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Take-all disease can cause losses in yield of up to 60% in Australian cereal crops.

Cereal **killer**

Take-all disease, caused by the soil fungus *Gaeumannomyces graminis*, is the number one root disease of cereals world wide. In Australia, farmers can lose up to 60% of their grain yield to the disease, and in South Australia alone, losses of up to $60 million have been recorded.

Crop losses can be minimised by employing a range of different disease-management strategies. But deciding which strategy will provide the right balance of financial reward and risk reduction can be difficult. A new model that allows farmers to assess the impact of various take-all management options is helping to make this decision easier.

Model designer, David Roget, is a pathologist and agronomist from CSIRO Land and Water. He says the most popular management strategy is to sow non-host crops such as pulses (peas, lupins), pasture legumes (clover, medic, lucerne) or oilseeds (canola) between cereal crop sowings. This helps reduce the fungal inoculum level in the soil and decrease the incidence of disease to less than 5% of plants in the next cereal crop.

Other strategies to reduce inoculum levels include burning cereal stubble after harvest, cultivation to encourage the breakdown of roots and crowns, and removing 'volunteer' cereals – plants that germinate from seeds left after harvest – from paddocks.

To help farmers assess their risk and understand the impact of management on future yields, Roget's computer model predicts take-all occurrence, based on a range of environmental and management options.

For example, if a farmer has come through a good growing season and a profitable wheat harvest, should he plant a high risk wheat crop the next year, or a less profitable non-host crop?

After entering information on rainfall and soil inoculum levels for his paddock, the farmer can then run a range of management scenarios through the model and look at the expected results for the next three years.

'Farmers may decide to plant a pea crop that may make only $50 per hectare instead of $150 if they planted wheat,' Roget says.

'But by planting that pea crop, they have a positive impact on the potential yield of the next one or two wheat crops, because they've reduced the inoculum level in the soil. So they may make $250 per hectare of wheat in the two years following the pea crop.'

Because the model can be run over a three-year period – the average cycle time for the disease, depending on rainfall – Roget says it enables farmers to look at the impact of their management decisions in the longer term. And it provides an estimate of the real economic benefit of the use of disease control strategies.

The model also performs a gross margin analysis, (total return per hectare minus operating costs), which farmers can use to determine the economic outcomes of different management strategies.

'In any decision-support system designed for farmers, it is the economic

outcomes, not the pathogen or disease outcomes of the model, that are the critical end points,' Roget says.

'The gross margin analysis function allows farmers to incorporate commodity prices and input costs, such as fertilisers and herbicides, into the model. These can vary significantly across districts and seasons, and it is critical to establish the correct economic inputs for any given district or farm, in order to obtain valid and credible outputs.'

Another key aspect of the take-all model is that it requires farmers to determine the levels of take-all inoculum in their soils. This measurement can be made through the root-disease-testing service, 'PreDicta B', run by C-Qentec.

'The model can be run with estimated levels of take-all, to evaluate management impacts for a range of scenarios. But an actual measurement of the take-all level is needed to make a recommendation for a specific paddock,' Roget says.

The take-all level is determined from soil samples using DNA probes, which quantifies the amount of take-all DNA in the sample. These techniques where developed by the South Australian Research and Development Institute (SARDI) and CSIRO.

Because of the complexity of the soil environment, the take-all model is one of only a handful of soilborne disease models in the world. Some of the environmental variables that make such predictive modelling difficult include soil nutrition, microbial activity and soil water / rainfall interactions, all of which can vary with soil type. Roget says the take-all model works because the modelling process begins with a known inoculum level, and because the disease is so dependent on soil moisture.

'The fungus requires moist soil conditions in order to spread. If there are regular rainfall events, particularly through spring when the soil is warmer, the fungus spreads rapidly. But in very dry conditions it just sits there,' Roget says.

'So these two factors – inoculum levels and soil moisture – allow us to predict what is going to happen.'

Roget says it's unlikely that a plethora of other soilborne disease models will be developed, unless key control factors, such as soil moisture, can be identified. If they can, the take-all model may provide a framework to assist the development of new soilborne disease models.

Take-all primarily affects wheat, barley and triticale, by penetrating the centre of plant roots and blocking the transport of water. According to CSIRO's David Roget, the fungus spreads in winter and spring, when there's more rainfall, by leapfrogging along and between roots with runner hyphae. After flowering, when dry conditions prevail, the blocked or partially blocked roots prevent the plant from taking up water. The plant dies off early, with shrivelled grain and unfilled heads.

The take-all model is now in use by industry. Because of the inherent complexity of soilborne disease modelling, the model requires some degree of expertise for use and interpretation of outputs. Some 600 agronomists across southern Australia have been trained and accredited, and these people now provide an interface between the model and farmers.

'The training and accrediting is a major exercise initiated and maintained by SARDI, which has allowed us to introduce the concept of DNA testing, and upgrade the skills of the agronomists in terms of cereal root disease generally. Once the agronomists have a better understanding of what's happening, they can then pass that information on to farmers,' he says.

More about take-all

Roget DK (2001) Prediction modelling of soilborne plant diseases. *Australasian Plant Pathology*, 30: 85–89.

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