Pest evolution and enhancement of the durability of IPM solution

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OBJECTIVES

Evolution of pests, diseases and weeds is continually posing new challenges to sustainable farming. Due to natural mutation and selection processes, new genotypes appear of plant pathogens, insect pests, and weeds that break through pest management approaches, including host plant resistance, crop protection chemicals, and biological controls. In this work package, we study the process of this evolution and assess how the risks can be mitigated by integration of multiple methods and judicious use strategies.

APPROACH

The evolution of "super strains" of pests, diseases and weeds that overcome control strategies can occur in few years or take decades. Mathematical modelling is indispensable to evaluate the effectiveness over time of a strategy and make predictions. Such models assess population genetics and population dynamics, as well as damage to the crop, and should be based on sound biological knowledge, generated by literature research and experimentation.

FIRST RESULTS

A meta-analysis of biological control of grey mould (widespread, and notorious, e.g., on strawberries, grapes, and tomato) has shown marked differences between pathogen strains in their aptitude to grow in the presence of antagonists, such as the bacterium *Pseudomonas chlororaphis (Figure 1)*.

Figure 1. Growth of two strains of grey mould fungus, *Botrytis cinerea*, in petri dishes in the presence of *Pseudomonas chlororaphis*; left: sensitive Botrytis strain ; right, a less sensitive evolved strain. Far right: infected strawberry.

These differences hold a warning against one-sided reliance on a single biocontrol agent. One sided usage of *Cydia pomonella* granulovirus has already resulted in resistance development in the target pest, the codling moth, an important pest on apple (*Fig. 2*). An SME partner in PURE, Natural Plant Protection, is developing new strains of the virus that can overcome this resistance.

Figure 2. *Cydia pomonella* granulovirus (CpGV) is a biocontrol agent for Codling moth (*Cydia pomonella*). PURE works towards identifying novel strains that overcome resistance in the target pest.

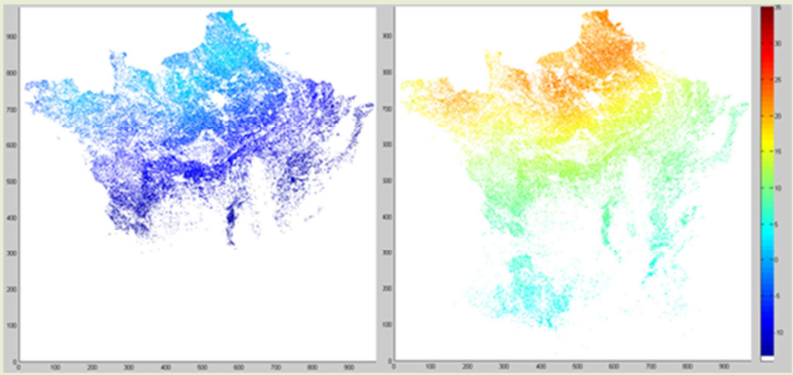

Figure 3: Model images of a yellow rust epidemic in France, after initialization with a novel strain in the Northwest in spring.

We have built a spatial population genetic and population dynamics modelling framework at a continental scale, to identify pathways for spread of yellow rust through France (Fig 3) and analyze the drivers of emergence of new rust strains. Modelling studies at regional scale suggest that gene stacking is not a panacea for providing durable resistance, and under certain conditions, alternation is as good as stacking. Vicious strategies that promote development of super-strains have been identified.

Figure 4: Herbicide resistant (left) and susceptible individual (right) of barnyard grass, *Alopecurus myosuroides*, indicating major difference in fitness.

Model studies on weed dynamics indicate the importance of diversified rotations to combat problem weeds. Empirical studies showed that herbicide resistant weed have fitness disadvantages, highlighting opportunities for controlling those weeds by using an integrated approach (Fig. 4).

INTERACTION WITH CROPPING SYSTEMS ACTIVITIES

Picture of field visit at INRA Grignon (June 2012) with participation from Wheat based cropping system colleagues. Here we inspect a wheat field with yellow rust infection in a cropping systems trial. Inset: leaf with yellow rust. *Photos: Wopke van der Werf*

NEXT STEPS

At the PURE annual meeting in Valencia, March 2014, we will again engage with the Cropping systems activities and discuss our findings and their implications for practical IPM approaches in key cropping systems in Europe.

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