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QUALITY AND STORAGE CHARACTERISTICS OF THE SEEDS OF IMPORTANT NATIVE PASTURE SPECIES IN SOUTH-WEST QUEENSLAND

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Abstract

Seeds of native plants can be difficult to germinate reliably. In addition, the useful life of a carefully harvested seed lot needs to be known. This paper reports on the laboratory germination over eight years of seed of 27 native pasture species hand-harvested near Charleville after the 1972-73 summer and stored in a laboratory without special conditions.

The legumes had prolonged hard-seededness and high viability. Forb species varied in their degree of hard-seededness and the level of initial dormancy. Most perennial grasses produced high quality seed which attained best germination between one and three years after harvest. The Andropogoneae had much poorer seed fill than most other species. Laboratory germination of annual and small seeded grasses was often low, even after scarification. Thus, the use of freshly harvested or old, untested seed of native rangeland species in research programmes is very unwise.

Introduction

Native plants are being increasingly studied and used in Australia for pastures, land reclamation and amenity areas. This involves studies of plant physiology, ecology, regeneration patterns and plant reaction to grazing under controlled conditions. For such work it is important to start with an even-aged plant population. Good germination from seed of native species is sometimes difficult to achieve because we are either uncertain of their dormancy peculiarities or have only old seed on hand. Research projects are often initiated with a request for seed to another person who used to work on the species, or by collecting fresh seed as soon as possible after funds are allocated. Supplies are almost invariably very limited.

Some germination studies have been conducted on native Australian pasture species, but only a few on western Queensland species. Data is recorded for *Aristida armata* (Brown 1982), curly mitchell grass (*Astrebla lappacea*) (Myers 1942), and Queensland bluegrass (*Dichanthium sericeum*) (Watt 1978, Lodge and Whalley 1981). Long-term viability in storage was not tested. Thus, information on the likely viability of seed of most native Queensland species acquired at short notice for a research project is still lacking. An excellent summer in the Charleville district in early 1973 allowed seed of many common summer-growing plants to be collected in reasonable quantities. This paper reports on the quality of that seed - its germinability initially and over the subsequent eight years while stored without refrigeration. The effect of some simple seed treatments such as scarification and dehulling were also tested where appropriate. The data collected should act as a guide to (a) how old seed needs to be before it germinates easily, (b) how long it might hold reasonable viability in a laboratory without special storage conditions, and (c) whether special treatment is needed to obtain reliable germination.

Materials and Methods

Seed of 27 species was tested - 17 perennial grasses, three annual grasses, four perennial legumes and three annual herbs (Table 1). It was gently stripped by hand from ripe inflorescences by experienced operators in autumn 1973. Pods of *Rhynchosia minima* had to be collected while still slightly green and covered with sticky hairs, and allowed to shatter in a bag. Other parts of the inflorescence were collected with the seeds of *Astrebla lappacea, Digitaria ammophila, Panicum decompositum, Themeda triandra* and *Iseilema vaginiflorum*. After air drying indoors, this 'seed' was stored uncleaned in brown paper bags in a loose-lidded plastic garbage bin in a laboratory at Charleville, south-west Queensland (26.4°S, 146.3°E). The room was cooled in summer by an evaporative air conditioner but was largely unheated in winter. Later temperature monitoring showed that bin temperatures probably reached extremes of 3° and 30°C while being between 15° and 27°C most of the time. Relative humidity inside the bin in the semi-arid climate at Charleville would have been quite low (25 to 40 per cent) most of the time.

Percentage seed fill and seed or caryopsis (i.e. naked grain) weight were determined after the seed had been stored for about 12 months. Batches (usually six to ten) of ten diaspores (i.e. natural dispersal units) were dissected to count the number of caryopses which were then weighed to give a mean weight (Table 1).

Seeds for germination were selected at random from the contents of each package at each sampling date. Tests were conducted postharvest when the seed was two to four weeks old and subsequently, six and twelve months and two, three, five and eight years after April 1973. All germination tests were conducted over 21 days on filter paper moistened with distilled water in glass petri dishes. The dishes were placed in a non-humidified germinator cycling between 25° and 35°C with fluorescent lights on during the 12 hours at the higher temperature.

These standard conditions were used because all were summer-growing species which presumably germinated satisfactorily under warm conditions. Other studies using a temperature gradient germination plate showed that many of these plants germinated best between 25° and 35°C (Silcock and Williams 1975a). Germinated seeds were counted regularly and then removed and the paper remoistened if necessary. Usually either four replicates of

Table 1. Floral dispersal unit (diaspore) disseminated by each species, mean seed or germ number/diaspore and mean seed or caryopsis weight of each.

Species	Type of diaspore shed	Seeds per diaspore (±SE)	Mean Seed/ Caryopsis weight (mg)
Perennial grasses			
Aristida armata Henr.	floret	1	0.72
Astrebla lappacea (Lindl.) Domin	spikelet *	2.5 (0.35)	0.86
Astrebla pectinata (Lindl.) Muell. ex. Benth.	spikelet *	2.6 (0.13)	1.12
Bothriochloa ewartiana (Domin) C.E. Hubbard	spikelet *	0.5 (0.11)	0.45
Cymbopogon obtectus S.T. Blake	spikelet *	0.7 (0.05)	1.20
Dichanthium sericeum (R. Br.) A. Camus	spikelet *	0.3 (0.07)	0.67
Digitaria ammophila Hughes	spikelet	1.0 (0.01)	0.34
Digitaria diminuta Hughes	spikelet	0.8 (0.09)	0.26
Eragrostis eriopoda Benth.	floret	#	0.08
Eragrostis setifolia Nees	floret	#	0.02
Eriachne mucronata R. Br.	spikelet *	1.0 (0.09)	0.83
Eulalia fulva (R. Br.) Kuntze	spikelet *	0.4 (0.06)	0.30
Monachather paradoxa Steud.	floret *	0.9 (0.06)	3.19
Panicum decompositum R. Br.	spikelet	1	0.68
Sporobolus actinocladus (F. Muell.) F. Muell.	caryopsis	1 (0.05)	
Themeda triandra Forssk.	awned floret	0.8 (0.05)	2.50
Thyridolepis mitchelliana (Nees) S.T. Blake	spikelet *	1	1.20
Annual Grasses			
Dactyloctenium radulans (R. Br.) Beauv.	spikelet S	#	0.34
Iseilema vaginiflorum Domin	spikelet *	1.5 (0.06)	0.75
Paspalidium rarum (R. Br.) Hughes	spikelet	1	1.04
Legumes			
Glycine tomentella Hayata	seed S	1	5.00
Muelleranthus trifoliolatus (F. Muell.) Hutch. ex. A.T. Lee	seed S	1	6.63
Psoralea eriantha Benth.	fruit S	0.35 (0.06)	2.84
Rhynchosia minima (L.) DC.	seed S	1	11.8
Forbs			
Atriplex muelleri Benth.	fruit	1	0.79
Haloragis odontocarpa F. Muell.	fruit	1.8 (0.21)	+
Ipomoea lonchophylla J.M. Black	seed S	1	18.6

\# Caryopses fall out too easily to make estimates from harvested seed.

\+ Seed impossible to extract cleanly from the woody fruit; 4 ovules per fruit.

* Species where caryopses were also extracted for testing.

S Species which needed seed scarification before significant germination occurred.

50 diaspores or three of 100 units were tested each time. However, only small amounts of seed of the legumes and *Ipomoea lonchophylla* were available so tests for those five species were conducted using four replicates of 25 seeds.

Seed Treatment

Seed treatment prior to a germination test was used either (i) to make the 'seed' more manageable and more like the condition in which it would be sown in bulk, or (ii) to allow seed coat induced dormancy to be separated from physiological dormancy in the grain.

The caryopses of *Eragrostis eriopoda, Eragrostis setifolia* and *Dactyloctenium radulans* readily fell out of their glumes so their 'natural' seed was tested as caryopses, not diaspores. The long awns of *Aristida armata* and the spathes of *Iseilema vaginiflorum* diaspores were clipped to 30 per cent of their normal length so that consistent contact was made with the wet filter paper. The papery glumes were removed from *Digitaria ammophila, Digitaria diminuta, Panicum decompositum* and *Paspalidium rarum* by gentle hand rubbing, and only brown 'seeds' were used. The awn of *Themeda triandra* was pulled out. If a species normally had awned diaspores, e.g. *Dichanthium sericeum*, only those diaspores showing same were chosen, to minimize the number of empty units sown. All four legumes were initially tested each time without deliberate scarification. Soft (swollen) seeds were counted after three days imbibition. Soft seed invariably germinated. The hard seeds of *Rhynchosia minima, Glycine tomentella* and *Muelleranthus trifoliolatus* were dried for a few hours, nicked with a scalpel and replaced in their dishes. The seed coat of *Ipomoea lonchophylla* was so thick that its seeds had to be severely clipped before they would imbibe. Seed of *Dactyloctenium radulans* was scarified by rubbing gently with sandpaper. Where seeds (*Atriplex muelleri* and *Psoralea eriantha*) or caryopses were rubbed out, this was done at each testing date using corrugated, rubber rubbing boards. For *Psoralea eriantha* this scarified fresh seed enough to allow nearly 50 per cent germination and further treatment was deemed unnecessary. The same procedure at subsequent tests scarified very few seeds adequately but was retained for consistency.

Ten grasses were tested as both diaspores and caryopses (Fig. 1). The exposed caryopses of *Monachather paradoxa* were extremely susceptible to bacterial attack by Enterobacteriaceae, so the paper-filled petri dishes were autoclaved before use, sterile water was added and the caryopses surface sterilized with calcium hypochlorite solution. Counting and seedling removal of these seeds was also done under aseptic conditions. Previous experience showed that if these precautions were not taken, all caryopses would rot within four days. If *Thyridolepis mitchelliana* caryopses are removed too harshly, they too can be susceptible to such bacterial pathogens. However, they were not protected against pathogens in this study.

Results and Discussion

Seed fill

The Andropogonoid species *Dichanthium sericeum, Eulalia fulva, Bothriochloa ewartiana, Cymbopogon obtectus* and *Themeda triandra* had a poorer proportion of diaspore fill than most other grasses (Table 1). However, the caryopses were usually viable (Fig. 2). Legumes and forbs, with the exception of *Psoralea eriantha*, almost invariably had a seed in each diaspore. The flower of *Psoralea eriantha* produces a single-seeded indehiscent pod which falls within the calyx. A significant percentage of these diaspores normally contain no seed (Silcock, unpublished data). Harvesting good quality seed of this species is difficult; it must be left to fall and the ensuing mixture of fruits and aborted florets swept up and cleaned to remove the mature seed. The seed has a downy, resinous coating so that threshing does not readily produce clean seed.

Only diaspores of *Astrebla pectinata, Astrebla lappacea, Iseilema vaginiflorum* and *Haloragis odontocarpa* consistently contained several seeds. Caryopsis size within each diaspore of the above three grasses usually varied considerably, but germination was not obviously affected by seed size.

Germination

For seed of all ages, most germination occurred within seven days of wetting up. As this is the crucial period in high quality seed, the data presented in Fig. 2 is for that period, not 21 days. Early germination rate was usually greatest in seed one to three years old and fell, often markedly, in subsequent tests irrespective of maximum seed viability. Most species had good quality seed (≥ 80% of maximum germination) for several years (Fig. 1).

Legumes

The legumes retained a very high level of hard-seededness and viability for the eight years of the trial (Figs 1 and 2), with the exception of *Psoralea eriantha* where the seed was picked too green and was sometimes shrivelled. Subsequent studies (Silcock, unpublished data) have shown that *Psoralea eriantha* seed can have sustained viability and hard-seededness under laboratory conditions if picked when fully ripened. Soft seed content of *Glycine tomentella* was up to 30 per cent depending on the seed lot tested, but followed no pattern. Under field conditions, seed of *Muelleranthus trifoliolatus* can soften quite rapidly (Silcock and Williams 1975b), but this did not happen in the laboratory. Soft and adequately scarified legume seeds usually germinated within five days unless the sample was newly harvested.

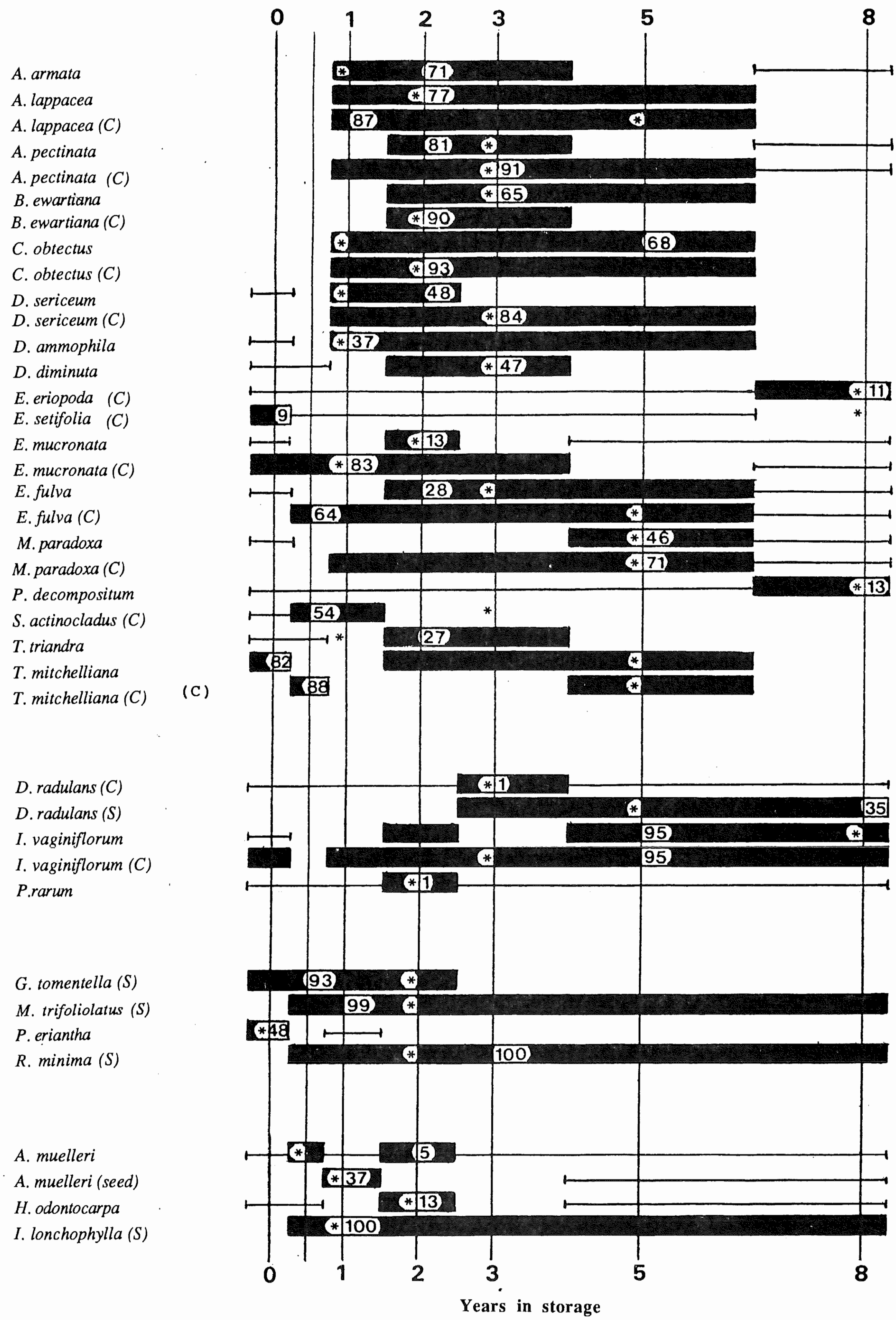

Fig. 1. Key data about each seed treatment in relation to its age. Broad black bars ( ) show when germination after 21 days exceeded 80% of the maximum ever achieved. Numbers give the maximum percentage germination recorded and the corresponding seed age, while asterisks mark the test when germination rate was greatest. The narrow bars (⊢—⊣) denote when germination failed to reach 5%. All bars terminate midway between sampling dates.
C = tested as caryopses rather than diaspores; S = results from scarified seed.

Forbs

The three forbs tested had very different seeds and each behaved differently. The pattern of germination of *Ipomoea lonchophylla* seed was very like that of the legumes while *Haloragis odontocarpa* fruit never germinated well despite the good colour and texture of the seeds within. This may be because the temperatures were too high for this normally winter-growing annual or because the woody fruit did not allow germination. Numerous scarification procedures have subsequently failed to improve the germination of this species at lower temperatures, yet it often emerges *en masse* in the field in late summer. Further study is needed on the germination mechanism of this valuable mulga herb.

Fruit of *Atriplex muelleri* never germinated well (Fig. 1), but naked seed reached 37 per cent germination after 12 months before declining to almost zero after five years (Fig. 2). Other native *Atriplex* species from southern Australia also have relatively short-lived seed plus inhibitors in the surrounding bracts (Beadle 1952). The chenopods world-wide seem to have short-lived seed and inhibition of germination in fresh seed by high salt levels in the enveloping fruit structures.

Grasses

In general, germination of grass diaspores and its rate (data not presented), increased for the first one to two years from quite low post-harvest levels. The much higher levels of germination by caryopses compared to diaspores (Fig. 2) in some species indicates seed coat induced dormancy is common, especially in fresh seed of grasses such as *Astrebla pectinata, Cymbopogon obtectus, Iseilema vaginiflorum* and *Dichanthium sericeum*. Seed coat inhibition under laboratory storage was maintained for many years by *Monachather paradoxa* and *Eriachne mucronata*, probably because of the stiff hairs on the coats. After two years storage, percentage germination of most grasses declined slowly but there was no general pattern. Those to hold their viability well for eight years were *Astrebla lappacea, Bothriochloa ewartiana, Dactyloctenium radulans, Iseilema vaginiflorum* and *Thyridolepis mitchelliana* (Figs 1 and 2). However, time to 50 per cent of final germination was much reduced after five years for all of these grasses except *Iseilema*. The results for *Astrebla lappacea* over the first year match closely those reported by Myers (1942). Germination of *Sporobolus actinocladus* was generally very slow and unpredictable in its onset. Significant germination was never recorded for seed of *Eragrostis eriopoda, Eragrostis setifolia, Panicum decompositum, Paspalidium rarum* or unscarified *Dactyloctenium radulans* (Fig. 1). Ross (1976) found that very high, sustained temperatures were needed for *Eragrostis eriopoda* to germinate. Scarification with sandpaper can sometimes enhance germination of *Eragrostis eriopoda* and *Sporobolus actinocladus* (unpublished data). However, their seeds are so small that it is difficult to control the severity of the process which was therefore not tried in this experiment. A 70 per cent H_2SO_4 solution will scarify *Dactyloctenium radulans* seed (Silcock and Williams 1975c), but the procedure is often excessive, producing aberrant seedlings lacking a radicle. We did not have any success in improving the germination of *Eragrostis setifolia, Panicum decompositum* and *Paspalidium rarum* by scarification, despite attempts using several methods. Under nursery conditions, *Paspalidium rarum* regenerates readily each summer so seed viability is not in doubt. In the field, *Paspalidium rarum* has a sporadic presence so some strong establishment barrier often exists which may be in the germination phase.

Seed of *Panicum decompositum* was also tested for germination using a range of alternating and constant temperatures (QDPI Standards Branch, unpublished data), but showed no significant response to any temperature regime different to the one used in this trial. This species continues to be difficult for us to germinate in the laboratory. Perhaps immaturity of seed contributes to the problem, as ripe seed falls quickly and hand-harvested seed thus tends to contain significant amounts of 'green' seed, like *Panicum maximum* (Hopkinson and English 1986). Only *Aristida armata* and *Thyridolepis mitchelliana* germinated reasonably from recently harvested diaspores, the former probably because the seed coat had been damaged by clipping the awns (Brown 1982). Germination of *Thyridolepis mitchelliana* during the study was erratic. This possibly reflects the sensitivity of this species to seed pathogens because the germination of both diaspores and caryopses followed similar trends in later years.

Seeds of *Themeda triandra* never germinated well or rapidly. Other samples of seed from the tetraploid ecotypes of western Queensland have behaved similarly. This contrasts with the results of Hagon (1976) and Mott (1978) where dormancy was quickly lost in the first year of storage. The species is so widespread in Australia and so genetically diverse that large differences in dormancy characteristics are found between ecotypes (Groves *et al.* 1982).

General discussion

The seed used was not treated in any way to control insects but no damage was evident. However, insects can be a problem at Charleville with seed stored in unsealed containers without refrigeration. The normally dry atmosphere at Charleville (mean relative humidity 51% at 9.00 a.m. and 29% at 3.00 p.m. - Bureau of Meteorology 1988) is very conducive to long-term maintenance of seed viability. In more humid climates, seed storage in unsealed bags is not advisable except in a cool room. The value of such cool storage in the humid environment in Brisbane, Queensland, has been clearly demonstrated for *Psoralea eriantha, Astrebla lappacea* and *Acacia aneura* seed. Seed of these species, harvested at Charleville, has retained high viability during 10 years storage in a Brisbane cool room (10°C, 40% relative humidity) (Silcock and Smith, unpublished data).

Unexpectedly poor germination sometimes occurred for reasons that cannot be convincingly explained, for example, *Thyridolepis mitchelliana* (Fig. 2). Others

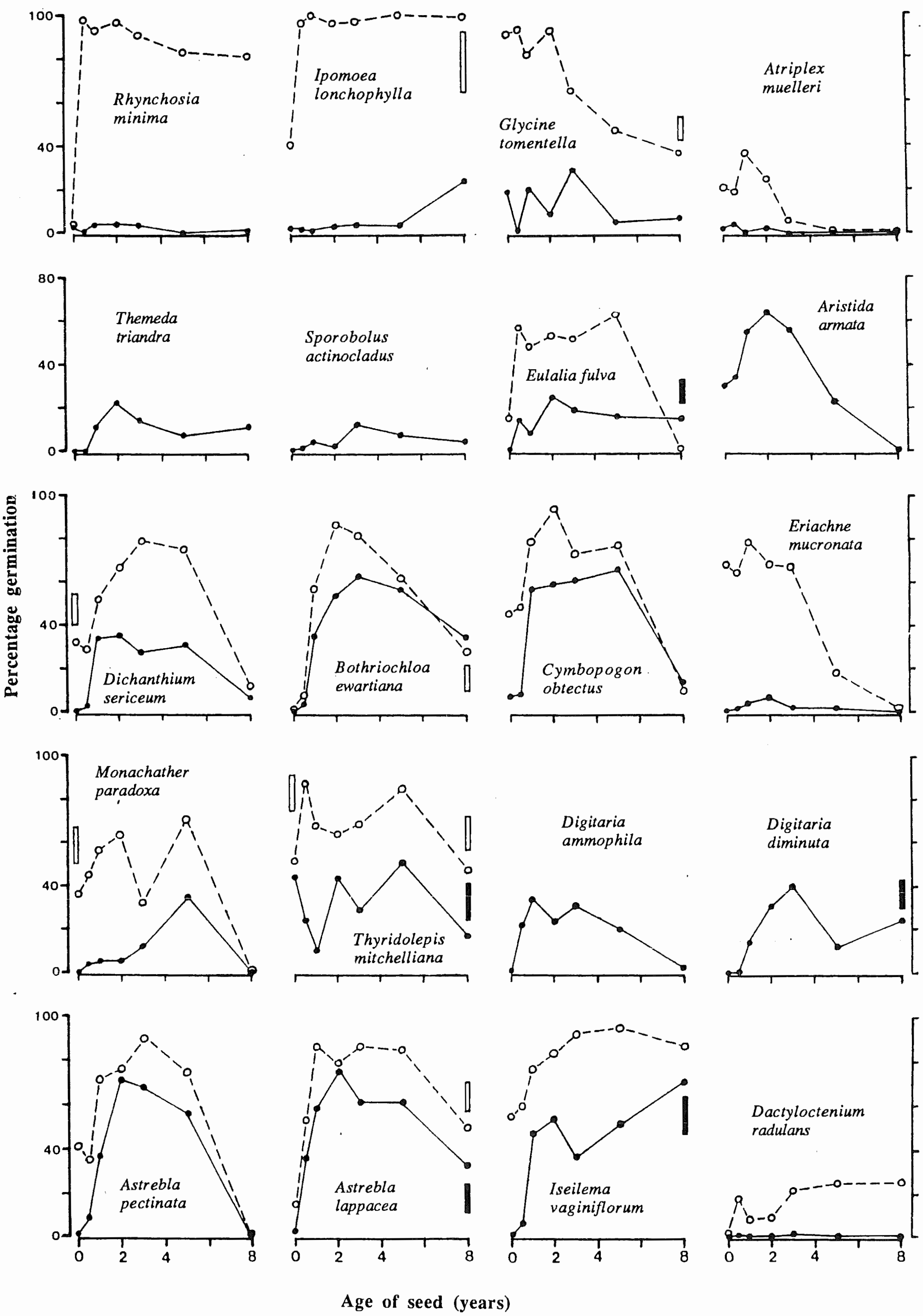

Fig. 2. Percentage germination after seven days in a cabinet at 35°/25°C (plus light) for seed stored without refrigeration for up to eight years in a Charleville laboratory. Untreated seed (●—●) and treated seed (○- -○) were handled as described in the text. Open bars indicate the standard deviation (where SD exceeded 10%) for treated seed at that age and closed bars apply similarly to untreated seed. Only species which germinated regularly are shown. For untreated *R. minima, G. tomentella* and *I. lonchophylla* seed, the data represent germination prior to scarification early on the fourth day after wetting.

showed irregular germination, probably due to the variability between years in vigour used when rubbing out caryopses or scarifying seeds. Therefore, the problems of working with seed of little known, undomesticated native species still remains. In summary, our data indicate that:

(a) Fresh seed should not be used except for the following:
(i) caryopses of *Astrebla pectinata, Cymbopogon obtectus, Dichanthium sericeum, Eriachne mucronata, Monochather paradoxa, Thyridolepis mitchelliana, Iseilema vaginiflorum,*
(ii) legumes,
(iii) *Ipomoea lonchophylla* and
(iv) *Atriplex muelleri*
Care must be taken to minimize damage when rubbing out caryopses.

(b) Germination of seed stored without refrigeration for more than five years may be unpredictably low - exceptions for our samples were, *Astrebla lappacea, Bothriochloa ewartiana, Digitaria diminuta, Thyridolepis mitchelliana, Iseilema vaginiflorum, Muelleranthus trifoliolatus, Rhynchosia minima* and *Ipomoea lonchophylla;*

(c) Caryopses of the grasses *Astrebla* spp., *Bothriochloa ewartiana, Cymbopogon obtectus, Dichanthium sericeum* and *Eriachne mucronata* were easy to extract and usually germinated better than the harvested diaspores;

(d) Germination of some species was consistently low and unreliable - namely *Eragrostis eriopoda, Eragrostis setifolia, Panicum decompositum* and *Paspalidium rarum.*

(e) Prior testing and refinement of some scarification technique may be advisable for the following: *Sporobolus actinocladus, Themeda triandra, Dactyloctenium radulans, Psoralea eriantha* and *Haloragis odontocarpa.*

(f) Native legume seed, no matter how old, should always be scarified unless good evidence to the contrary exists.

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