How Do Your Daisies Grow?

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***Rhodanthe chlorocephala* ssp. *rosea* (pink paper daisy) and *Schoenia filifolia* ssp. *subulifolia* (yellow strawflower) are Western Australian daisies with potential for use as bedding plants and pot plants. The influence of irrigation on seed production was examined in field trials. Water deficit reduced branching which limited sites for terminal flower development and seed production. *Rhodanthe chlorocephala* seed was dormant at harvest but 97% germinated after 3 months storage at 30C. *Schoenia filifolia* seed was still dormant (8% germination) after 3 months storage. Dormancy could be overcome by application of gibberellic acid (GA_3, 30% — 87% germination) or by exposure to 80C for 11 days (79% germination).**

INTRODUCTION

Rhodanthe chlorocephala ssp. *rosea*, pink paper daisy, and *Schoenia filifolia* ssp. *subulifolia*, yellow strawflower, are everlasting daisies with potential for development as bedding and pot plants. *Rhodanthe chlorocephala* is native to the interior of southwestern Western Australia between the Moore and Murchison rivers and *S. filifolia* to the Geraldton district (Wilson, 1992). In their natural habitats these species provide a spectacular display in late winter and early spring. Most pot or bedding plants are commercially propagated from seed. For commercial production seed must be available, viable, germinable, and hence not dormant. However, seed for most Australian species is bush picked and of inferior quality compared to traditional bedding plant species. The availability of bush-picked seed varies with season and rainfall, viability may be low, dormancy is common, and germination often poor (Bell et al., 1993). These factors have severely restricted the exploitation of Australian herbs suitable for bedding or pot plants. Bush picked *R. chlorocephala* and *S. filifolia* seeds have relatively high viability but are dormant when collected. There is little information about the water requirements of Australian species from the southwest of Western Australia, which has a Mediterranean-type climate of winter rains and summer drought. Species which originate from areas of seasonal drought may avoid dry conditions by existing as dormant structures such as seeds during this period, tolerating drought through various morphological and physiological adaptations, or having short life cycles which use water when it is available (Turner, 1986).

The aim of these experiments was to provide information on the water requirements for production of high yields of viable seed, conditions suitable for storage, and a method to break dormancy and provide high germination of seed.

MATERIALS AND METHODS

Irrigation During Production. Plants were grown in field plots at the University of Western Australia, Perth. Seed of *R. chlorocephala* and *S. filifolia* were sown in 10-m^2 plots with a 50-cm row spacing and were thinned to 5 cm between plants within rows 30 days after emergence. Seedlings were irrigated by sprinklers with an equivalent of 100% class A pan evaporation until 45 days after sowing. Plants were then treated with three irrigation regimes, water replacement to the equivalent of 100%, 50%, or 25% class A pan evaporation. Plants were harvested 112 days after planting and the number of stems, flowers, and seed yield were recorded. Branching was examined by division of shoots into primary, secondary, tertiary, and quaternary stems. Inflorescence heads will be termed flowers. Data were analysed using analysis of variance and Fisher's Protected least significant differences were used to compare means.

Seed Storage. Seed from the field trial was cleaned and stored at ambient temperatures for 3 months before transfer to controlled temperatures of 5, 15, 25, 30, 40, 55, or 65C. Viability and germinability were monitored at 2-month intervals for *R. chlorocephala* and 1-month intervals for *S. filifolia*. Viability was determined either by germination test or germination followed by a tetrazolium test (Moore, 1973) of nongerminating seeds. The germination test was carried out in petri dishes using three replicates of 25 seeds incubated for 35 days in the light at 20C (Plummer and Bell, 1995).

Breaking Dormancy. Newly harvested seed of *S. filifolia* was 100% dormant. Dormant seed was treated with various concentrations of gibberellic acid (GA_3: 0.01, 0.03, 0.1, 1, 3, 10, 30, 100 μM) and incubated in the light at 20C. Other dormant *S. filifolia* seed was incubated at 65, 80, 95, or 105C for 0.5, 3, 5, 7, 11, or 14 days. Germination and viability were assessed as above.

RESULTS

Irrigation During Production. Decreasing irrigation reduced vegetative growth, flower number, and seed yield (Table 1). Most stems of *R. chlorocephala* (80% to 89%) and *S. filifolia* (99% to 100%) produced terminal flowers irrespective of irrigation treatment. Hence the effect of water regime on branching and stem number was also critical for flower production. Seed yield per flower decreased with reduced irrigation with *R. chlorocephala* having means of 109, 85, and 80 seeds per flower in 100%, 50%, and 25% A pan treatments, respectively, and *S. filifolia* having 134, 101, and 86. However, this effect contributed less to the decline in seed yield with reduced irrigation, than reduced stem number.

Table 1. The influence of irrigation on stem number, flower number and seed number per plant in *Rhodanthe chlorocephala* ssp. *rosea* and *Schoenia filifolia* ssp. *subulifolia*. Different letters indicate significant difference within columns (p=0.05).

Irrigation	*Rhodanthe chlorocephala*			*Schoenia filifolia*		
(% A Pan)	Stems	Flowers	Seed	Stems	Flowers	Seed
100	18.3a	16.6a	338a	22.3a	22.3a	404a
50	14.3ab	11.3b	255b	13.7b	13.4b	304b
25	13.0b	10.4b	208b	8.7c	8.5c	201c

Seed Storage. At harvest seed from all water regimes of both species had high viability but was dormant. After 3-months storage at ambient temperatures *R. chlorocephala* had broken dormancy and 96% of seed germinated, whereas *S. filifolia* were 96% viable but only 8% germinated. Storage of *R. chlorocephala* seed for a further 3 months at 15 to 55C did not affect germination (94% to 97%), however, germination of seed stored at 5C or 65C decreased to 90%. Storage temperature influenced dormancy release of *S. filifolia*. Seed stored at 5 or 15C for 3 months had 53% and 63% germination, respectively, and approximately 90% of seed stored at 25 to 40C germinated. Seed stored for 2 months at 65C had high germination (80%) but this decreased to 60% after 3 months due to reduced viability.

Breaking Dormancy. Application of GA_3 broke dormancy in *S. filifolia*. The optimum concentration was 30 µM, which resulted in 87±4% germination. Temperature and duration of exposure influenced seed viability and germination. All seed remained viable when treated for 0.5 to 14 days at the lowest temperature (65C), however, dormancy was not completely broken even in seed stored for the maximum duration. Seed treated with 105C were all dead after 1 day and more than half of the seeds treated with 95C died after 3 days. Intermediate temperatures were more successful in breaking dormancy and maintaining viability. Seed treated with 80C for 7 days were completely viable (94±4%) but not germinable (0%). However, after 11 days at 80C 79±3% germinated and 87±3% were viable.

DISCUSSION

Supply of adequate water is important for seed production in these everlasting daisies. Water deficit restricted branching and this was the major factor influencing seed yield. When less water was applied the number of stems was reduced and this limited the number of flowering sites. Flowers are borne terminally on stems and the number of stems per plant, which produced flowers, was not affected by irrigation regime. Hence a reduction in stem number flowed on to a reduction in flower number. Seed number per flower was reduced by water deficit but the impact on seed yield was less. These daisies avoid summer drought as dormant seeds but once germinated and growing were luxury users of water and showed considerable developmental plasticity (Turner, 1986) in their growth response to irrigation.

Storage temperatures greatly affected seed viability and germinability. *Rhodanthe chlorocephala* seed was able to tolerate a wide range of temperatures (15C to 55C) with little effect on viability and germinability over the 3-month period. However, low storage temperatures appeared to be detrimental and germination declined at 5C. In *S. filifolia* moderate temperatures (25C to 40C) improved germination by breaking dormancy over the 3-month period. Low temperatures did not completely overcome dormancy and high temperature (65C) had a detrimental effect on seed viability and germination. Generally (Harrington, 1972) low temperatures prolong longevity but ambient storage temperatures appear to be appropriate for short-term storage of these species.

Seed dormancy in *S. filifolia* was overcome by the application of 30 µM GA_3 resulting in 87% germination. It would not be easily employed in a commercial situation as the procedure involves treatment with an aqueous solution of GA_3 and seed would have to be dried before shipment. Treating seed for 11 days at 80C overcame dormancy without substantially reducing viability and resulted in 79% germination. Seed could be treated in bulk without the need for wetting and drying.

Rhodanthe chlorocephala and *S. filifolia* have potential as bedding and pot plants. Cultivated plants yielded substantial quantities of seed with high viability. *Rhodanthe chlorocephala* seed broke dormancy with 3-months storage at ambient temperatures. *Schoenia filifolia* seed required 11 days at 80C. This enables seed of both species to be harvested over summer and sold for autumn planting. High levels of irrigation increased seed yield in *R. chlorocephala* by more than 50% and doubled it in *S. filifolia*. Increased irrigation improved branching and this was the major factor contributing to increased flower production and seed yield. Increased flower number would also improve aesthetic appeal of bedding plant displays and value of pot plants and irrigation regimes should also be considered for these uses.

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LITERATURE CITED

Bell, D.T., J.A. Plummer, and **S.K. Taylor.** 1993. Seed germination ecology in southwestern Western Australia. Botan. Rev. 59:24-73.

Harrington, J.F. 1972. Seed storage and longevity. pp. 145-245. In: T.T. Kozlowski (ed.). Seed biology. Vol. 3. Academic Press, New York.

Moore, R.P. 1973. Tetrazolium staining for assessing seed quality. pp. 347-365. In: W. Heydecker (ed.). Seed ecology. Butterworths, London.

Plummer, J.A. and **D.T. Bell.** 1995. The effect of temperature, light, and gibberellic acid (GA_3) on the germination of Australian everlasting daisies (Asteraceae. Tribe Inulae). Aust. J. Bot. 43:93-102.

Turner, N.C. 1986. Adaptation to water deficits: A changing perspective. Aust. J. Plant Physiol. 13:175-190.

Wilson, P.G. 1992. The classification of Australian species currently included in *Helipterum* and related genera (Asteraceae: Gnaphalieae): Part 1. Nuytsia 8:378-438.