Horticultural weed control in organic systems – a modelling approach

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ABSTRACT

Weed control is an important yet mainly unaddressed research issue in organic systems. At present there is little agronomic support to underpin weed management decisions. Computer modelling and simulation techniques may provide a valuable tool for understanding the nature and processes of the organic system thus generating knowledge and information of direct benefit to growers, which will aid in short and long term weed management strategies.

Keywords: organic farming, weed control, modelling, decision support

INTRODUCTION

Research work has great potential to develop and expand current organic weed control knowledge for the direct benefit of the grower. Weed control is one of the most significant production problems growers face (Beveridge & Naylor, 1999), and is ranked as a major research and development priority by the UKROFS board (UKROFS, 1998). There is little prescriptive information for growers to follow on weed control. This is partially due to the diverse nature of the system but also because of the lack of direct research in the organic arena. Specific research in organic systems is therefore needed to support the interpretation of work already undertaken in the conventional sector. Organic systems are fundamentally more dependent on the underlying biology of crops and weeds and would benefit from greater understanding and research in this area, (Bond & Lennartsson, 1999) the organic system also lends itself well to the application of models.

The growing process can be separated into two main stages; the planning and design of the system followed by the practical implications of the decisions. In terms of organic weed control the planning stage is of major importance to growers, who have both fewer options and, sometimes less effective remedial measures to rely on when the crop is planted than their conventional counterparts. When considering the design stage aspects such as tillage, crop rotation and farm hygiene should be taken into account. In the crop management stage decisions will include whether and when to weed and with what equipment. Modelling can aid in both of these decision making stages but may be more focussed towards aiding in the three main questions of when, where, and how (Figure 1).

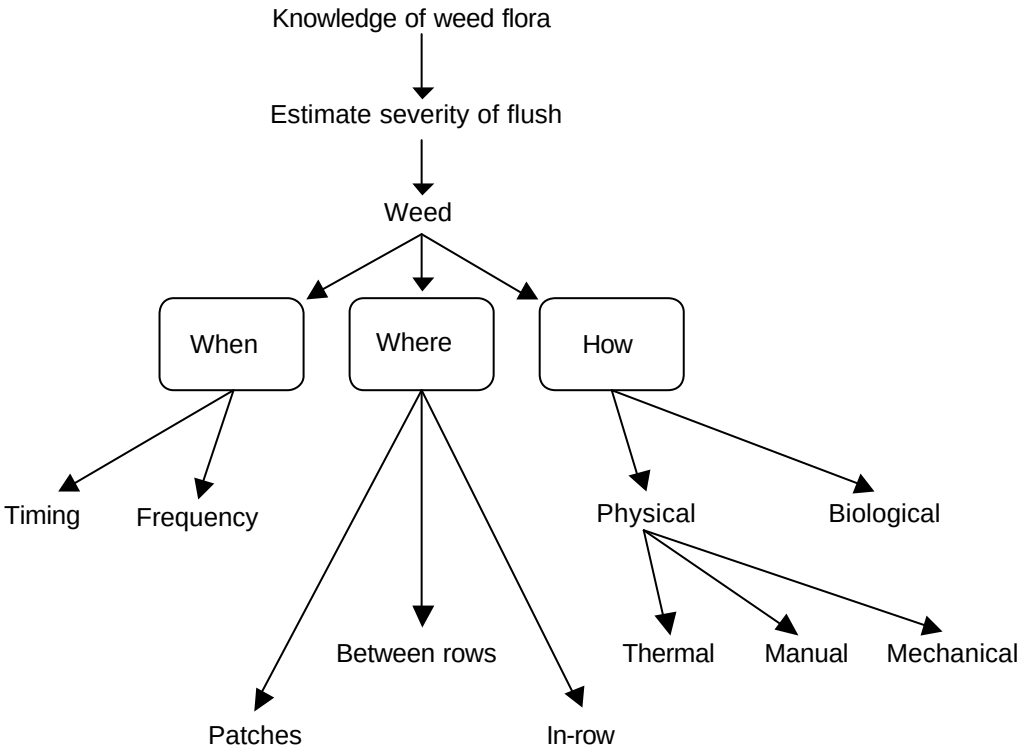

Figure 1. Organic weed control management decisions

Modelling approaches

A major focal point of the modelling associated with weed control has been to predict crop weed competition. The aim of these models is to encompass in one or several models all the variables that will influence this balance and hence provide the most agronomically and economically advantageous weed control strategies for growers.

Models began as static, empirical approaches to the competitive interactions between crop and weeds. Such models generally describe what is observed in a given set of conditions at a certain point in time (for example Kropff & Spitters, 1991). In recent years these have included a wider range of variables, for example weather conditions, that have allowed them to broaden their applicability and become more dynamic (for example Aikman *et al.*, 1995). Physiologically-based models may offer scope for more universal application (Kropff *et al.*, 2000) e.g. incorporating different soil types. These models are essential to understand the biological processes (Mortensen *et al.*, 2000), but more likely to remain as research tools as the sheer number of variables makes them impractical and difficult to parameterise. However, they will be just as vital to generate knowledge and information to feed to growers through effective dissemination channels, as growers actually interfacing with a modelling package. Combining elements of the more simple empirical type models with elements of the mechanistic may offer the best way forward for generalisation and flexibility that would be required for grower decision support systems.

Models of crop weed competition should be an essential part of cost-effective decisions in weed management (Vitta & Satorre, 1999). However, few models are

actually used by growers at the field level. What is needed is an approach with simple inputs that is used to underpin grower decisions rather than make them for them. Growth and competition simulations that have been soundly calibrated and validated can do the work of many experiments and allow a grower to examine many different scenarios and give confidence to decision making. The closer the observations and data which drive the model are taken to the time of implementation the greater the accuracy of the results that will be obtained from the programs. The quality of the information entered is directly correlated with the reliability of the output.

Modelling is of relevance to organic systems in several ways. The mapping and knowledge of the weed seedbank over time could aid in long-term management of rotational design and crop choice. Giving growers flexibility with weeding by helping to target the timing of specific operations in each crop so that priorities can be decided in terms of which crops are actually competing for resources with the weeds. Models can give confidence to growers in a sector where there is little agronomic advisory support and could provide the opportunity to try new techniques which have a scientific base rather than trying more hap-hazard approaches. A multi-disciplinary system encompassing many biological processes in one model would be of particular relevance for organic systems in which a holistic approach is really required. When making decisions a grower cannot necessarily isolate weed control from other factors, such as pest and disease control or maintaining soil structure.

For models to be effective research is needed in a number of areas:

- Return of weed seeds and survival in soil
- Simple weed mapping systems
- A greater understanding of weed biology/weed population dynamics from seed to mature plant
- The suppressive ability of different cultivars
- Quantify the secondary effects of mechanical weeding for example the effects on nitrogen mineralisation and soil structural damage
- Improve accuracy of long-term weather forecasting to incorporate into multi-discipinary models
- Many good starting frameworks are in place but they require more work and adaptation to organic systems, as has been attempted with the N_ABLE model of nitrogen management (HDRA, 2000)
- There needs to be an identification of simple realistic and practical inputs for driving the programs and adaptation of models by scientists of models to be driven by this kind of data
- The model outputs have to be tangible results, preferably described in economic terms rather than biological ones
- There has been a huge hesitation in the take up of models; there needs to be more research which includes the growers at the base level of devising the system as for example in the Weed Management Support System model which aims to address weed control decision support in the conventional arable sector (Parker & Clarke, 2001)

CONCLUSIONS

There is some very positive scientific modelling work occurring. The potential to be gained from fine-tuning the current organic weed control measures and increase in grower confidence validates the need for research. For organic systems the models need simple inputs to be reliable and generic with clearly interpretable outputs designed specifically for these systems. Science should provide a conduit of information from the biological, chemical and physical processes occurring in nature into agricultural practice with effective farming knowledge, modelling could be one tool to achieve this.

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