The role of crop genetic diversity in determining plant community resilience to experimental drought

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Introduction

Crop-based systems provide testing grounds for fundamental ecological processes. At the same time, lessons from ecology can contribute to the development of more sustainable crop systems. There is increasing interest in the agricultural sector in the possible benefits of enhancing crop diversity – for example through mixed cultivar or mixed crop systems – for system sustainability. This includes long-term sustainability, which in part is delivered through the resilience of the system to environmental extremes. By exploring such processes in crop systems, we increase our understanding of how they might function in natural or semi-natural ecosystems.

Method

In small mesocosms we constructed synthetic crop plant communities, including a standard set of common arable weeds. We manipulated:

- Diversity of barley genotypes - giving communities with 1, 2 or 3 genotypes.
- Drought – rain shelters were used so that half of our mesocosms received reduced water throughout the growing season (50% of ambient).

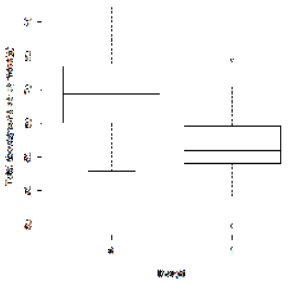
We examined the response of barley and weed biomass, and of barley aphid infestation, using linear mixed effects models (with shelter as a random effect).

Results

For simplicity we show here only the effects of genetic diversity and drought.

Total above ground barley biomass

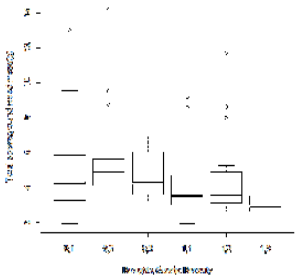
	DF	F	P
Drought	1,53	100.63	**<0.001**
Barley genotype diversity	2,53	0.344	0.711
Drought * Diversity	2,53	0.001	0.999



Message: Drought reduces total barley biomass with no influence of genotype diversity.

Total above ground weed biomass

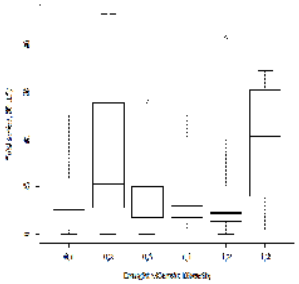
	DF	F	P
Drought	1,53	7.940	**0.006**
Barley genotype diversity	2,53	4.230	**0.012**
Drought * Diversity	2,53	0.417	0.612



Message: Drought and barley genotype diversity reduce weed biomass; barley genotype diversity effects are consistent under both levels of water availability.

Total aphids, July (square root transformed)

	DF	F	P
Drought	1,53	0.384	0.538
Barley genotype diversity	2,53	0.559	0.575
Drought * Diversity	2,53	4.603	**0.014**



Message: There is a complex interactive effect of drought and barley genotype diversity on aphid abundance. Under drought the high barley diversity treatment appears to have a higher aphid load.

Conclusions

- Increasing genetic diversity may help increase resilience of ecosystem functions to environmental extremes such as drought, but our results indicate that its effects can cut both ways.
- High crop diversity maintained a suppressive impact on weeds under drought conditions, despite reduced aboveground crop biomass (suggesting competition is belowground).
- But high crop diversity appears to have enhanced aphid abundance under drought.
- The overall effect of genetic diversity - in terms of delivering resilience to extreme conditions such as drought - is clearly a complex combination of these underlying positive and negative effects.

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