Preliminary Investigations of Adhesive Sprays To Improve Seed Retention in Tropical Grasses [1]

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ABSTRACT

Preliminary experiments on *Chloris gayana* Kunth cv. Callide and *Setaria sphacelata* (Schumach.) Stapf & Hubbard ex M. B. Moss var. *sericea* (Stapf) W. D. Clayton cv. Narok in southern Queensland, Australia assessed the effects of glue and paint-derived sprays on seed retention. In *S. sphacelata* var. *sericea*, adhesive sprays formed droplets on inflorescence hairs and did not improve seed retention. In contrast, spray coverage and penetration of *C. gayana* inflorescences were more effective and results were encouraging, with reduced shattering and an extension of the potential harvest period by about two weeks. In any future work, high priority should be given to the possible use of additives (e.g. wetting agents) to achieve better coverage and penetration of inflorescences by adhesive mixtures.

Additional index words: shattering, seed production.

INTRODUCTION

Shattering, or the loss of ripe seed from inflorescences, generally allows little margin for error in the timing of harvest for tropical grass seed crops. Together with the problem of uneven crop ripening caused by the spread of maturity between and within inflorescences, shattering contributes to the relatively low seed yields from tropical grasses and the high cost of seed of many cultivars.

McWilliam and Schroeder (1974) sprayed inflorescences of *Phalaris aquatica* L. (formerly *Phalaris tuberosa* L.) with a quick-setting plastic lacquer (PTSB or *Phalaris tuberosa* seed coat builder, a paint-derived product — H. E. Schroeder, personal communication) just prior to seed maturity. This treatment reduced shattering and is therefore a promising technique to improve both the yield and quality of harvested seed, although more developmental work is necessary before it can be applied successfully on a commercial scale.

Essentially the same approach was used by Williams (1976, 1978, 1979) in South Australia on vegetable crops. In his work, a polyvinyl acetate (PVA) glue was applied and showed promise even on a commercial scale.

The high value of tropical grass seeds makes this technique potentially attractive for such crops. Unlike temperate grasses, however, the seed of tropical grasses abscisses above the glumes (Hacker and Jones, 1971; Strickland, 1971; Humphreys, 1979), thereby reducing the possibility of improving seed retention through the use of adhesive sprays, especially in very open panicles (*e.g. Panicum* spp.). Grasses with light, chaffy "seeds" (*e.g. Chloris gayana* Kunth) or with tight heads incorporating inflorescence hairs [*e.g. Setaria sphacelata* (Schumach.) Stapf & Hubbard ex M. B. Moss var. *sericea* (Stapf) W. D. Clayton] (formerly *Setaria anceps* Stapf) therefore offer the best chances of success. This paper covers the results of preliminary experiments evaluating the use of glue and paint-derived sprays on such species.

BACKGROUND

Chloris gayana and *Setaria sphacelata* var. *sericea* are major components of sown pastures in tropical regions and the particular cultivars used have been released as superior pasture types (Barnard, 1972; Bogdan, 1977). Both grasses stand about 1.8-2.0 m high in full head, but *S. sphacelata* var. *sericea* forms distinct tussocks and produces tight spike-like panicles with dense, free-flowing seeds, in contrast to *C. gayana* which spreads by stolons and produces digitate or sub-digitate panicles comprising one-sided sessile spikes with light, chaffy seeds. Because of the perennial nature of individual plants, successive cropping cycles — conventionally designated as "crops" — can be imposed for a number of years on the same seed area as outlined by Loch (1980, 1982).

MATERIALS AND METHODS

Experiment 1

An established 39 x 16 m area of *C. gayana* cv. Callide (sown November 1971) was mown to 15 cm on 16 February 1976 and fertilized with 150 kg N (as ammonium nitrate), 150 kg superphosphate, and 125 kg muriate of potash per ha. This was situated on a Udic Argiustoll (Soil Survey Staff, 1975; B. Powell, personal communication) at Upper Wonga (26°10'S, 152°25'E, with 1000 mm average annual rainfall) in southern Queensland.

Walkways (1 m wide) were mown out on 6 April 1976 leaving 12 plots, each of 8 x 1.5 m, which were allocated randomly within pairs to either an unsprayed control (Treatment A) or a sprayed Treatment B. Spraying (with 1 part

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PTSB in 7 parts of water) was carried out at a rate of approximately 1400 l/ha of mixture on 18 May 1976, just prior to crop maturity.

Quadrat samples (0.5 m^2) were cut at 14 day intervals from randomly allocated sub-plots (1.6 x 1.5 m) and the percentage of empty inflorescences (*i.e.* with seed completely shed) was calculated as follows: —

$$\frac{\text{No. empty inflorescences x 100}}{\text{Total no. inflorescences}}$$

To facilitate hand-stripping of seed, freshly-cut inflorescence samples were "sweated" for three days by storing them between sheets of damp newspaper to maintain a high moisture content. Samples were then dried at 40 C and the seed stripped and weighed. The proportion of pure seed was determined in two alternative ways. Method 1 (the Irish method) is used for testing chaffy grass seeds for sale in Australia and classifies as pure seed all intact spikelets minus the unequal basal glumes, irrespective of whether a caryopsis is present or absent. Method 2 (the international method) imposes the additional refinement that pure seed must contain a caryopsis, and is in accord with International Seed Testing Association (ISTA) rules (Anon., 1976).

Experiment 2

A 24 x 24 m area of *S. sphacelata* var. *sericea* cv. Narok was sown in 50 cm rows on 14 November 1975. This was situated on a Paleustalf (Soil Survey Staff, 1975; R. C. McDonald, personal communication) at "Bungawatta" (25°57'S, 152°42'E, with 1250 mm average annual rainfall) in southern Queensland.

Two cropping cycles were studied in this experiment. The stand was initially mown to 15 cm on 18 August 1976 (crop 1) and 10 January 1978 (crop 2) and fertilized with 150 kg N/ha (as ammonium nitrate). In addition, crop 1 received 250 kg superphosphate and 50 kg muriate of potash/ha, while crop 2 received 375 kg superphosphate and 125 kg muriate of potash/ha. Mown walkways (1 m wide) were maintained, leaving 27 plots each 6 x 1.5 m for the following treatments arranged in nine randomized blocks: —

A — Unsprayed control
B — Sprayed once:
  Crop 1 — 30 December 1976
  Crop 2 — 22 March 1978
C — Sprayed twice:
  Crop 1 — 30 December 1976, 28 January 1977
  Crop 2 — 22 March 1978, 19 April 1978

Because PTSB was unavailable, a commercial water-soluble acrylic glaze (Duralex Aqua-Clear Flat) was used on crop 1 at a dilution of 1 part in 7 parts of water and applied at 2000 l/ha of mixture. For crop 2, this was changed to a PVA glue without toxic plasticisers (thalates) or acrylic compounds (Vinamul 9300) at 1 part in 10 parts of water and the mixture applied at 1650 l/ha.

As in experiment 1, quadrat samples (0.5 m^2) were cut at 14 day intervals and percentages of empty inflorescences calculated. Seed was "sweated" and hand-stripped and samples were lightly cleaned by conventional screening and winnowing before recovering pure seed using a modified Ottawa seed blower descibed by Hergert, Zillinsky and Kemp (1966).

RESULTS

In experiment 1, sprayed plots had significantly fewer empty inflorescences (Figure 1) and more seed per inflorescence (Figure 2) 28-56 days after spraying, indicating that PTSB delayed seed shedding for around two weeks. Spraying also appeared to increase both the percentage and the size of caryopses present in spikelets sampled during this period (data not presented). Our observations, however, suggested that spray penetration of inflorescences could be improved, even though plots were sprayed from the sides and (as appeared more effective) from above.

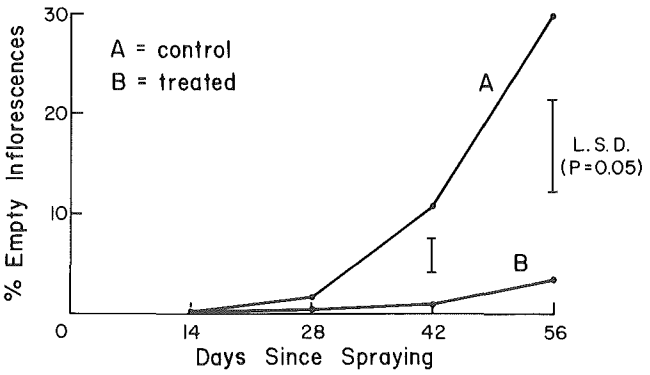


Figure 1. Change in percent empty inflorescences of *Chloris gayana* cv. Callide (experiment 1).

In experiment 2, neither of the mixtures used was effective in penetrating *S. sphacelata* var. *sericea* inflorescences. Although plots were thoroughly wet after spraying, droplets merely formed on inflorescence hairs and, as indicated in Figure 3, spraying had no effect on seed retention. Spraying also appeared to increase both the percentage and the size of caryopses present in spikelets sampled during this period (data not presented).

DISCUSSION

Effective coverage and penetration of inflorescences are essential if adhesive sprays are to improve seed retention in tropical grasses. In the preliminary experiments reported here, the importance of these aspects was clearly demonstrated: in *S. sphacelata* var. *sericea* where spray droplets did not appear to penetrate beyond the inflorescence hairs, adhesive sprays were ineffective; in contrast, spray coverage and penetration of *C. gayana* inflorescences were more effective and results were encouraging, with reduced shattering and an extension of the potential harvest period by about two weeks. In addition, a few *S. sphacelata* var. *sericea* inflorescences from crop 2 were dipped directly into the adhesive spray mixture to ensure proper coverage and penetration, and our subsequent observations of these indicated that seed retention was markedly improved. Similar

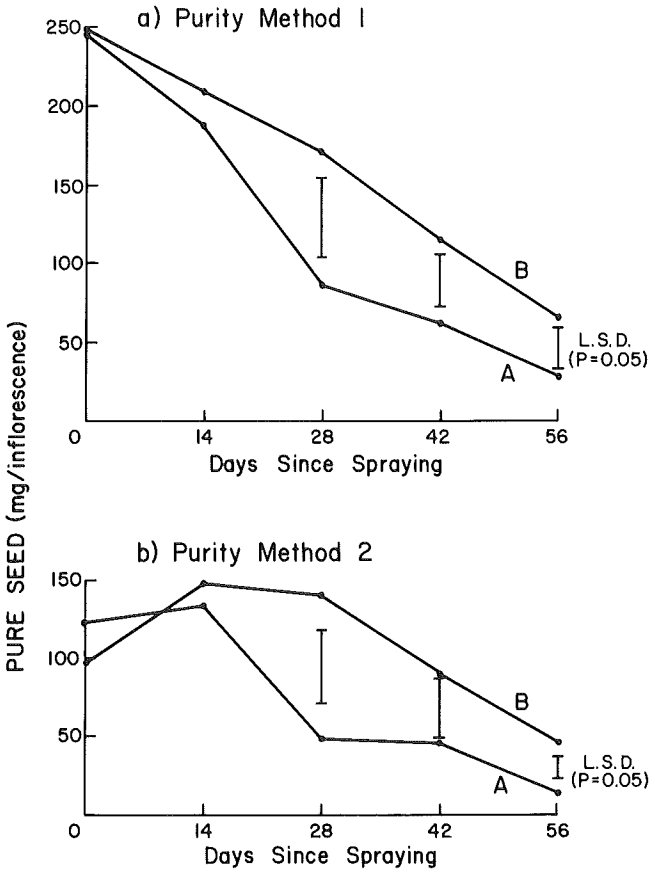


Figure 2. Change in seed per inflorescence of *Chloris gayana* cv. Callide (experiment 1) determined by (a) purity method 1 and (b) purity method 2.

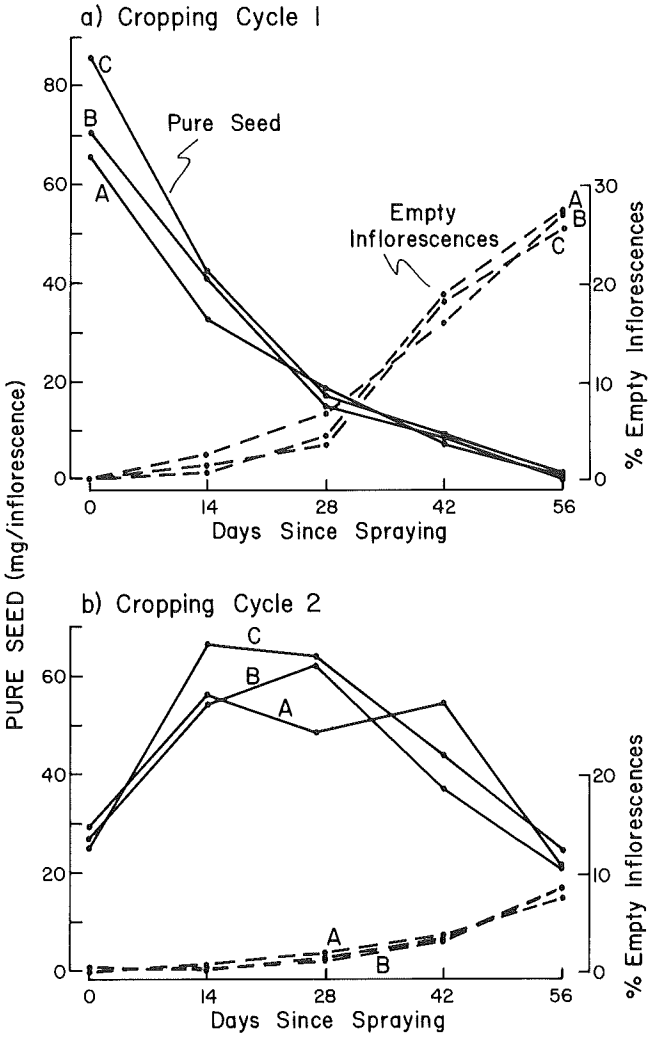


Figure 3. Change in percent empty inflorescences (---) and pure seed per inflorescence (—) of *Setaria sphacelata* var. *sericea*, cv. Narok in experiment 2. A (unsprayed), B (sprayed once), C (sprayed twice).

adhesive sprays, including both PVA glues and other compounds, have also reduced shedding losses when applied to seed crops of onions, celery, and carrots in South Australia (Williams, 1976, 1978, 1979) and cultivars of *Lolium* spp. in England (Budd, 1981). However, it appears that beneficial effects can be negated by light rainfall before harvest (Williams, 1979), though this was not observed following either PTSB sprays or dipping in a PVA solution during our investigations.

From the foregoing, it can be readily deduced that the yield of seed presented for harvest will be increased (as in Figure 1) if there is a reduction in seed lost through shattering, but the importance of reduced shedding in terms of seed quality is less obvious. However, higher quality could be expected by prolonging the average retention time for an individual seed on the standing crop because this would lead to a higher proportion of mature seeds present (Hopkinson and English, 1982), thereby increasing both the number and the average size of caryopses present as indicated in experiment 1.

The range of compounds tried in the present experiments and by previous workers is by no means exhaustive and the potential range is continuing to expand as new products become available. Intending users should therefore seek appropriate technical advice about likely alternatives in their country of origin before initiating experiments of this kind.

In any future work, high priority should be given to the possible use of additives (*e.g.* wetting agents) to achieve better coverage and penetration of inflorescences by adhesive mixtures, bearing in mind the need for these sprays to become waterproof after drying. Despite some encouraging results from our experiments, more effective spray application is obviously essential before serious consideration can be given to the possible commercial use of adhesive sprays to improve seed retention in tropical grass seed crops.

ACKNOWLEDGMENTS

We are indebted to the Australian Meat Research Committee for financial support, to Mr. H. E. Schroeder for supplying PTSB, and

to A. C. Hatrick Chemicals Pty. Ltd. for Vinamul 9300.

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