Plant and seed population dynamics of *Emex*

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Summary

The population dynamics of *Emex* show that although seed germination can vary markedly from year to year, the total number of seeds in the soil pool remains very constant. Ungerminated seeds are likely to be dormant. Seedling mortality varies as does seed production per unit area, increasing with density.

The success of *Emex* is partly due to early seed production in the rosette and control measures should aim to prevent this. Long term control should also incorporate establishment of desirable replacement species.

Introduction

Control of spiny weeds such as *Emex* sp. has been attempted for many years by all the traditional methods of control - cultivation, use of competing species, herbicides and, in the last 15 years, biological control. However, it has been only in conjunction with the latter that detailed research has been conducted into the population dynamics of *Emex*. Such quantitative knowledge of the various stages in the life cycle should increase the chances of successful control.

However, control is made difficult by the fact that, even six weeks after seedling emergence, *Emex* can produce up to eight seeds in the middle of the rosette. These may be at the soil surface in doublegee, *Emex australis* (Steinh.) or buried in lesser jack, *Emex spinosa* (Campd.) (Weiss 1980). Ecologically, this represents a method of survival of the species against predators, unfavourable seasonal conditions or control methods after initial seed production. In addition, particularly in the case of the subterranean seeds, they are already in position in the soil in readiness for the next generation. Many more are produced on the stems at a later stage, particularly if favourable conditions ensue. The achenes enclosing these are spinier and are thus adapted for dispersal.

Soil seed pool

The total population of *Emex* in a given area can be divided into various categories, of which soil seed are an important part (Figure 1). At three sites in NSW and South Australia and over three years, the numbers in each category varied throughout the season in a year and from year to year (Weiss 1981). However, the total number was remarkably constant at a given site. The mean yearly germination as a percentage of viable seed was comparatively low (37%), indicating dormancy of the remaining seeds.

Indeed, more than 30% of seeds produced in one year can remain dormant in the soil for at least four years depending on factors such as depth of burial and moisture conditions (Gilbey and Weiss 1980).

Cultivation often brings the seeds closer to the soil surface where light and increased aeration stimulates germination. However, while this occurs with aerial seeds of *E. spinosa*, its subterranean seeds will germinate equally well in light or darkness (Weiss 1980).

Seedlings

Seedling emergence of *E. australis* can be very high (>500 m^{-2}), particularly after rainfall, cultivation and in the absence of competing species (Weiss 1981). However, subsequent seedling mortality is also high (a mean of 52% between emergence and flowering), particularly at high densities and in wet years. Fungal infection, insect attack and competition for nutrients and water all have potential for reducing seedling survivorship (Weiss 1977). The probability of mortality was significantly greater when plants had less than five leaves than in more established plants. There was also greater mortality of seedlings emerging after earlier accessions had become established.

A high seedling emergence reduces the soil seed pool but this is subsequently replaced after new seed production. Under unfavourable seasonal conditions, down to 15 seedlings m^{-2} yr^{-1} may emerge, leaving more seeds in a viable but ungerminated state in the soil.

Seed production

In common with many weeds, *E. australis* can produce a large number of seeds (more than 1100 per plant) (Weiss 1978). However, this depends on the growing conditions, time of emergence, density of plants and timing of any control methods. Most seed production arises from the earliest accession of seedlings each year.

Plasticity of growth is a notable feature in *Emex* so that high populations of seedlings lead to small plants with low seed production per plant. This can be compensated somewhat by a density dependent mortality of seedlings but in any case, seed production per unit area is usually directly proportional to mature plant density.

The imposition of stress on plants can arise also from various control measures e.g. reduction of leaf and stem area by a biological control agent or by competing plant species or interference with photosynthesis and respiration by herbicides. High stress conditions of very low soil volume reduced seeds per plant of *E. australis* down to 15 but this still presents a control problem.

With *E. spinosa*, under field conditions varying from harsh to favourable, mean shoot weights varied by some 27 times. Numbers of aerial (stem) seeds also varied by a factor of 27 but subterranean (rosette) seeds only by a factor of 1.4 (Weiss 1980). It thus appears that *E. spinosa* (and probably *E. australis*) have a capacity to buffer the effects of stress by diverting scarce resources into the initially produced rosette seeds.

Hybridization

The increasing prevalence of *E. spinosa* since it was first recorded in Victoria in 1975 (Weiss and Julien 1975) means that effective control measures need to be implemented as soon as possible. One of the reasons for this is that more than 50% of the progeny of *E. australis* grown from seed collected at Mer-

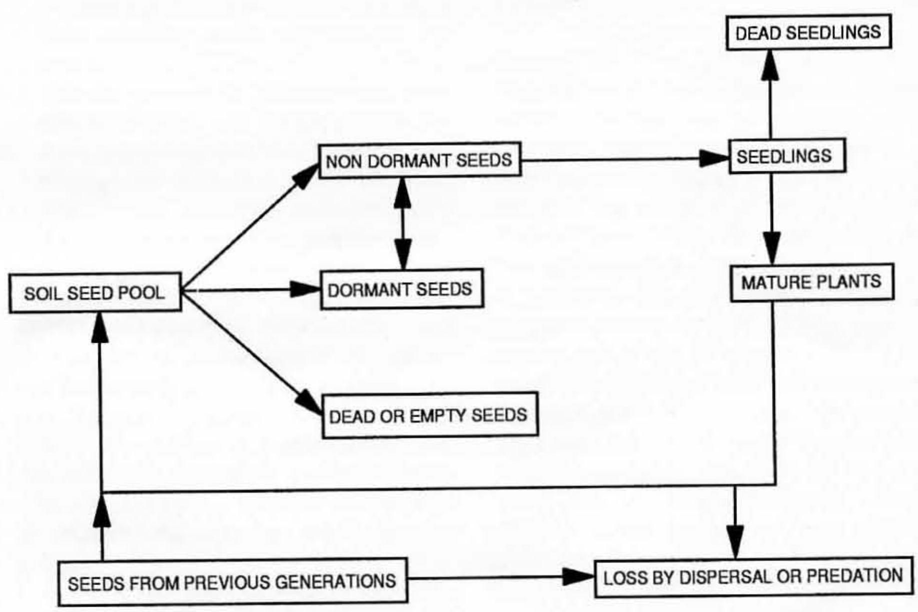

Figure 1. Stages in the Life Cycle of *Emex*

bein, where the two species co-occur, were interspecific hybrids (Putievsky *et al.* 1980). Although the hybrids were sterile when self-pollinated, they backcrossed readily to either parent to form viable seed. Thus, although subspecies variation is at present comparatively low (Weiss and Simmons 1979), introgressive hybridization could lead to the development of increased variation and make control more difficult.

Control

It is apparent that control methods such as cultivation or herbicides need to be used or biological control agents need to be active before the initial rosette seeds have formed. A biological agent affecting already formed seeds is unlikely because of the woody nature of the achene. A weevil, *Perapion antiquum* (Gyllenhal) which has already been released in the seventies, damages mainly the stems - after the rosette seeds have been produced (Gilbey and Weiss 1980). There is some leaf feeding but removal of even 75% of the area of each leaf has little effect on seed production (Weiss 1976).

The taller *E. spinosa* should at least be slashed to lessen the likelihood of its cross-pollinating *E. australis* and so to decrease the chances of hybrids proliferating.

If *Emex* is controlled effectively, competing species should be established, perhaps in the form of sod culture where this is feasible, to lessen the risk of invasion by other weeds or by *Emex* dispersed from other areas.

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Questions and discussion

Q. Vicki Bates. With your research at what stage in the growth of *Emex* did you commence defoliation?

A. The defoliation commenced at the start of the plants growth and continued throughout.

Q. Colin Roy. At what stage are viable seeds set?

A. Viable seeds can be set within six weeks of emergence. Plants ensure their long term survival by setting seed before stem elongation.

Q. Alison MacGregor. At what period of the year are most seeds produced?

A. The first cohort of the season produce the most seeds.

Q. Jim Hill. Do selective herbicides effect seed viability?

A. No.

Q. Dick Johnstone. Do we have a description of a plant that does not produce viable seed?

A. Yes. A plant that is less than six weeks old.