Wheat LINK: Sustainable production of organic wheat.

Start and end date of the project: 1/10/2005 – 30/09/08

Background and objectives

A major obstacle in the development of organic farming in the UK is the problem of winter wheat production. At present, there is still a substantial gap between the supply of home-grown organic milling wheat and demand, partially due to variability and shortfalls in wheat yield and quality. To find ways of improving yield and quality of organic wheat this project pursued an ecological approach by studying potential interactions among appropriate varieties and various farm management practices, including seed rates, drilling systems, weeding, and the inclusion, or not, of legume undersowing. Specifically, the objectives of the project were -

1. To determine the **best spatial arrangement** for wheat and for wheat-clover undersown systems for cereal productivity.
2. To determine the **best seed rate** to optimise cereal productivity of wheat and for wheat-clover undersown systems.
3. To compare a common conventionally bred **variety** of wheat with a variety bred for low input systems and with a population from composite crosses, in undersown systems.
4. To determine the **stability** of wheat varieties bred for low input and high input agricultural systems, and a composite cross population relative to environmental variability.
5. To compare **undersowing** for weed and nitrogen management with mechanical weeding.
6. To determine the most **economically** viable system for organic wheat production.
7. To **disseminate** the project developments and final results widely in the farming community and associated industries in the arable chain.

Methods and results

Multi-factorial field trials were conducted on three organic farms over three years Selected parameters were tested for their response to the trial factors, including grain yield, yield components (e.g. germination rate, survival rate and thousand grain weight), foliar diseases, roots, and grain quality for milling (e.g. protein content and Hagberg Falling Number).

Overall, row spacing, seed rate and variety were the most influential factors, whereas undersowing and weeding did not have strong effects on the response parameters. The high seed rate (250 kg/ha) gave higher yields than the low seed rate (150 kg/ha). However, the analysis of yield components revealed that plants sown at the high seed rate lost a substantial proportion of their yield potential over the growing season. This effect was mitigated when plants were spaced more evenly, i.e. higher yields were observed in narrow than in wide rows. This suggests that competition among wheat plants played a major role in determining grain yield, and that minimising such competition by means of more equal spacing forms a key tool for organic wheat growing. Choice of variety had the greatest impact on grain quality. Therefore, good availability of information on variety performance under organic conditions is a crucial element for successful organic wheat growing. Composite cross populations showed a tendency for increased yield stability among and within trial sites.

Interactions among studied factors were relatively rare and were not consistent across sites and years. This indicates that the main effects of year, location, variety and various farming practices may often be more important than the complex interdependencies among these factors. Thus, sources of variability in organic wheat performance are either unpredictable (e.g. weather), or known and controllable (e.g. seed rate). In contrast, complex interactions of farm management practices, which are potentially

controllable but often unknown, are not expected to play a major role for determining wheat performance. A major step towards coping with unpredictable factors is expected from using composite cross populations, which offer higher resilience against environmental variation than pedigree varieties and are currently being tested in a further Defra funded project (LK 0999).

Benefits to the food chain and the environment

The project has flagged up key areas for the improvement of wheat yield and quality under organic farming conditions in the UK. These areas are the choice of variety, sowing density and row spacing. In addition, the project has shown that multiple interactions among farming management factors do not play a very large role in determining wheat yields. This means that by focussing on the main factors (variety, sowing density etc.), progress in wheat growing can be made relatively quickly for a wide range of farming conditions. It will therefore help growers and breeders in the UK to address the current shortcomings in organic wheat production. Furthermore, the project has helped to develop a range of wheat populations with a potential for high adaptability and buffering capacity against environmental variability. These wheat populations are therefore likely to be a contribution to higher resilience of wheat growing in a changing climate.

The development of appropriate new systems based on inter-cropping wheat with clover should have a wide range of environmental benefits. These include a potential reduction in the use of fossil fuels, largely through reduced cultivations and weed control; increased levels of carbon sequestration, particularly at higher densities of inter-cropping; benefits for biodiversity among macro- and micro-organisms; and improved soil structure. While the project did not show any consistent effects of intercropping on wheat yield or quality, it could still help to encourage growers to pursue these systems for more sustainable cereal growing.