# COMPETITIVE EFFECT AND RESPONSE OF *EMEX AUSTRALIS* IN A GRAZED ANNUAL PASTURE

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*Summary*. Competitive relationships of *Emex australis*, *Trifolium subterraneum* and *Hordeum glaucum* were investigated experimentally using a neighbourhood design in a grazed pasture. Neighbourhoods of *Emex* had the smallest effect upon target plants of *Trifolium* and *Hordeum* (competitive effect), but of the three species, *Emex* targets suffered the greatest reductions in growth when grown in mixtures (competitive response). Since *Emex* was the least competitive species, we suggest that a) its impact in rotations could be reduced by sowing desirable plants into sparse first-year pastures and b) the effect of a biocontrol agent for *Emex* might be greatly enhanced in a competitive environment.

## INTRODUCTION

*Emex australis* Steinh. (henceforth *Emex*) is a major annual weed of pasture/crop rotations in southern Australia (Gilbey and Weiss 1980). One of its adaptations to this form of land management is an ability to accumulate large seed banks; seeds can survive for more than four years either on the soil surface or when buried (Cheam 1987). While a number of herbicides provide effective control of *Emex* in wheat and grain lupin crops, seed production is prodigious in the sparse pastures which follow cropping sequences, in part owing to the absence of a reliable selective herbicide for controlling *Emex* in pastures (Gilbey 1976). Without effective control, enough seeds can be produced during the first year of pasture to ensure the predominance of *Emex* throughout the remainder of the rotation (Gilbey 1976; Gilbey and Lightfoot 1979). One possible method for damping this seed production cycle would be to resow the annual grasses and legumes whose seed banks are progressively depleted during the cropping phase of the rotation (Reeves 1987; Taylor and Ewing 1988). The success of this approach would depend largely upon the relative competitiveness of *Emex*, particularly under conditions of grazing. This paper describes the competitive relationships between *Emex* and two other annuals (*Trifolium subterraneum* L. and *Hordeum glaucum* Steud., henceforth *Trifolium* and *Hordeum*) in a pasture naturally dominated by these species and grazed by sheep.

## METHODS

The study was conducted in a fifth-year pasture, set stocked at 5 D.S.E./ha, on a sandy loam soil at Wongan Hills Research Station (approximately 200 km north-east of Perth). On 27 April 1989, two weeks after the first germination flush of the growing season, an area 24x24 m was cultivated to a depth of 5 cm. Seeds of either *Emex*, *Trifolium* or *Hordeum* were then hand broadcast along single 8x24 m subplots and lightly incorporated.

Competitive relationships within individual species and in pairwise combinations of the three species were investigated with a neighbourhood design described by Goldberg and Werner (1983). Individual neighbourhoods were established on 17 May 1989. For both single species and pairwise combinations, PVC rings (15 cm diameter and 2 cm deep) were centred upon a nominated target individual, pressed into the ground and anchored with tent pegs. Neighbouring plants were thinned so that either 0, 2, 4, 8 or 12 individuals remained, corresponding to total (including target plant) densities of 56, 157, 278, 501 and 723 plants/$m^2$. Three replicates were set up at each density.

Top growth of target and neighbour plants was harvested on 29 September 1989. Following oven-drying, weights were obtained of the target plants and the combined neighbours from each neighbourhood. Target plant performance was assessed over the range of density and biomass of each neighbour species by fitting linear regressions to transformed ($log_{10}$ and square root) data. Competitive effects were compared among neighbour species by utilizing a *t*-test for slopes of the linear regressions. A second method for comparing the competitive effects among neighbour species and competitive responses among target species consisted of averaging the target plant weight of a species over all non-zero neighbour densities, then expressing this average as a percentage of the mean value for isolated (competition-free) plants.

## RESULTS AND DISCUSSION

While both log and square root transformations succeeded in linearizing the data, the latter transformation almost always yielded higher $r^2$ values for fitted regressions. When reciprocal comparisons of competitive effect were made within pairs of species, only two significant differences were detected. One was the greater ($t$ = 1.82; df = 24; P = 0.05) slope of the regression of *Emex* target biomass on *Hordeum* neighbour density, compared to the regression fitted to *Hordeum* target biomass on *Emex* neighbour density (Fig. 1). This difference indicated that *Hordeum* had a greater per individual competitive effect on the target than did *Emex*. The second significant difference lay in the reciprocal comparisons between *Emex* and *Trifolium*, where the latter species had a greater ($t$ = 2.79; df = 26; P = 0.005) per gram competitive effect (Fig. 2). However, this difference may have been an artefact of the method of sampling; had roots been harvested as well, the disparity between the ranges of total neighbour biomass for *Trifolium* and *Emex* (Fig. 2) might have been smaller.

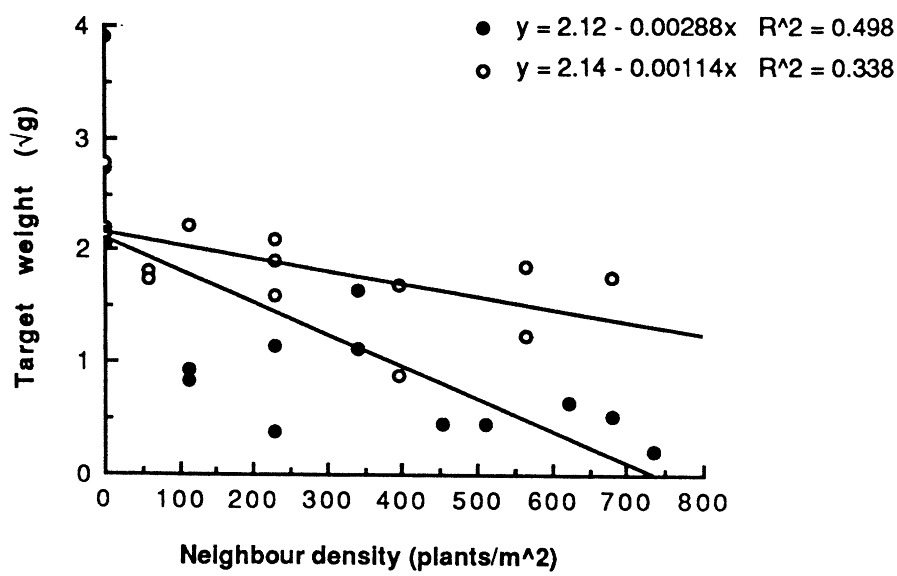


Figure 1. Regressions of target plant biomass on neighbour density. ( ● ) *Emex* target, *Hordeum* neighbour, ( O ) *Hordeum* target, *Emex* neighbour.

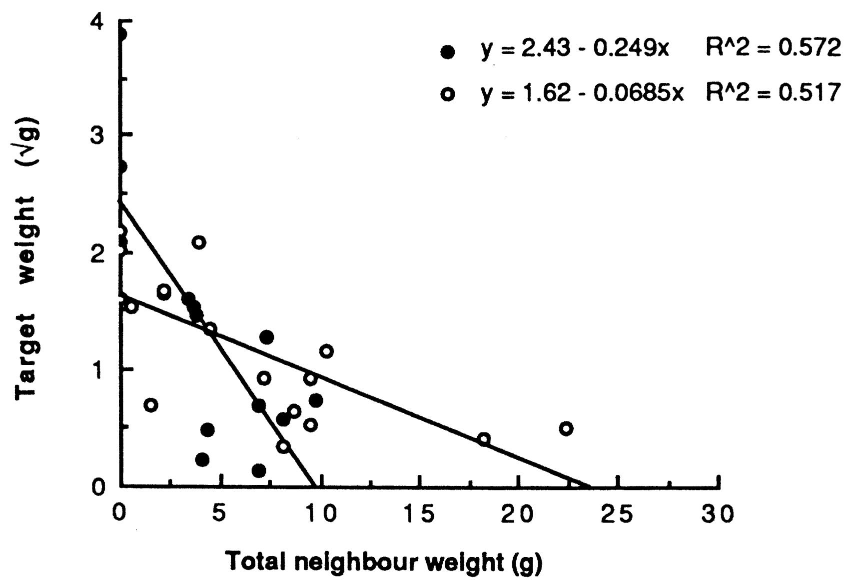


Figure 2. Regressions of target plant biomass on total neighbour biomass. ( ● )*Emex* target, *Trifolium* neighbour, ( O ) *Trifolium* target, *Emex* neighbour.

When target weights were expressed as percentages of the mean weights of isolated plants, a significant overall competitive effect (rows) was detected only in the case where *Hordeum* was grown with various neighbour species. The rankings of the three neighbours in relation to the reduction of target weight.were generally in the order of *Hordeum* > *Trifolium* > *Emex* (Table 1). All competitive responses (columns) were highly significant (P = 0.01). The rankings of the three species in terms of competitive response were *Emex* >*Trifolium* > *Hordeum*. Thus the rankings of competitive effects and responses were complementary; *Emex* showed the weakest effect and the strongest response.

Table 1. Comparison of competitive effects among neighbour species and competitive responses among target species averaged over all neighbour densities > 0. For each target species, weight is expressed as a percentage of the mean value for isolated plants. Values are means ± s.e. For within-column comparisons (among targets), values with the same letters are not significantly different by a Mann-Whitney *U*-test (P = 0.05). * P = 0.05; ** P = 0.01.

| | Neighbour species | | | |
|---|---|---|---|---|
| Target species | *Emex* | *Trifolium* | *Hordeum* | Kruskall-Wallis $X^2$ (d.f. = 2) |
| *Emex* | $19.5 \pm 6.32^{a}$ | $13.1 \pm 3.61^{a}$ | $8.25 \pm 2.64^{a}$ | $2.43^{ns}$ |
| *Trifolium* | $32.5 \pm 9.24^{ab}$ | $20.5 \pm 3.15^{ab}$ | $15.0 \pm 3.44^{b}$ | $2.38^{ns}$ |
| *Hordeum* | $53.2 \pm 6.13^{b}$ | $33.2 \pm 3.90^{b}$ | $38.9 \pm 13.7^{c}$ | 8.35* |
| Kruskall-Wallis $X^2$ (d.f. = 2) | 9.27** | 10.8** | 12.3** | |

The competitive rankings of these three species could be expected to be affected by the degree to which they were grazed. Detailed measurements of the defoliation of *Emex* indicated that approximately 80% of marked plants were defoliated between 4-8 weeks following emergence. However, only 30% of leaves on offer were removed at the time of heaviest grazing and levels of leaf removal dropped markedly as the season progressed (Panetta and Randall, unpublished data). While the degree of defoliation of *Trifolium* could not be distinguished from that of *Emex* on the basis of casual observation, *Hordeum* individuals appeared to be defoliated severely and regularly, especially in the early part of the growing season. Hence the species which was most heavily grazed was also the one which exhibited the greatest competitive effect and least competitive response (Table 1).

The results from this study suggest that the impact of *Emex* within pasture/crop rotations could be lessened by sowing mixtures of grass and legume seed into otherwise sparse first-year pastures. Since *Emex* is a relatively weak competitor, not only is its seed production decreased in the presence of other pasture species (Panetta and Randall, unpublished data), but the implementation of biological control would appear most feasible in a competitive environment (Burdon *et al.* 1981). Owing to certain undesirable characteristics of *Hordeum* spp., assessment of the relative competitiveness of other annual grasses, in particular *Lolium rigidum*, is required.

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REFERENCES

1. Burdon, J.J., Marshall, D.R. and Groves, R.H. 1981. Proc. 5th Int. Symp. Biol. Contr. Weeds, Brisbane. pp. 21-29.
2. Cheam, A.H. 1987. Aust. J. Exp. Agric. 27, 101-106.
3. Gilbey, D.J. 1976. Working Papers. 5th Aust. Weeds Conf., Melbourne. pp. 2(a) 24-25.
4. Gilbey, D.J. and Lightfoot, R.J. 1979. J. Agric. W. Aust. (Series 4) 20, 21-23.
5. Gilbey, D.J. and Weiss, P.W. 1980. J. Aust. Inst. Agric. Sci. 46, 221-228.
6. Goldberg, D.E. and Werner, P.A. 1983. Amer. J. Bot. 70, 1098-1104.
7. Reeves, T.G. 1987. In: Temperate Pastures - Their Production, Use and Management. (Eds J.L. Wheeler, C.J. Pearson and G.E. Robards) (Australian Wool Corporation/CSIRO: Melbourne). pp. 501-515.
8. Taylor, G.B. and Ewing, M.A. 1988. Aust. J. Exp. Agric. 28, 77-81.