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Sustainable Production of Organic Wheat

The aim of this project is to assess the effects of seed rate, drill arrangement, variety and clover bi-cropping of wheat grain quality and quantity, doing so in a way that highlights any interactions among these different aspects.

Project code: WheatLINK

Project leader: Elm Farm Organic Research Centre

Project partners:

Research

EFRC: Prof Martin Wolfe
Scottish Agricultural College (SAC): Dr Christine Watson

Industry

Claydon Yieldometer Ltd.: Mr Alan Claydon
Grain Farmers PLC: Mr Andrew Trump
Norton Organic Grain Ltd.: Mr Nigel Gossett
Organic Arable Marketing Group (OAMG): Mr Andrew Trump
Organic Farmers and Growers (OF&G): Mr Richard Jacobs
Organic Food Federation (OFF): Mr Julian Wade
Progressive Farming Trust: Ms Pat Walters
SAC Commercial: Mr David Younie
Scottish Organic Producers Association (SOPA): Mr Donald Watson
Sheepdrove Organic Farm (SOF): Mr Keith Preston
Soil Association (SA): Ms Helen Browning
Soil Association Certification Ltd. (SA Cert): Ms Helen Browning
Wakelyns Agroforestry: Prof. Martin Wolfe

Start date: 1st October 2005

End date: 31st December 2008

Funder: Sustainable arable LINK project (Defra)

EFRC Programme: Cereals

Project aim:
The main aim of the project is to use an ecological approach to analyse the interactions of a range of key variables in organic wheat production (wheat genotype, spatial arrangement of seed and seed density) including the major factor of wheat/white clover inter-cropping, so as to determine an optimal approach to improved and stabilised production.

Abstract of research:
Conversion to and development of organic farming in the UK is hindered by the central problem of winter wheat production, which is low in both yield and quality. Demand for organic wheat is high, and increasing, but the supply of home-grown milling wheat fulfils less than one third of this demand. Critical deficiencies are a lack of appropriate varieties and inadequate information on basic field establishment criteria for those varieties that are suited to organic production. There is also a need to improve nitrogen supply to wheat crops during both early stages of development and grain establishment. Recommendations are needed in these directions not only to improve yield and quality but also to provide adequate buffering against environmental variation.

The main objective therefore is to undertake a multifactorial analysis of different wheat genotypes, with or without clover bi-cropping, planted at different seed rates in a range of different spatial patterns. This will allow a comparison of weed management and nutrient flow through bi-cropping or mechanical control and an overall assessment of environmental stability of the optimal system.

Rapid and widespread dissemination of the outcomes will encourage existing and new producers to modify their own systems towards improved production and quality. Potentially, this could have a major impact not only in relation to import substitution but also environmentally, and for farmer and consumer assurance.

Organic farming has been, and should be regarded as a form of ecological farming, making optimal use of interactions among plants, soil and other factors. However, previous work in this area has tended to examine parts of the problem, e.g. seed rate, in isolation as single factors. It is essential, however, that as many relevant factors as possible should be analysed together in order to understand the interactions among the components. Here, we are using the LINK system to integrate the experience of EFRC in organic production with expertise offered by SAC in the management of soil nutrients and with innovative Claydon Yieldometer machinery for strip drilling of cereals for cereal yield optimisation.

The work plan is divided into seven integrated work packages. The first, overarching package is the central field trials at two sites over three years, and an additional site in 2 years which integrates variety choice, seed rate and four spatial arrangements, with or without clover bi-cropping. The next three work packages evaluate the main

component effects (variety, seed rate and spatial arrangement) including the question of varietal stability. The fifth work package will focus on the comparison of weed management and nutrient flow by the use of the clover bi-crop versus mechanical weeding. The sixth work package will evaluate the relative economics of the major options. The seventh work package is a major dissemination exercise covering all aspects from science to farming to public awareness of the main issues.

Objectives:

1. To determine the best spatial arrangement for wheat and for clover-wheat bi-crop systems for cereal productivity.
2. To determine the best seed rate to optimise cereal productivity of wheat and for clover-wheat bi-crop 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 bi-cropping 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 bi-crop 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.

Expected benefits:

The proposed work will determine:

- The interactions among a range of key components involved in the establishment of organic wheat crops under a range of environmental conditions;
- The optimal drilling arrangement, including precision drilling, for low and high input wheat varieties, with or without white clover, for optimal grain yield and quality;
- Whether bi-cropping is more economically viable, in terms of weed and nitrogen management, compared to mechanical weeding;
- The optimal seed density consistent with drilling arrangement and wheat varietal variation for grain yield and quality;
- To determine the optimal spatial arrangement of wheat and white clover for weed suppression;
- The effect of different bi-cropping arrangements on pest and disease incidence;

- The relative effect of variation in wheat foliar nitrogen at key developmental stages (which will be influenced by the trial variables) will be determined on the subsequent grain yield and quality;

- The evaluation of wheat-wheat competition from different drilling technologies (and thus plant distribution);

- The potential advantages/disadvantages of using clover as a weed suppressor in comparison with mechanical weeding, including the aspect of nitrogen release and uptake within the cropping system; and

- The potential value of the adaptability of the population samples from the composite crosses in coping with the range of intercrop arrangements and for buffering against the variability inherent in these systems under organic conditions. This is important in helping to evaluate composite cross breeding as a way of generating rapidly material that is adapted to a range of organic conditions and ecological systems.

The proposed work will also:

- Have a number of farmer-consultation meetings to ensure farmer involvement in problem solving in the project;

- Provide high quality research for the integration of novel technology for organic cereal growers in the UK and conversely, for a major agricultural machinery company to develop future markets;

- Provide the UK organic sector with a better opportunity to substitute quality, home-grown wheat for current imports; and

- Add value to presently funded Defra projects.

First Year results:

Aristos out-yielded Hereward despite the observation that Hereward exhibited several traits associated with high yielding varieties (higher crop emergence, establishment, tillering, canopy cover, late weed suppression and harvest index). In contrast, the phenotypic characteristics of Aristos were ultimately beneficial. These included greater straw height, foliar disease resistance, longevity of flag leaves, mass of grain and straw per stem and the quality parameters of thousand grain and specific weight.

The high seed rate consistently performed more favourably than the lower rate, with the medium seed rate intermediate.

The narrow row drilling arrangement performed well in terms of crop emergence, establishment, tillering, canopy cover, late weed suppression, grain yield, thousand grain weight and specific weight. By contrast the broadcast yielded poorly. This may be a result of the drilling method, which is not yet perfected and which resulted in poor crop establishment. However, the plants present in the broadcast arrangement had high survival rates, a large mass of grain and straw per stem and a favourable harvest index. This was probably a result of reduced intra crop competition. Wide rows and strips performed similarly to each other.

The clover was sown at the time of wheat drilling in October, and due to poor establishment was re-sown in March at both trial sites. Clover clearly established better at Sheepdrove than Wakelyns, but the cover could only be assessed late in the season. The presence of clover under the crop resulted in greater yields of grain and straw per stem, reduced canopy cover and suppressed weeds at low seed rates.

Increasing seed density per unit area (with both greater seed rates and drilling techniques that approach more evenly spaced distribution) may deliver further yield and economic returns. This may arise from a reduction in intra-crop competition interacting with maximised inter-crop competition. Repetition of trials in the coming two years trials and economic analyses will help to confirm this and to determine the most favourable factors for optimising winter wheat yield and profitability.

At the end of the first year, the optimum choice of variates for high yield is narrow rows x high seed rates x Aristos.

Outputs:

Jones, H., M.S. Wolfe, S. Clarke, K. Hinchsliffe, Z. Haigh, 2005, Sustainable Production of Organic Wheat. Presentation at six Organic Crop Demonstration Project (OCDP) meetings.

Jones, 2005, H. Linking yield and quality in organic winter wheat. Leaflet to attendants of OCDP meetings.

Jones, H., M.S. Wolfe, S. Clarke, K. Hinchsliffe, Z. Haigh, 2005. Chasing yield and quality in organic winter wheat. Bulletin article, December 2005.

Jones, H. 2005. Agronomy focus for organic winter wheat production. OAMG Newsletter.

Jones, H., M.S. Wolfe, S. Clarke, K. Hinchsliffe, Z. Haigh, 2006, Sustainable Production of Organic Wheat. Project update presentation at six Organic Crop Demonstration Project (OCDP) meetings.

Jones, H., Haigh, Z., Hinchsliffe, K., Clarke, S., and Wolfe, M. 2006. Sustainable production of organic wheat, Wheat LINK (DEFRA LK 0970). Poster.

Haigh, Z., Clarke, S., Hinchsliffe, K., Jones, H. and Wolfe, M.S. 2006. *Wakelyns Agroforestry… science for ecological agriculture*. Leaflet on the agroforestry system and research activities at Wakelyns Agroforestry.

Farmer Event at Open Day: 21st June 2006. Wakelyns Agroforestry, Suffolk.

Farmer Event at Open Day: 27th June 2006. Sheepdrove Organic Farm, Berkshire.

Haigh, Z., Clarke, S., Hinchsliffe, K., Jones, H. and Wolfe, M.S. 2006. Sustainable Production of Organic Wheat. Aspects of Applied Biology 79, What will organic farming deliver? COR 2006, pp. 131-134