DRYING TEMPERATURE AND ITS EFFECT ON VIABILITY OF SETARIA SPHACELATA SEED

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ABSTRACT

*Freshly harvested seed of Kazungula setaria (*Setaria sphacelata*) was collected using a header-harvester and dried at temperatures of 30, 40, 46, 61, 70 and 80°C in standard laboratory ovens. The time required to reduce the moisture content from 62% to below 14% varied between 1 hr 28 min at 80°C and 21 hr 40 min at 30°C.*

Two months after treatment there were no significant differences in the viability of seed dried at 30, 40, 46 and 61°C. However, viability was seriously reduced when the seed was dried at 70 and 80°C. There was a very marked decline in the viability of seed from all treatments after storage for one year.

INTRODUCTION

*Setaria sphacelata*** is becoming increasingly important in coastal, subtropical Queensland as a grass component in improved tropical pastures (Hacker and Jones 1969). However, commercial seed yields are poor. Inflorescences are produced over a period of several weeks, individual inflorescences flower for up to 32 days, and mature seed is shed almost immediately. Commercial producers of seed are forced to harvest at the time of optimum recovery and to dry both the green and ripe seed before cleaning. A considerable quantity of moist immature seed is always collected and some of this is capable of germinating if the seed is dried correctly.

The moisture content of the freshly harvested material, which includes much vegetative material as well as seed, may be as high as 55 to 60% (wet weight basis)†, although the seeds themselves may be drier. For safe storage, the moisture content of the seed should be below 14% (Griffiths *et al* 1967). The drying operations necessary to reduce the seed moisture content to this level are slow and expensive. If time of drying could be reduced a considerable saving would result.

In this experiment the effect of drying temperature on the viability of freshly harvested *S. sphacelata* cv. Kazungula seed was investigated.

MATERIALS AND METHODS

The seed for this experiment was collected by a header harvester from a slightly immature seed crop of Kazungula setaria. The good seed was mixed with a large amount of shredded vegetative material and empty florets plus numerous insects. This contributed to the high moisture content for the "seed mass" of 62%,

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** Hacker and Jones (1969) now consider that both commercial strains 'Kazungula' and 'Nandi' belong to the *S. anceps* group.

† All moisture contents are expressed on a wet weight basis.

$$\text{Moisture content \% wet weight basis} = \frac{\text{weight of moisture in material}}{\text{wet weight of material}} \times 100$$

although for the seeds themselves this would have been lower. After drying the pure seed amounted to only 37% of the weight of the harvested material and had a moisture content of 13.5%.

Samples of the "seed mass" were dried using normal laboratory ovens equipped with fans, a separate oven being allocated to each temperature used. The seed was put into gauze-bottomed trays (15 × 15 × 4.5 cm) in a layer 2 cm deep. There were 65 g of moist seed material per tray and each oven held seven trays. Oven temperatures were set at 30, 40, 46, 61, 70 and 80°C. The seed was periodically stirred to ensure even drying. The drying time at each temperature necessary to reduce the moisture content to approximately 12% had been determined in earlier experiments. Air movement inside the ovens, though not great, was considered to be adequate for this quantity of seed (Nellist, Rees and Higgs 1965, 1966).

After drying the seed was allowed to cool to room temperature. The trash was then removed by sieves and a General ER Seed Blower. The air flow used in the Seed Blower was the standard rate used by Standards Branch, Department of Primary Industries, Brisbane for purity analyses on *S. sphacelata* seed (Prodonoff 1967).

The seed was stored in paper packets in a laboratory between drying and the germination tests. Viability of the seed was tested (i) two months and (ii) one year after drying. Two samples, each of fifty seeds, were taken from each of the seven trays in each drying temperature. The first germination was carried out at 35°/20°C on Greens LR 52 paper using an Overaa Germination Apparatus (Prodonoff 1967) in an air-conditioned room. The higher temperature was maintained for 16 hr per day, during which time the seed was subjected to the prevailing June daylength conditions. The second test, on the same type of moist absorbent paper, was conducted in a cabinet germinator at 35°/20°C and 95% relative humidity, this time under natural daylength conditions during April. Counts of germinated seeds were made at four day intervals.

Arc sine or $\sqrt{X + \frac{1}{2}}$ transformations were performed on the data before statistical analysis.

RESULTS

TABLE 1

Effect of drying temperature on the viability of Kazungula setaria seed

	Drying temperature °C					
	30	40	46	61	70	80
Drying time (min)	1300	779	295	155	140	88
% Germination 2 months	28.6^{a}	22.4^{ab}	27.2^{a}	23.6^{ab}	7.9^{cd}	3.9^{def}
% Germination 12 months	12.3^{c}	18.4^{b}	8.7^{cd}	6.9^{d}	4.7^{de}	1.9^{f}

Values with the same superscript do not differ significantly from each other ($P < 0.01$).

After the seed was stored for two months there were no significant differences in germination percentages among the 30, 40, 46, and 61°C drying treatments. There was, however, a significant difference ($P < 0.01$) between this group and the germination of seed dried at 70 and 80°C. A general deterioration in seed viability occurred between two and 12 months. The viability of seed stored for 12 months and dried at 30, 46, 61 and 80°C fell to below 50% of the viability at two months (Table 1). There was no significant difference between the 30 and 46°C, 46 and 61°C and the 61 and 70°C treatments, respectively. There were some minor changes in the pattern of germination as the seed aged, particularly from seed dried at 46 and 61°C (Fig. 1).

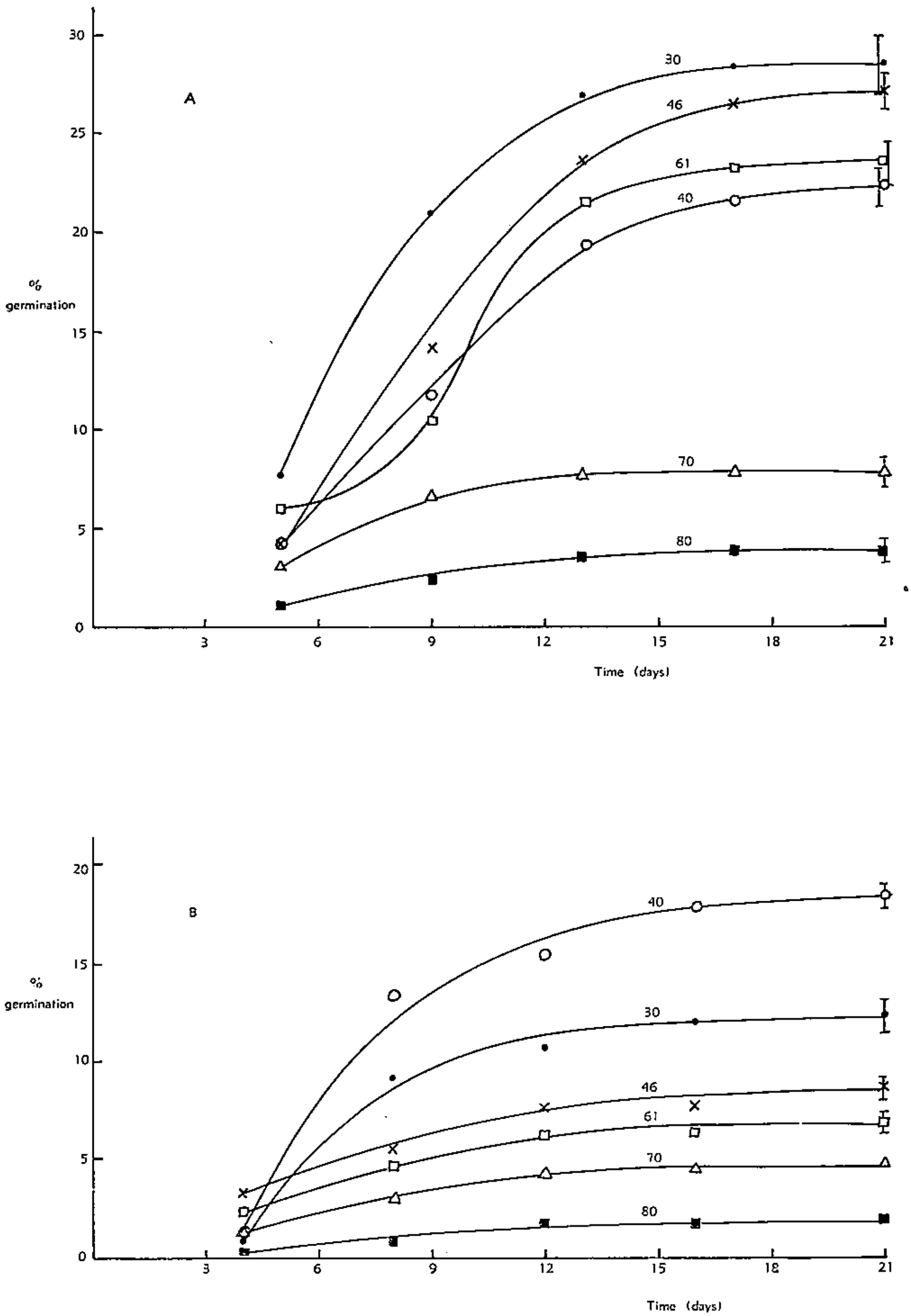

FIGURE 1

The effect of drying temperatures on the pattern of germination in *Setaria sphacelata* seed (A) two months old and (B) 12 months old. Vertical bars represent standard errors.

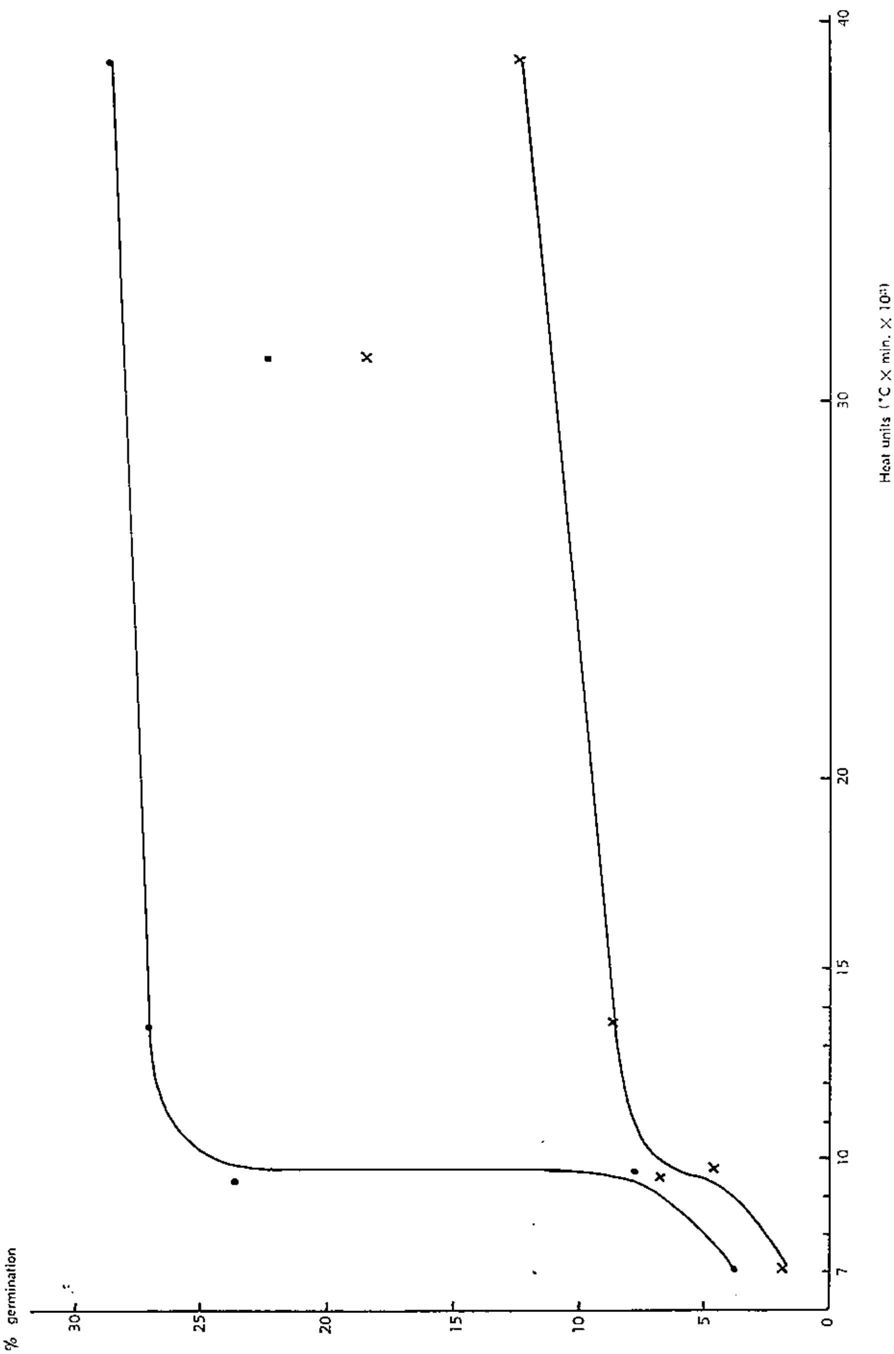

FIGURE 2

Changes in seed viability due to differences in total units of heat applied during drying { • 2 months old seed
x 12 months old seed }

When viability is plotted against heat units of drying, and some liberties are taken with seed at 40°C, the critical heat tolerance of *S. sphacelata* seed becomes evident (Fig. 2). When less than 10 heat units (°C × min × 10^3) were used to bring the seed to satisfactory dryness, the intensity of drying caused serious reductions in seed viability. This occurred most noticeably in seed two months old.

DISCUSSION

Fresh seed of *S. sphacelata* normally has a moderate amount of dormancy (CSIRO unpublished data). By commercial standards 22-28% germination is quite an acceptable figure. However, the sharp fall in percent germination with time was not expected. This same pattern has been noted by Jones (1967) for Nandi setaria. The aberrant results obtained at 40°C are inexplicable. However, it was clear that temperatures up to 60°C were not unduly deleterious to seed viability when the seed was still young. This may be associated with the breaking of a small percentage of dormancy by heat, compensating for very immature seed killed at 46 and 61°C. Drying techniques normally used do not cater for seed with a moisture content greater than about 30% and even then 40°C is often the maximum temperature advised (Griffeth and Harrison 1954; Harrington 1923; Heygate 1964). More recently, Nellist, Rees and Higgs (1965) found that timothy seed (*Phleum pratense*) of less than 30% moisture could be dried quite safely at 49°C with a moderate air-flow. In their experiment seed with greater than 40% moisture content suffered only small declines in viability at 49°C compared to 35°C. Tropical grass seed may be able to withstand slightly higher drying temperatures than that of temperate grasses.

The results of this experiment and those of Jones (1967) show that *S. sphacelata* seed loses its viability rapidly and does not increase its viability with age as do some other tropical grasses, e.g. buffel grass (*Cenchrus ciliaris*) (Brzostowski and Owen 1966). However, as there was always a percentage of apparently healthy ungerminated seed remaining at the end of the 21-day germination period (sometimes as much as 17%) it is possible that a seed dormancy or hard seed factor was still operative even after 12 months.

High drying temperatures did not alter the pattern of germination in any major way (Fig. 1) and the time to reach 50% of the final germination percentage was similar in all cases despite very different rates of germination. The marked reduction in the germination rate between two and 12 months of seed dried at 46 and 61°C is of interest. These two temperatures bridge the critical drying temperature for this experiment. A marked fall over the same period in the viability indicated that the drying temperatures used had reduced the seed germination energy to such an extent that unless planted shortly after drying many seeds would fail to hold their viability for 12 months. This is shown by the 61°C treatment particularly. At two months it did not differ significantly in viability from seed dried at 30 or 46°C, but at 12 months it was not significantly better than seed dried at 70°C. The 70 and 80° treatments proved far too severe for most seeds.

As it is impossible to differentiate between the effects of temperature and drying time in this experiment, the two have been combined (Fig. 2) to give heat units (°C × min). When expressed this way, the time factor becomes the dominant influence over the number of heat units applied, e.g. a 2.7 times increase in the temperature (°C) reduced the drying time (min) by a factor of nearly 15. This is because the drying power of air at a constant water vapour content increases very rapidly with increasing temperature.

The higher temperatures dried the seed to below 14% at an ever increasing rate. However, when this rate exceeded a certain critical value the viability of the seed was impaired. The rate corresponded to the use during drying of about 10,000 heat units and if slightly fewer units were required to dry the seed to below 14% moisture then the rate of drying was too great. The number of fewer units required to produce a fall of 64% in the viability of seed two months old was comparatively small (only 1300 units, i.e. a 13% reduction). The same trend was evident in seed 12 months old, the major decline in viability again occurring around 10,000 units. No examination of the dried seeds was made so the reason for this sudden change is not known. The optimum number of heat units was achieved at a drying temperature of a little above 46°C in this experiment. Drying the seed at 46°C took only 295 min, compared to 779 min at 40°C and 1300 minutes at 30°C. The vastly increased volume of heated air required to dry moist seed at temperatures below 46°C does not seem warranted in terms of the slight improvement in viability.

Commercial seed producers could make savings in time and possibly power consumption by increasing their drying temperature to around 46°C without harming the market value of the seed in the first few months after harvest.

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