Experimental increases in diversity and evenness improve productivity and reduce weed invasion in grassland swards over three years across 12 European sites

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Key words: diversity-function, evenness, persistence of diversity effects

Introduction Increased emphasis on the multifunctionality of European agriculture has called for a re-investigation of the use of mixtures in productive grasslands. Ecological research suggests that increased species diversity in species-poor intensive grassland systems may potentially provide multiple benefits. We present results from the COST 852 multisite Agrodiversity Grassland Experiment, where we test a number of basic questions in agronomic diversity-function research. It was hypothesised that (1) mixtures can outperform monocultures both in terms of productivity and weed suppression (2) the diversity benefits will be persistent through time (3) the diversity benefits will be consistent across a wide geographical scale.

Materials and methods A common experiment was established at 35 sites across Europe and Canada. At all sites, mixtures consisted of two legumes and two grasses. Using a simplex design (Cornell, 2002), 15 experimental communities were sown with varying levels of evenness and the design was repeated at two levels of overall initial abundance. Communities were monocultures, mixtures dominated in turn by each species, mixtures dominated in turn by pairs of species or communities with each species equally represented. For estimation of yield at each harvest, a subplot ($\geqslant 3m^2$) was harvested to a height of 5 cm. Total above-ground biomass for the first three years after sowing and the weed component of that biomass were analysed for 12 sites that used the same mid-European (ME) species (Figure 1). Average monocultures and mixtures were compared in a combined random coefficients repeated measures analysis across the 12 sites. This allowed us to assess whether, in general, mixtures outperformed monocultures across the three years.

Figure 1 *Location of 12 sites that used the mid-European species.*

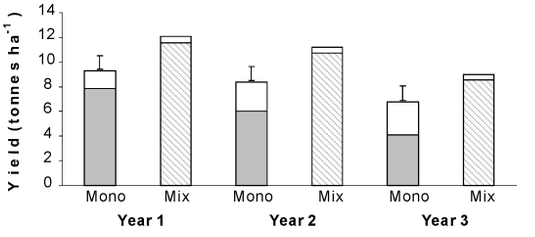

Figure 2 *Average yield of sown (shaded) and unsown (white) species in mixtures (mix) and monocultures (mono) for three years across 12 European sites.*

Results In each of the three years, the average yield of mixtures was greater than the yield of monocultures (Figure 2). While the average weed component of the monocultures increased from 15% in year 1 to 40% in year 3, weeds made up only around 5% of the total yield of the mixtures. By the third year, the average yield of the sown species in mixture was more than double that in monoculture.

Conclusions In Kirwan et al., (2007) we showed that in the first harvest year for 28 sites, there was a positive effect of diversity on productivity and that the effect was related to the evenness of the mixture. Here we show that for 12 of the sites, the diversity benefit persists into the third year both in terms of productivity and resistance to weed invasion. The diversity effect was consistent over a large range of environmental conditions, thus adding generality to our findings. The diversity effect was much greater than expected from previous studies and in the first year the diversity benefits were not only due to a legume effect; the positive interaction between two grass species and two legume species was as strong as that between a grass and a legume (Kirwan *et al.*, 2007).

References

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