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Category: Research: Project Summary

Key words: wheat, breeding composite cross populations, mixtures, yield, quality, John Innes Centre

Project Title: Generating and evaluating a novel genetic resource in wheat in diverse environments



Short Title: Wheat Breeding

Project Code: AR 0194

Project Leader: Prof. Martin Wolfe, Elm Farm Research Centre

Project Partners: Prof. John Snape, John Innes Centre

Start Date: November 2001

End Date: November 2007

Funder: Defra

Key Words: wheat, breeding composite cross populations, mixtures, yield, quality, John Innes Centre

EFRC Programme: Cereals

Project Aim: The principal objective of the project is to develop composite cross populations of wheat based on a wide range of key parent varieties. The parents will be selected partly on past knowledge of successful performance in terms of yield, quality and disease resistance and partly on the basis of molecular ancestry to try to ensure as wide range of diversity as possible. Following parental inter-crossing in all possible combinations, progeny population samples will be exposed to a range of widely different agricultural environments and systems through several seasons of, largely, natural selection. Performance of the population samples will be compared at different stages against both the parents grown as pure stands and as physical mixtures.

Abstract of Research: The potential for the adaptation of wheat to UK environments has been constrained by the framework of the pedigree selection method that has dominated plant breeding for a century. Pedigree breeding evolved as a method of selecting and fixing specific genotypes, which has clear advantages of simplicity and stability. However, the relatively limited number and range of true-breeding genotypes that are produced lack the ability to adapt to different and changing environments. There has been a tendency, therefore, to select for single genotypes that have broad adaptation or, in other words, to select against genotype x environment interaction. Because of the wide range of environments even within the wheat-growing area of the UK, pedigree line breeding may have thus imposed limits on the performance of wheat, particularly with respect to environmental buffering, thus increasing the need for synthetic inputs.

The research will therefore address the DEFRA ROAME A objective by identifying traits or sets of traits that determine or improve adaptation of wheat to the range of UK arable environments, production systems and markets. The principal objective of the project is to develop composite cross populations of wheat based on a wide range of key parent varieties. The parents will be selected partly on past knowledge of successful performance in terms of yield, quality and disease resistance and partly on the basis of molecular ancestry to try to ensure as wide range of diversity as possible. Following parental inter-crossing in all possible combinations, progeny population samples will be exposed to a range of widely different agricultural environments and systems through several seasons of, largely, natural selection. Performance of the population samples will be compared at different stages against both the parents grown as pure stands and as physical mixtures.

The research will deliver a unique insight into the evolution of a genetically diverse wheat population in a diverse range of environments. This will provide information on the characters of winter wheat that confer improved performance within each environment. From inclusion of production environments (including organic), it should be possible to determine key characters and ideotypes that contribute to successful production under these different systems. Population material from the project will provide a valuable genetic resource for breeders and growers and samples will be lodged in the gene bank at the John Innes Centre.

Objectives: To increase the sustainability and competitiveness of both non-organic and organic farming systems by developing genetically diverse wheat populations that will respond rapidly to on-farm selection for improved productivity and yield.

1. To generate six distinct, highly heterogeneous composite-cross populations of winter wheat for further development and selection. The populations will comprise; one with parental material selected for good milling potential, one with parents selected for high yield potential and one comprising both sets of parent material. Each of these populations will then be split to either include or exclude heritable male sterility.
2. To evaluate the performance and evolution of composite-cross populations over time under a diverse range of environmental conditions and identify characteristics that confer improved productivity in these environments.
3. To track the genetic changes that accompany selection, so providing a better understanding of the assemblages of traits that underlie improved productivity in diverse environments.
4. To provide genetically diverse crop material for further selection by farmers and as a resource for future publicly funded research.

To disseminate the results to the scientific community and industry

Expected Benefits: It is anticipated that the winter wheat composite cross populations produced by this project will offer significant agronomic advantages over existing varieties for organic farmers. This will result in improved productivity in organic systems. Also, the resulting information on the characters of wheat that confer improved productivity under a wide range of environmental conditions will be of benefit to plant breeders for the re-direction of non-organic agriculture to reduced pesticide usage. This would clearly have major environmental benefits. Both of these benefits will assist DEFRA in realising its policy objectives.

Output:

- Annual Report- 2002
2003
2004
- Welsh, J., M. S. Wolfe, J. Snape, L. Fish and B. Pearce, 2003, Generating and evaluating a novel genetic resource in wheat in diverse environments. Poster for IFOAM conference 2003.
- Wolfe, M. S. W. and S. P. Phillips, 2004, Breeding options and their future for organic production. A presentation for ABACUS
- Phillips, S. and M. S. Wolfe, 2004, Plant breeding for agricultural diversity. A Presentation for COR conference 2004.

- Phillips, S. and M. S. Wolfe, 2004, WG5 Plant-disease complex interactions: An interpretation of the word complex in low-input systems. A presentation for COST 860.
- Phillips, S. L. and Wolfe, M. S., 2004, Plant Breeding For Agricultural Diversity. COR conference paper 2004.
- Wolfe, M. S., S. Phillips, J. Snape and L. Fish, 2004, AR0914 Generating and evaluating a novel genetic resource in wheat in diverse environments. Presentation for COST 860 2004.
- Wolfe, M. S., 2004, Designing Crops for Variable Environments. Presentation for BCPC conference 2004.
- Wolfe, M. S., 2004, Designing Crops for Variable Environments. Paper for BCPC conference 2004.
- Wolfe, M. S., 2004, Ecological Cropping Systems – An Organic Target. COR conference paper 2004.
- Jones, H., K. Hinchliffe, S. Pepler and M. S. Wolfe, 2005, Evolutionary Breeding of Wheat for Low Input Systems. Poster for Cost 860 meeting, January 2005.
- Phillips, S. L and Wolfe, M. S. (2005) Centenary review: Evolutionary Plant Breeding For Low Input Systems. *Journal of Agricultural Science* **140**, 1-10.