SEASONAL WEATHER FORECASTS IN THE CONTROL OF APHIDS AND OTHER PESTS AND DISEASES

Richard Harrington

Department of Entomology and Nematology, Institute of Arable Crops Research, Rothamsted Experimental Station, Harpenden, Hertfordshire, AL5 2JQ, UK

(Tel: +44 1582 763133 ext 2452; Fax: +44 1582 760981; email:richard.harrington@bbsrc.ac.uk)

Aphids are the most important insect pests of agriculture in Europe, and billions of euros are spent annually on insecticides that are often used prophylactically for their control. Forecasts of the timing and size of aphid migrations in relation to damage control thresholds are useful in order to reduce unnecessary use of chemical control that might cause environmental damage, select for resistant aphid clones and decrease gross margins.

Some forecasting is already possible for aphids which pass the winter as active, asexual (parthenogenetic) stages, as opposed to eggs. Many pest species have clones which are continuously parthenogenetic throughout much of Europe. A network of 73 suction traps has been established for many years throughout Europe (Figure 1) for the purpose of monitoring aphids. The system provides the most comprehensive, standardised, spatio-temporal dataset for any invertebrate group in the world and is ideally suited for analysis with long term weather data. Strong relationships between winter temperature and the timing and size of aphid migrations have been found for many continuously asexual species (Figure 2a,b). Thus it is possible by early March to forecast the timing and size of the spring migration which is a threat to spring planted crops. The forecast comes before planting, allowing decisions as to the need for insecticidal treatments at planting. However, for some crops, farmers now have the option of using seed which is pre-treated with insecticide. In the case of sugar beet, for example, such seed would usually be ordered in autumn, well before current forecasts are available. This is where probabilistic seasonal weather forecasting could be beneficial. If it was possible to predict the January to February mean temperature by October, advice on the need for treated seed could be given. Farmers would not be told whether or not to use insecticides, just what the probability of economic damage would be if they did not. Thus their decision making would be aided, but the decision would be theirs, and would vary according to their risk acceptance level.

In autumn sown cereals, aphids transmit barley yellow dwarf virus. However, serious spread only occurs in mild winters when aphids can develop, reproduce and move around the crop. The virus cannot be seen until it is too late for control, and hence an assessment of spread is needed in order to determine the point at which economically damaging levels of virus have occurred, requiring control of aphids to prevent further dispersion. A weather (largely temperature) driven model has been developed for this purpose. However, the longer the decision to spray is delayed, the greater is the risk that it will be impossible to use spraying equipment in the field. Seasonal weather forecasts would allow the model to be run predictively, providing the opportunity to make a sensible decision on spraying as soon as winged aphids have ceased flying into the crop. Assessment of monthly temperature averages from October to March, one to three months in advance, would be useful in this respect. Prediction of extreme minima would also be useful, as ground temperatures of –10°C and below cause a rapid drop in aphid abundance and activity.

Figure 1 Map of European Suction Trap Network

Significant correlations have been found between the time of aphid migration and a seasonal index of the North Atlantic Oscillation (Figure 2c). More work is needed to check the degree of universality of such relationships, but it would appear that if NAO indices can be predicted, there is the potential to use them for advice on aphid control.

For many insect pest species, especially those with discrete generations, it is useful to know the time of emergence of the damaging stage. This is often related to thermal time, ie the number of day degrees accumulated above a given developmental threshold. Seasonal-scale prediction of this, tailored to individual pests and regions, would have widespread usage in pest control decisions.

Plant disease severity is often determined by rainfall and humidity, as well as temperature, and seasonal forecasts of these would be useful in control advice.

Although there may be some strategic value in regional forecasts, the degree of variability throughout a region is likely to be considerable, leading to difficulties in application at farm level. The seasonal forecasts that are likely to be available may thus be of more value to those with regional concerns such as pesticide manufacturers and distributors rather than individual growers and their advisers.

In conclusion, the severity of different pest and disease problems is controlled by different combinations of weather acting at different times. Seasonal prediction of monthly temperatures (averages, extremes and derivatives such as day degrees), rainfall, humidity and, to a lesser extent, windspeed, would be widely welcomed. Cost would be a major issue. During the development phase of pest and disease forecasts, it is unlikely that significant funds would be available for purchasing data. Scientific collaboration with weather data providers, with all parties sharing in publications and later commercial rewards, would be a useful way forward as an alternative to direct data purchase.