WECOF: A new project developing enhanced weed control through improved crop and plant architecture

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ABSTRACT

A primary objective of the EU-funded WECOF project is to optimise the natural competitiveness of winter wheat in reducing weed growth, and thus reduce the need for direct weed control interventions. Crops are characterised by ranking the relative importance of key plant and crop factors in shading weed growth. A series of core trials have been established in Germany, Scotland, Poland and Spain comparing plant structure by the use of different varieties and crop architectural factors by the use of different sowing row widths and direction. Variety trials have also been established in Scotland with constant row width and sowing direction to give more detailed varietal comparisons. Results from the first set of trials in Scotland are described. There are clear varietal differences in weed suppression; row-width has a bigger effect than sowing direction. Results will be used to develop models to assist breeders in producing improved crop ideotypes for organic production, and in production of a decision support system to assist farmers and advisers in variety selection and management for improved weed suppression. WECOF also includes work on allelopathy and photocontrol, and on the related economic factors.

Keywords: organic farming, weed management, weed suppression, crop architecture, plant architecture, light interception, winter wheat, cultivar

INTRODUCTION

Weed management is one of the most significant problems facing organic arable production (Davies & Welsh, 2001). Organic farmers generally rely on using direct control measures such as mechanical weeders, but other than rotation, many indirect measures are less widely implemented. The EU funded WECOF (Weed Control in Organic Farming) project puts an emphasis on optimising the natural competitive relationships between the crop and the weeds in reducing potential weed growth and competition. The WECOF partners are led from the Institut fur Organischen Landbau, University of Bonn, with SAC, Edinburgh, Warsaw Agricultural University and Instituto Madrileno de Investigation Agraria y Alimentaria, Madrid, providing the agronomic research, with micro- and macro-economic analysis provided by Dipertimento di Biotecnoligie Agrarie e Ambientali, University of Ancona. The project started in October 2000, using winter wheat as a model crop.

OBJECTIVES

The primary objectives of WECOF include:

a) Optimisation of the natural competitive relationships between crops and weeds by identifying, and ranking through modelling, the relative importance of key crop and plant factors responsible for weed suppression.
b) Evaluation of allelopathy and photocontrol as further indirect husbandry tools in weed suppression.
c) Specification of weed species and types that show improved suppression to the factors assessed.
d) Development of a crop physiological and agronomic model to link all the factors under study.
e) Micro- and macro-economic analysis of the consequences of the study.
f) Development of decision support systems for breeders to assist in the selection of new cultivars for organic farming, and for farmers and advisors in the selection from available varieties for improved weed suppression, and for improved management of such varieties.

This paper introduces the work associated with objectives (a) and (d). A key component is expected to be crop varietal characteristics, and it is proposed that a methodology is published for routine characterisation for weed suppression. A dialogue with breeders is assisting in the development of the methodology.

It has been recognised for some time that early prostrate (planophile) ground cover reduces weed emergence and growth in wheat (Richards & Davies, 1991; Eisele & Kopke, 1997). Tall varieties of wheat also reduce the penetration of photosynthetically-active radiation into the crop (Cosser *et al.*, 1996). Reducing the plant height of cv. Maris Widgeon through introduction of the dwarfing gene increased weediness (Cosser *et al.*, 1997). However, later trials by Cosser *et al.* (1997) and Eisele & Kopke (1997) indicate that tallness is not the prime character, and that good overall shading ability is more important. WECOF will attempt to evaluate the relative importance of the different parts of the developing wheat plant above ground, and the importance of relative shapes, attitude and speed of development.

The development of the plant architecture will be influenced by row width (e.g. Younie & Taylor, 1998), and Eisele & Kopke (1997) noted that increased shading ability in taller varieties could be seen when the crop was sown in an East-West (E-W) direction. The importance of sowing direction may, however, also be influenced by latitude.

Work programme

In a series of core field trials the agronomic partners are comparing varieties of contrasting plant architecture under narrow- medium- and wide-row widths, and sown in E-W and N-S directions in a 3-factorial design. The range of sites allows comparison under different environmental and latitudinal conditions. A reference core cultivar, Pegassos, a medium planophile/erectophile type from Germany, is sown at all sites, with local varieties with clear differences in planophile and erectophile structure included for comparison. A model weed is sown into part of the plots to assist in analysis. In winter 2000/01 core sites were established in

East Lothian and Aberdeen in Scotland, two sites in Nordrhein-Westfalen, Germany, one site near Warsaw and one near Madrid. This is repeated in 2001/02 and 2002/03. This paper presents some of the Scottish results for the first year, but due to severe weather problems in 2000/01, particularly affecting the Aberdeen site that has required more complex analysis, the examples in this paper come from the East Lothian site alone. The model weed, *Sinapis alba,* performed poorly, but the high population of *Polygonum aviculare*, allowed its use as a standard weed population at this site.

A second trial series, based at SAC in East Lothian, examines key components of varietal differences in competitiveness at a constant row width and sowing direction. This included German as well as British varieties in 2000/01, and after their successful inclusion, notable varieties from the other partners have also been included in 2001/02.

RESULTS

Core trial

Figure 1 shows the weed biomass meaned throughout the wheat growth stages at the East Lothian site in 2000/01. At this site Pegassos, marginally the taller variety, and Rialto, (a variety with rapid spring development) showed greater weed suppression than the erectophile, Consort, and Eclipse (an early planophile variety). Pegassos also performed well in Germany, but less well in Poland and Spain. This also shows that at this site there was not a clear response to sowing direction. There was a complex interaction with row width, but only a tendency for E-W sowing to show benefits at narrow row widths in 3 varieties, whilst at wide row widths, N-S direction may have had some benefit. Interim results from the other centres suggest a bigger advantage to narrower spacing than sowing direction.

Variety trial

The interim first season results indicate that shading and competition with weeds is likely to be strongly influenced by leaf shape and angle, particularly higher in the canopy. A number of varieties show changes in shading and cover between growth stages, with Rialto giving the most consistent weed suppression, closely followed by Genghis and Eclipse. However, a consistently medium weed suppressor, Malacca, gave the best yield.

Looking forward

Defining the relationships between plant architecture and its development and weed suppression through modelling are the first steps towards defining a crop ideotype, and a support system for breeders in developing such ideotypes. The modelling will link plant and crop architecture to assist the grower in utilising available varieties in an optimal manner. WECOF is also examining other indirect methods of weed control, and where possible, these will be included in the modelling. The crop-weed model will link with micro- and macro-economic models, and will form a key part of the DSS for farmers in optimising varietal and agronomic choice.

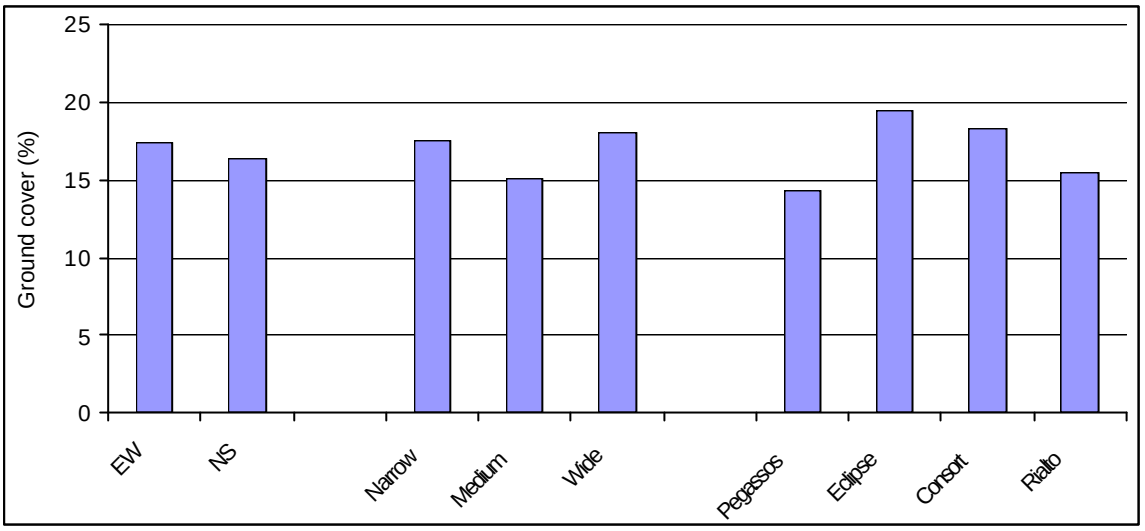

Figure 1. Mean weed ground cover assessments at East Lothian, by variety, row width and sowing direction, 2000/1.

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