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Sustainable production of organic wheat

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Summary

The aim of the project is to use an ecological approach to analyse the interactions of a range of key agronomic variables in organic wheat production (wheat genotype, spatial arrangement of seed, seed density and wheat/white clover bi-cropping) to determine an optimal approach to improved and stabilised production. The first set of data revealed that seedling competition was influenced by seed rate and drilling arrangement. Furthermore, the variety Hereward had increased emergence and establishment to Aristos. An interaction exists between wheat variety, seed rate and drilling arrangement on the level of canopy cover at different developmental stages – these factors are important for the suppression of weeds. The input of farmers in the selection of trial variables ensures results have a direct application to the industry. The results of yield and quality at harvest will provide further insights into the interaction of agronomic variables.

Key Words: *Triticum aestivium*, agronomy, bi-cropping, drill arrangement, seed density, multifactorial, cultivar

Introduction

Development of organic cereal farming in the UK is hindered by the central problem of winter wheat production, which is relatively low in both yield and quality (Lampkin *et al*., 2004). The market for organic wheat is high, and increasing, but the supply of home-grown milling wheat fulfils less than one third of this demand (N Gossett, Organic Grain Link, pers. comm., 2004). Critical deficiencies are a lack of appropriate varieties (Jones & Wolfe, 2005) and inadequate agronomic information. There is also a need to improve nitrogen supply, as the nitrogen concentrations of organic wheats are significantly lower than those in conventional systems (Gooding *et al*., 1999). Recommendations are needed to improve yield and quality but also to provide adequate buffering against environmental variation.

Organic farming has been, and should be, regarded as a form of ecological farming (Weiner, 2003), 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 in isolation as single factors (Gooding *et al*., 2002). It is essential, however, that as many relevant factors are analysed together in order to understand the interactions among the components (Gooding & Davies, 1997).

The main objective 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 weed control and an overall assessment of environmental stability.

Materials and Methods

The first trial year of three is taking place at two sites (Wakelyns Agroforestry, Suffolk, and Sheepdrove Organic Farm, Berkshire), and an additional site (Scottish Agricultural College, Edinburgh) will be included for years two and three. Each site contains a randomised, replicated split-plot design integrating two varieties: Hereward (a nabim Group 1 variety) and Aristos (a variety bred for low input systems (Phillips, 2003)); three seed rates: low, medium and high (150 Kg ha^{-1}, 200 Kg ha^{-1} and 250 Kg ha^{-1}); and four spatial arrangements (wide row (20 cm), narrow row (10 cm), broadcast and strips (a seeded band 17.5 cm wide with 30 cm centres, J Claydon, Claydon Yieldometer, pers. comm., 2006), with or without white clover mixture under sown at 7 Kg ha^{-1}). Site definition and standard agronomic assessments on plant, weed and clover growth will take place throughout the growing season and post harvest. Analysis will evaluate the main component effects (variety, seed rate and spatial arrangement) including the question of varietal stability. It will also focus on the comparison of weed management and nutrient flow by the use of the clover bi-crop versus mechanical weeding and evaluate the relative economics of the major options. An important part of the project is to have direct input from farmers at all stages, as part of our commitment to the participatory research approach. The project will select trial variables of direct application to the industry through consultation with farmers, advisers and the project consortium.

Results

The trial is in its first year; data presented is largely from one site (due to drilling problems at Sheepdrove), for assessments completed to June 2006.

Emergence and establishment

Hereward had significantly better emergence than Aristos ($P < 0.05$). Seed rates have significantly different ($P < 0.05$) emergence values in the rank: high > medium > low.

Hereward had significantly higher establishment than Aristos ($P < 0.05$). The ranking of the drilling arrangement was (Narrow row (NR) > Wide row (WR) > Strip (S) > Broadcast (BC), ($P < 0.05$) (Fig. 1). The ranking of the seed rates remained the same overall (high > med > low), ($P < 0.05$) (Fig. 1).

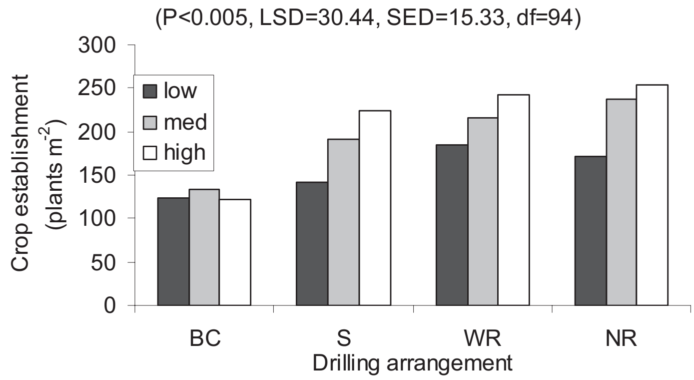

Fig. 1. Crop establishment for drilling arrangement × seed rate, Wakelyns

Crop seedling survival

There was no significant difference between the survival of cultivars at both sites. BC survived significantly better ($P < 0.001$) than all other drilling arrangements. High seed rates had a significantly ($P < 0.05$) poorer survival than medium and low. Aristos had significantly better ($P < 0.05$) survival than Hereward in BC and WR.

Clover cover

Clover was drilled in October following trial drilling, however established poorly. A second drilling was possible in March, but established insufficient clover for assessment.

Canopy cover

Hereward had significantly ($P < 0.001$) better early (GS 31) cover than Aristos at both sites. High seed rates had a significantly ($P < 0.05$) higher cover than low, at both sites. Ranking of drilling arrangement at Wakelyns was NR > WR > S > BC (Table 1).

Hereward maintained a significantly ($P < 0.001$) better cover by GS 35 than Aristos at Wakelyns. High seed rates maintained a significantly ($P < 0.05$) higher cover than low, at both sites. Ranking of drilling arrangement at Wakelyns had changed to S > NR > WR > BC (Table 1).

At Wakelyns there was no difference between the canopy cover of the cultivars at GS 50. High seed rates maintained a significantly ($P < 0.05$) higher cover than low at Wakelyns. Ranking of drilling arrangement at Wakelyns had changed again to NR > BC > WR > S (Table 1).

Table 1. *Mean canopy cover for cultivars in drill arrangements (broadcast (BC), narrow rows (NR), strips (S) and wide rows (WR)) at sequential assessment dates at Wakelyns*

	Canopy cover (Leaf area index)		
Drill arrangement	Early	Mid	Late
BC	1.1	3.2	5.5
NR	1.5	3.5	5.7
S	1.3	3.3	4.8
WR	1.3	3.4	5.0
P	0.021	0.061	< 0.001
LSD	0.228	0.242	0.305
SED	0.1151	0.1223	0.1545
df	(143)	(143)	(143)

Stakeholder participation

Eighty farmers attended three meetings across England to discuss the objectives, feasibility and relevance of field trials. Farmers suggested the use of feed varieties (nabim Group 3 or 4), using inter row hoeing rather than harrowing as the weeding method, and were concerned about the practicalities of drilling arrangements.

Discussion

Cultivar, drilling arrangement and seed rate are influential factors at early growth stages (emergence and establishment). Survival of seedlings was highest in the broadcast drilling arrangement, as expected. Seeds in this arrangement are closest to equidistant spacing as possible, and therefore intraspecific competition is reduced. Plants at high densities had the lowest seedling survival due to increased intraspecific competition.

Canopy cover was significantly influenced by cultivar and seed rate. The influence of drilling arrangement on canopy cover changes with plant development, i.e.:

- Early: NR>WR>S>BC
- Mid: S>NR>WR>BC
- Late: NR>BC>WR>S

Although current data is valuable, yield and grain quality data gathered after harvest will be more revealing.

Trial variables (to include weeding) for future years will be shaped by farmer consultation and available trial data.

Ongoing, 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.

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