Modelling the Path to Better Soil Applied Pesticides

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Introduction

Current fate models used for pesticide registration within the EU are 1-dimensional and have a simplified representation of root development, root architecture and uptake of pesticides (see FOCUS 2009). Recent regulatory opinion (EFSA 2013) has identified that these mathematical models cannot describe ridge and furrow systems and their ability to simulate drip irrigation has also been questioned. There is a need, therefore, to produce a spatially explicit model that can simulate such systems for regulatory purposes. The pressure of regulation of pesticides within the EU is driving registrants to examine the option of using application strategies such as slow release formulations to reduce environmental impacts due to off-site movement of pesticides. However, there is no currently available model that can allow them to evaluate the optimum performance of such technologies without expensive testing. We describe a project to develop a new model of pesticide fate in soil that may be used as a basis for future models to address this need. The project is a collaboration between Syngenta, Rothamstead Research and the University of York and is co-funded by the Technology Strategy Board, the Department for Environment, Food and Rural Affairs (DEFRA), and the Biotechnology and Biological Sciences Research Council (BBSRC).

Method

Starting from a review of available models of pesticide fate, plant growth and distribution within plants, we selected CHAIN2-D as the basis of the fate in soil compartment, SPACSYS as the plant growth model and the Trapp (Trapp 2007) model as the basis of plant uptake. A 2-dimensional framework was selected as the simplest means of incorporating spatial elements while retaining reasonable run times. The choice of a 2-dimensional framework meant incorporating the rooting density function from the DAISY model into SPACSYS, which was originally a 3-dimensional plant growth model. The final model was benchmarked against the PEARL model and the FOCUS scenarios to test the routines of pesticide fate and plant development.

Results

Figure 1 shows a comparison between leachate concentrations of FOCUS substance D at Okehampton predicted by FOCUS PEARL and the new model at 1m depth. This shows excellent agreement between the two models.
Figure 1: Comparison between the new model (blue line) and FOCUS PEARL (red line) predictions of leaching at 1 m for 20 years simulation of FOCUS substance D at Okehampton.

Figure 2 shows a comparison between model predictions and measured data for leaf area index and plant dry matter for wheat grown in a single year in 1983 at Bouwing in the Netherlands.

Figure 2: Comparison between measured plant growth parameters Leaf Area Index (solid red line) and dry matter content (solid green line) measured in 1983 at Bouwing in the Netherlands and model predictions (marked lines).

Conclusions

We have produced a new spatially-explicit model of pesticide fate capable of representing plant growth dependent upon environmental conditions. The model performs well in benchmark tests with the PEARL model of pesticide fate.

References

