

## A review of the ecology of fleabane (*Conyza* spp.)

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**Summary** Fleabanes (*Conyza* spp.) are an increasing problem in annual summer crops in Australia. In this paper we review the available literature on the ecology of *Conyza* species in order to better understand the possible reasons for this recent increase. Aspects of germination, growth and development, seed dispersal, crop interaction and herbicide resistance are included. In addition we highlight research gaps in fleabane ecology for subsequent investigation of the species in Australia.

**Keywords** *Conyza*, germination ecology, weed ecology.

### INTRODUCTION

Fleabanes (*Conyza* spp.) are annual, exotic, herbaceous, invasive weeds of the Asteraceae family. There are seven *Conyza* species naturalised in Australia, with infestations of one or more species in every state and territory and climatic zone (Everett 1990). These species most commonly invade disturbed sites including roadsides, wastelands and crop edges. *Conyza bonariensis* (L.) Cronquist (flaxleaf fleabane), has the widest geographic distribution in Australia, tolerates a wide range of climates and habitats (Everett 1990), and is an increasing problem in summer fallows and crops such as sorghum and cotton. The objective of this paper is to describe the current understanding and research gaps of fleabane ecology.

### SEED PRODUCTION AND DISPERSAL

*Conyza* species are prolific seed producers. Flaxleaf fleabane has a range of reported total seed numbers per plant, up to 375,561 (Kempen and Graf 1981). *Conyza canadensis* (L.) Cronquist (Canadian fleabane) is reported to produce 200,000 seeds per plant (Weaver 2001). Seeds are dispersed within one or two days of capitula maturing, dependent on climate (Thebaud *et al.* 1996). Primary dispersal of fleabane seeds is via wind. There is no seed dormancy in *Conyza* with viability estimated as 1–2 years in the field (Weaver 2001).

### GERMINATION AND EMERGENCE

The temperature preferences for germination are between 10 and 25°C (Zinzolker *et al.* 1985); optimal temperature for flaxleaf fleabane was estimated at 20°C with a 4.2°C base temperature (Wu *et al.* 2007). A study by Nandula *et al.* (2006) demonstrated that a 24°C day and 20°C night temperature achieved the highest germination result in Canadian fleabane of 61% after 10 days.

The findings of light requirements for germination are mixed. Nandula *et al.* (2006) report that Canadian fleabane does not require light. Others report an absolute requirement for light (Zinzolker *et al.* 1985) including for flaxleaf (Wu *et al.* 2007). The length of any requirement for light has been debated, with Milberg *et al.* (1996) finding that Canadian fleabane can germinate with a total light exposure of five seconds.

Under sustained flooding conditions (14 days), there was a 50% reduction in the survival of Canadian fleabane (Stoecker *et al.* 1995). Conversely, water stress experiments showed 25% germination at 0 MPa reducing to 2% at –0.8 MPa (Nandula *et al.* 2006). Observations in the Australian landscape indicate that significant rain events stimulate emergence of fleabane (Wu and Walker 2004).

A limited amount of documented experimentation is available on the effect of soil type on germination. Wu *et al.* (2007) investigated burial depth impact on flaxleaf fleabane in heavy black vertosol and light sodosol soils. They found that no emergence occurred in the heavy soil, and only the minimal burial depth (0–2 cm) in the light soil produced emergence. Canadian fleabane had a higher rate of germination under neutral-to-alkaline conditions (Nandula *et al.* 2006). Soil temperature showed only a weak correlation ( $r^2 = 0.21$ ) with germination when tested with Canadian fleabane (Main *et al.* 2006).

Other ecological factors that affect fleabane germination include intraspecific competition and pesticides. Palmblad (1968) found the germination rate in Canadian fleabane was reduced with an increase

in intraspecific competition. The use of dimethoate, a phloem-feeding insect control, was also found to significantly reduce germination of Canadian fleabane (Gange *et al.* 1992).

The emergence of fleabane, favoured by mild conditions, is predominantly in autumn and early winter with limited emergence in spring. Within the northern grain region of Australia, *Conyza* species are reported to emerge all-year-round with active growth in spring and early summer.

#### FLOWERING

There is limited information available on flowering requirements. One molecular based study found that Canadian fleabane contained proteins similar to plants requiring vernalisation (Rudnoy *et al.* 2002). Flowering in flaxleaf fleabane is favoured by long photoperiods, such as 14 hours (Amsellem *et al.* 1993). Fleabane flowers sequentially within an individual plant and the flowering period can span 1–4 months (Thebaud *et al.* 1996). Flowers reproduce autogamously and are self-compatible. Documented effects of ecological factors on growth and development in fleabane are limited.

#### INTERFERENCE

Intraspecific and interspecific competition has been explored. Thebaud *et al.* (1996) reported that the ability to absorb and utilise both water and nutrient resources within a competitive environment was greater in *Conyza sumatrensis* (Retz.) E.Walker (tall fleabane) than Canadian fleabane. Furthermore, they found that tall fleabane established and persisted in previously cultivated fields (0–30 years) whilst Canadian fleabane was restricted to recently disturbed habitats (Thebaud *et al.* 1996).

Lavorel *et al.* (1999) showed that the impact of functional group composition (e.g. grasses, herbs or shrubs) of surrounding vegetation varied across life stages of flaxleaf fleabane and Canadian fleabane. Survival of fleabane increased with an increase in Asteraceae species richness. Biomass and reproduction decreased in the presence of higher annual grass species (e.g. *Avena sterilis*, *Bromus* spp. and *Lolium italicum*) richness but increased in the presence of annual legumes (Lavorel *et al.* 1999).

An investigation of the effect of cattle grazing on plant density in South East Queensland found that flaxleaf fleabane density increased with grazing whilst tall and Canadian had no significant increase or decrease (McIntyre *et al.* 2003). Neave and Tanton (1989) explored grazing effects of the grey kangaroo on grasslands in plots within the Australian Capital Territory, which showed that flaxleaf fleabane appeared only in plots that excluded kangaroos.

#### HERBICIDE RESISTANCE

Herbicide resistance has evolved within *Conyza* populations in several countries. The first recorded incidence of glyphosate resistance was in Canadian fleabane in Delaware in 1999 (VanGessel 2001). The mechanism of resistance in Canadian fleabane is believed to be that of reduced translocation (Feng *et al.* 2004), with glyphosate resistant populations estimated to be present on 44,000 ha in 12 states of the USA (Heap *et al.* 2005). Glyphosate resistance in flaxleaf fleabane was also reported in South Africa in 2003 (Heap *et al.* 2005). The development of resistance to glyphosate is of great concern to farmers, especially those that utilise glyphosate resistant crops and conservation tillage. Flaxleaf fleabane has also developed resistance to other herbicidal mode of action groups (L, C and B) in certain countries (Heap *et al.* 2005).

#### TILLAGE SYSTEM

*Conyza* is a relatively new and emerging weed of cotton systems, believed to have progressed as a result of a shift towards conservation tillage practices and reduced reliance on soil-applied residual herbicides. The viability and germination of *Conyza* species seed decreases with soil burial depth and therefore under minimal tillage, the fleabane seeds remain on or near the soil surface – the preferred germination site. In Australia, flaxleaf fleabane is the most prevalent *Conyza* species within dryland cropping systems and its increased incidence has increased the cost of fallow weed control (Wu *et al.* 2007).

In a reduced tillage system, crop residue remains on the soil. Canadian fleabane showed 77% less emergence after a cotton crop (with residue) compared with bare fallow (Burke *et al.* 2003).

#### CONCLUSION

It is evident from this review of literature that there have been no detailed comparisons of the ecology of the three main species of *Conyza* in Australia. This includes abiotic and biotic factors that affect the weed throughout its life stages. Such work is likely to reveal why flaxleaf fleabane is the most abundant in cropping in Australia, compared with the overseas experience where tall and Canadian fleabane are the most populous and problematic for agriculture, and help to identify weed characteristics that may be favoured by conservation farming systems in the future.

#### ACKNOWLEDGMENTS

We would like to acknowledge the Cotton Catchment Communities CRC and the Cotton Research and Development Corporation for funding this research.

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