Seed germination in goose grass (*Eleusine indica*)

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Low germination of freshly harvested *Eleusine indica* caryopses indicated some form of dormancy. Water uptake studies indicated that the covering structures of the propagules are permeable to water. As scarification breaks the dormant condition a mechanical effect for the covering structures is indicated. With ageing, dormancy becomes progressively less and the seeds become more sensitive to gibberellic acid applications which increase germination significantly.
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Die swak kieming van vars geoeste *Eleusine indica* saad dui daarop dat die sade rustend is. Wateropnamestudies het getoon dat die saadhuide vryelik deurdringbaar vir water is. Aangesien skarifikasie-behandelings die rus van die sade verbreek dui dit daarop dat die saadhuid 'n meganiese invloed op kieming het. Met veroudering word die saadrus geleidelik minder en raak die sade meer sensitief vir gibberelliensuur-toedienings wat kieming betekenisvol verhoog.
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Introduction

Goose grass (*Eleusine indica* (L.) Gaertn., a tufted annual or weakly perennial grass which occurs in the tropics and sub-tropics is regarded as one of the ten most serious weeds in the world (Holm 1969). Its weedy character is enhanced by a well developed root system and the fact that its caryopses are dormant and can retain their viability in the soil for as long as five years (Schwerzel 1976). Owing to its considerable economic importance this plant has recently received a great deal of attention, particularly with respect to its seed biology. In separate studies Schwerzel (1976) and Horng & Leu (1978) reported that after two years in the soil the viability of *E. indica* caryopses decreased rapidly and that after five years it approached zero. A number of studies have indicated that its germination is enhanced by treatments with light (Fulwider & Engel 1960), potassium nitrate (Dale 1975) and gibberellic acid (Hawton & Drennan 1980). A moderate increase in seed germination was also obtained when the caryopses were stored at 50 or 60°C (Taylorson & Brown 1977). Despite these studies the germination characteristics of *E. indica* have however, not been studied in sufficient depth to allow the planning of effective eradication programmes. In this study attempts were made to establish the mechanisms responsible for the seed dormancy of this species.

Materials and Methods

Caryopses (seeds) of *Eleusine indica* (L.) Gaertn. were collected between February and March, sorted, and then stored dry at ambient temperatures in brown paper bags. By imbibing the seeds in 0,3% 2,3,5-triphenyltetrazolium chloride for seven days it was established that 96% of the embryos turned pink to red and could thus be regarded as being viable.

Water uptake studies were conducted on both intact and hand scarified seeds. Four replicates of 25 seeds each were allowed to imbibe in petri dishes on moist filter paper at 20°C. At six-hourly intervals the seeds were blotted dry, weighed and the percentage mass increase over that of the original mass was calculated. This experiment was repeated three times.

All germination studies were conducted on moist filter paper in petri dishes. For each treatment eight replicates of 15 seeds each were used. Germination (radicle protrusion) was recorded every two days over a period of 30 days.

Results are expressed as cumulative germination percentages and 95% confidence limits were calculated.

The following experiments were conducted: (i) Freshly harvested seeds were incubated with different concentrations (0; 10; 100 and 500 mg dm^{-3}) of gibberellic acid (GA_3) at 10; 20; 30 or 40°C both in the light (cool white fluorescent) and in the dark. (ii) The palea and lemma of seeds were removed and the 'naked' seeds then incubated at 20°C in the light and dark. (iii) Mechanically and sulphuric acid (1; 4; 10 and 20 min) scarified seeds were incubated at 20°C. (iv) One minute acid scarified seeds were incubated at 10; 20; 30 and 40°C either in the light or dark. (v) Seeds were incubated with kinetin or ethrel (0; 0,01; 0,1; 1; 10; 100; 1000 mg dm^{-3}) at 20°C. (vi) Seeds were leached in running tap water for one to 24-hour periods prior to incubation at 20°C. (vii) Seeds were incubated in KNO_3 (0; 3; 10 and 30 mmol dm^{-3}), azide (0; 0,3; 1 and 3 mmol dm^{-3}), or thiourea (0; 3; 10 and 30 mmol dm^{-3}) at 20°C. (viii) After-ripening of the seeds was accelerated by storage for one or two months at 60°C prior to incubation at 20°C. (ix) The original experiment as in (i) was repeated using six-month-old dry stored seed.

Results and Discussion

When incubated at 20°C only 2% of the freshly harvested *E. indica* seeds germinated. This low germination percentage did not improve at higher or lower incubation temperatures, indicating some form of dormancy mechanism. The results on water uptake showed that both control and hand scarified seeds imbibed water readily and reached an asymptote within 6 h (Figure 1). While the control seeds did not germinate and did not further imbibe, the scarified seeds started germinating after 36 h. This commencement of germination was accompanied by increased water uptake.

From these results it would therefore appear as if seed dormancy in this species is not due to an impermeable seed covering but could be the result of some mechanical effect. Scanning electron microscopy of the seed coat confirmed this view as the zip-like ornamentation was associated with numerous small pores (Figure 2A).

That the coat mechanically restricts germination was confirmed by scarification treatments (Figure 3). The highest percentage germination was obtained when the seeds were hand scarified. Acid scarification also increased germination significantly. The best response with this treatment was obtained after a one minute immersion in concentrated H_2SO_4. As a result of this treatment the outer surface layer of the seeds was removed or damaged (Figure 2B) and it would appear that it is this layer which is responsible for the mechanical effect of the covering structure. Periods of 10 and 20 min of acid treatment, while increasing germination over that of the control, gave less significant responses than the one minute acid treatment. This suggests that with prolonged acid treatment the embryos were damaged, particularly as the coat is freely permeable to water and residual acid could easily have moved into the seed upon subsequent incubation. Using one minute acid scarified seeds as experimental material it was found that *E. indica*

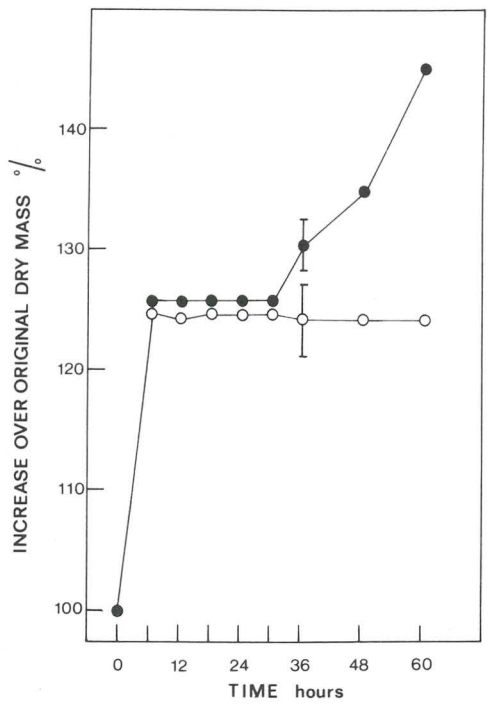

Figure 1 Water uptake of unscarified (○--○) and mechanically scarified (●——●) *Eleusine indica* seeds incubated at 20°C. Bars represent 95% confidence limits.

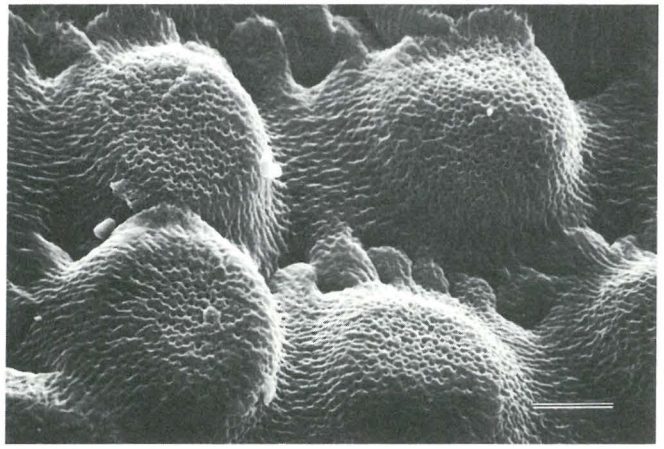

Figure 2 (A) Scanning electron micrograph of intact *Eleusine indica* seed coat showing zip-like ornamentation and pores. (Bar represents 10 μm)

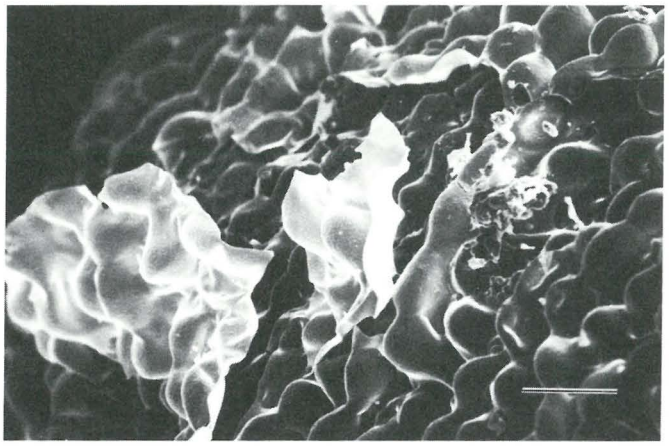

Figure 2 (B) Scanning electron micrograph of one minute H_2SO_4 scarified seed. Note peeling of outer surface layer. (Bar represents 50 μm)

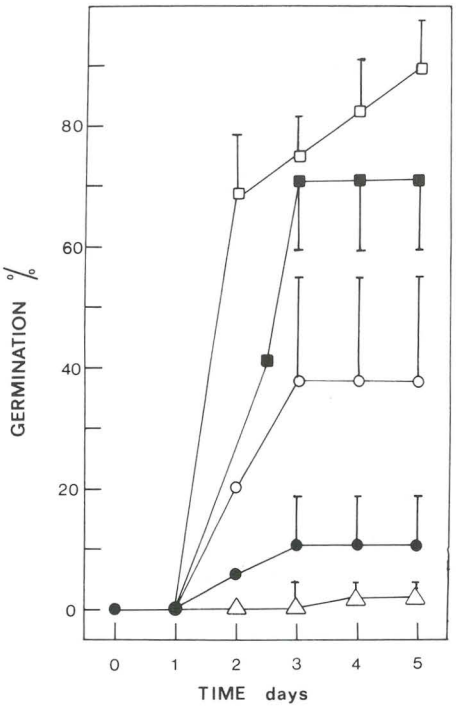

Figure 3 Germination of scarified seeds of *Eleusine indica* incubated at 20°C. Control = △——△; Mechanical scarification □——□; H_2SO_4 scarification 1 min = ■——■; 10 min = ○——○; 20 min = ●——●. Bars represent 95% confidence limits.

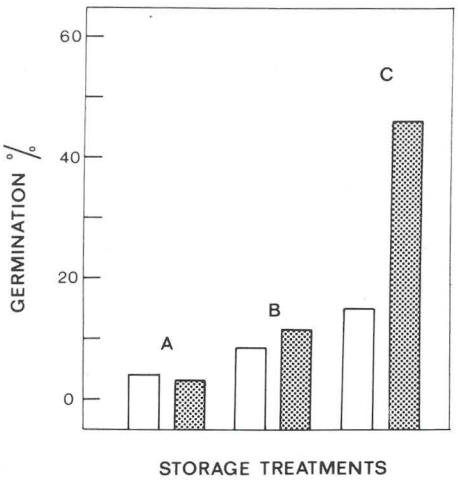

Figure 4 Effect of dry storage on the germination of *Eleusine indica* seeds incubated in the absence (□) or presence (▩) of 100 mg dm^{-3} gibberellic acid in the light at 20°C. A = Freshly harvested seeds; B = Six-month-old seeds; C = Seeds stored at 60°C for two months (accelerated after-ripening). A and C are significantly different at the 95% confidence limit.

seeds germinated readily between 20 and 40°C. This germination was equally effective under white light (cool white fluorescent tubes) and in the dark (Table 1).

None of the other treatments, except the gibberellin and ageing treatments, had a beneficial effect on germination. With dry storage, either natural or forced, seed germination increased. The increased germination was enhanced by the application of 100 mg dm^{-3} gibberellic acid (Figure 4). From these latter results it would appear that in *E. indica,* in common with other grass species (Barton 1965), dormancy is broken by a period of dry storage. Taylorson & Brown (1977) have reported moderate increases in grass seed germination following accelerated after-ripening. Similar results were also reported for one-year-old seeds by Hawton & Drennan (1980). They also reported that aged *E. indica* seeds could become sensitive to light. It therefore appears that while there is an increase in germinability with time other physiologically regulated mechanisms are activated. These latter aspects warrant further investigation as they may prove important in the development of weed control programmes.

Table 1 Germination of *Eleusine indica* seeds at different temperatures in the light and in the dark. All seeds were treated for one minute with concentrated H_2SO_4 and washed in running water prior to incubation

	Incubation temperature (°C)			
	10	20	30	40
Light	0,6 ± 0,6	78,8 ± 5,8	76,3 ± 7,2	73,1 ± 1,8
Dark	0	77,5 ± 10,8	66,3 ± 7,8	78,8 ± 9,9

Acknowledgements

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References

BARTON, L.V. 1965. Seed dormancy: General survey of dormancy types in seeds. In: Handbuch der Pflanzenphysiologie, ed. Ruhland, W. Vol. 15. Springer-Verlag, Berlin. pp. 699–720.

DALE, J.E. 1975. Nitrate-induced germination of soil stored weed seed. *Proc. 28th Meeting Southern Weed Sci. Soc.* 323.

FULWIDER, J.R. & ENGEL, R.E. 1960. Seed characteristics and control of goose grass, *Eleusine indica. U.S. Golf Ass. J.* 12: 24–27.

HAWTON, D. & DRENNAN, D.S.H. 1980. Studies on the longevity and germination of seed of *Eleusine indica* and *Crotalaria gorceansis. Weed Res.* 20: 217–223.

HOLM, L. 1969. Weed problems in developing countries. *Weed Sci.* 17: 113–118.

HORNG, L.C. & LEU, L.S. 1978. The effects of depth and duration of burial on the germination of ten annual weed seeds. *Weed Sci.* 26: 4–10.

SCHWERZEL, P.J. 1976. The effect of depth of burial in soil on the survival of some common Rhodesian weed seeds. *Rhodesia Agric. J.* 73: 97–99.

TAYLORSON, R.B. & BROWN, M.M. 1977. Accelerated after-ripening for overcoming seed dormancy in grass weeds. *Weed Sci.* 25: 473–476.