid. The current practice of adding sufficient acid to cover the seeds should now be discontinued.

Although concentrated hydrocholoric acid is manufactured locally and is cheaper than sulphuric, it is far less effective and its use as a seed scarifier is not warranted.

In the hot water treatment, the practice is to pour water heated to near boiling over seeds, there being no consideration of the temperature or duration of treatment. However, scarification is conditioned both by the temperature of water and the duration of treatment as illustrated by the data (Fig. 3) obtained. Although it is impracticable at the estate level to treat seeds under controlled conditions of temperature, it is clear that manipulating the ratio of weight of seeds to the volume of hot water used may result in improved germination ; the optimal ratio could vary according to species.

The dry heat treatment as tested was no more effective than the hot water method. It was not possible to conclude whether dry heat causes effective opening of fissures on seeds or moisture absorption by seed coats on cooling after the heat treatment causes the closure of fissures.

CONCLUSIONS AND RECOMMENDATIONS

Acid treatment

The concentrated sulphuric acid treatment is superior to all other methods tested for seed scarification ; and the following chart should be a useful guide in using this method.

Species		Volume of acid (ml)	Treatment time (min)
Pueraria	1 kg seed	50	30
Calopogonium	,,	50	15 - 30
Desmodium	,,	200	15 - 30
Mimosa	,,	100	60
Centrosema	,,	50	30

Seeds should be mixed thoroughly with the acid using a stick or a glass rod and left for the specified time. Excess acid should then be drained off and the seeds rinsed several times with fresh water. The seeds may be sown immediately or stored for a few weeks without loss of viability after thoroughly drying in air or sun.

Hot water treatment

This method is as good as the acid method only for thornless *Mimosa* (*Mimosa invisa*). *Mimosa* seeds should be immersed in a large excess of water heated to 80 — 85°C for 5 min. The hot water should then be drained off and seeds soaked overnight in cold water before sowing.

Hot water treatment is ineffective for *Calopogonium* and *Desmodium*.

As for the other common covers, *Pueraria* and *Centrosema*, this method should only be used if sulphuric acid is unavailable. Treatment is as for *Mimosa* except that the water temperature should be 65°C and treatment times of 20 and 10 min are suggested for *Pueraria* and *Centrosema*, respectively.

Hot water — treated seeds cannot be stored and should be sown immediately.

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