Plant genetic vs. trait diversity: impacts on weed community assembly

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Introduction

A key research challenge in both plant ecology and crop production is to understand the role of biological diversity in regulating functions such as productivity.

We have an improving understanding of the roles of species diversity, but our understanding of the function of genetic diversity is weaker.

Plant traits are key in regulating ecosystem functions. Genetic diversity may be important only as it regulates trait variation. In this sense there may be nothing "special" about genetic or species diversity in regulating ecosystem function: they might only represent different drivers of trait variability.

- If we change genetic diversity without changing trait variability, do we see any response of ecosystem functions?
- Is this effect direct, or mediated through complex interactions within the community?

Methods

We built synthetic communities of mixed barley cultivars which varied in both genotypic and phenotypic (trait) diversity:

- 3 barley phenotypes (dwarf + erect leaves, semi-prostrate + short + planophile leaves, tall + planophile leaves); 2 genotypes per phenotype.
- Barley mixtures ranged from 1-6 genotypes and 1-3 phenotypes, including all combinations
- 3 replicate blocks, each of thirty 2 m x 1.5 m plots, sown April 2016; harvested August 2016
- No herbicide treatment: allowed impacts on weed community to be assessed

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The Scottish Government

Results

1. Barley biomass - impact of barley phenotype and genotype (nested within phenotype) (+ barley plots only)

Factor	DF	F	P
Intercept	1,76	23941.980	<0.0001
Phenotypes	1,76	0.266	0.6072
Genotypes(Phenotypes)	1,76	0.577	0.4497

Message: Phenotypes and genotypes do not impact on barley mass

2. Richness of common weeds - impact of barley presence, genotype and phenotype richness

Factor	DF	F	P
Intercept	1,84	1661.330	<0.0001
Barley (+ or -)	1,84	0.002	0.9634
Phenotypes	1,84	11.401	0.0011***
Genotypes(Phenotypes)	1,84	0.638	0.4265

Increasing phenotype richness has a negative effect on common weed species richness

3. Barley biomass - impact of weed species richness (+ barley plots only)

Factor	DF	F	P
Intercept	1,75	671.655	<0.0001
Weed richness	1,75	10.594	0.0017***
Phenotypes	1,75	0.455	0.5020
Genotypes(Phenotypes)	1,75	0.398	0.5302

Common weed species richness is positively associated with barley biomass (Figure 1)

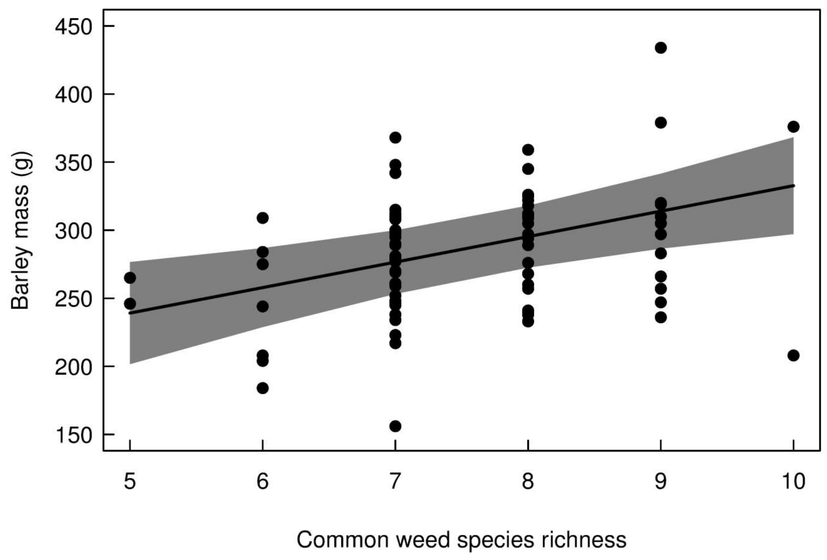

Figure 1 Relationship between common weed species richness and barley mass. Dots show values for individual plots, and the line the fitted regression line (with associated 95% confidence limits indicated by the shaded grey zone).

Conclusions

- Once phenotypic diversity is accounted for, genetic diversity of a dominant species (i.e. barley) had no impact on a key ecosystem function (crop productivity).
- Phenotypic diversity of barley negatively affected common weed species richness.
- Weed species richness was positively associated with increased barley biomass, but we need to understand whether this effect is causal or correlative.
- Our results indicate that especially in low intensity farming systems, or those seeking to reduce herbicide usage, high crop yields do not have to come at the expense of diversity.