Developing Agroforestry-Adapted Cereals Using an Evolutionary Plant Breeding Approach

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INTRODUCTION

Within northern temperate regions, the main limiting resource for plants is usually light, and studies have shown that shading has reduced yields in temperate agroforestry systems. The impact of trees on crop yields has also been identified by arable farmers as a key management challenge of silvoarable agroforestry (Smith *et al*,. 2014). One approach to developing agroforestry-adapted crops is the use of **evolutionary plant breeding** to develop Composite Cross Populations (CCPs) that are particularly well adapted to growing in close proximity to trees.

Wheat **Composite Cross Populations** are created by crossing several varieties and developed by iterative natural selection on-farm and characterised by very high genetic diversity in the field (Fig. 1).

Figure 1: Composite cross population shows variability of plant height in the field (Photo: N. Fradgley)

High genetic variability within the crop is predicted to support increased yield stability in comparison to genetically uniform monocultures, and this stability has been documented for wheat CCPs in a number of studies (Wolfe, 2000; Wolfe, 2001; Döring *et al.,* 2010).

Hypothesis

In **silvoarable systems,** it is proposed that increasing the genetic variability within the cereal crop should help to buffer against variations in biotic and abiotic conditions present in the crop alley.

Experimental approach

In 2014, a spring wheat composite cross population (CCP) was grown in plots across a 10m crop alley at Wakelyns Agroforestry, an organic silvoarable system in eastern England. Plots of bulk CCP were harvested separately from plots on either side of the alley and the alley centre. In 2015, this seed was used in a replicated cross-over trial to test the effect of the population adapting under natural selection to each environment.

METHODS

Site: Wakelyns Agroforestry organic silvoarable system, 10m alleys with hazel SRC, East Anglia, UK
Year: 2015
Field trial set up: 3 replicates, replicated cross-over design
Plot size: 1.2m by 10.2m
Entries:

- East of trees population (EOT);
- West of trees population (WOT);
- Centre of alley population (COA)

Assessments: grain yield (t/ha);
hectolitre weight (g);
thousand grain weight (TGW).

Figure 2. Field trials in the organic silvoarable system at Wakelyns Agroforestry (Photo: N. Fradgley)

RESULTS

- Significant effect of location on yield and hectolitre weight, with crop yields at the edges of the alleys roughly half what they were in the centre of the alley (Fig. 3)
- No significant difference between different populations for any of the yield parameters
- No significant interactions between the populations and their locations.

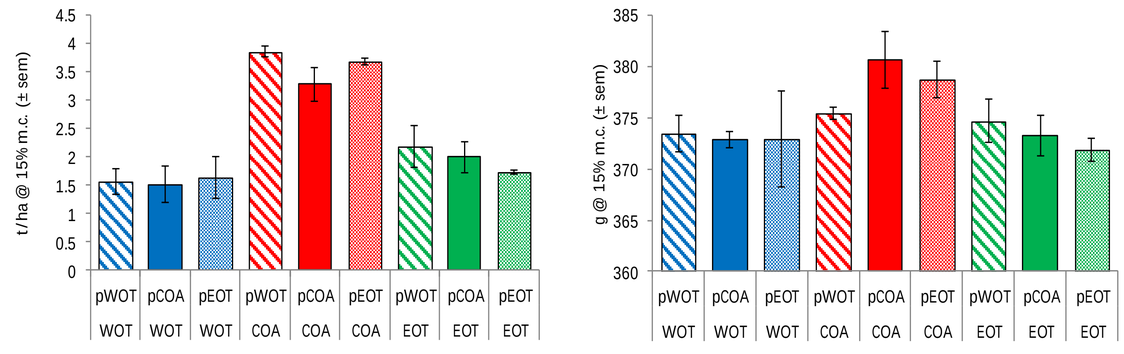

Figure 3. The mean grain yield (left) and mean hectolitre weights (right) of three composite cross populations (pWOT, pCOA and pEOT) in three positions (West of Trees WOT; Centre of Alley COA; and East of Alley EOT) across a 10m wide alley.

CONCLUSIONS

- No major interactions between populations and location suggests that, in this first year, there is no evidence of adaptation to alley location.
- It may be necessary to carry out more detailed selection of high performing individual plants by hand, which are then bulked up, to develop specific 'alley edge' populations for agroforestry.

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