Planning for the Evolutionary Battle

Improvement of agricultural production is of paramount importance for the alleviation of poverty in lesser developed countries. Plant viruses are a major constraint of many staple food crops, like cassava, sweet potato, maize and plantain, making disease control a key issue. Considerable investments have been made to develop more effective disease control methods, especially plant resistance.

Cassava leaf infected with cassava mosaic virus disease transmitted by the whitefly Bemisia tabaci *– note the characteristic yellowing and curling on the leaf*

Plant viruses, transmitted from infected to healthy plants by insect vectors, are notorious for their rapid adaptive evolution. Such rapid evolutionary change can in some cases render disease management methods less effective. Research to develop new or improved disease control normally does not take such future evolutionary changes into consideration.

Plant resistance mechanisms can be based on resistance to the virus or to the vector of the virus. CPP Project R8222 applied modelling methods from evolutionary ecology to the evolution of the virus as a result of the use of resistant cultivars. The project showed that resistance expressed through reduced acquisition of the virus by the feeding vector **does not** put a selection pressure on the virus to evolve higher within plant multiplication rates. The same holds for resistance expressed through a reduced rate with which insects, carrying the virus, infect healthy plants. These types of resistance thus are candidates for sustainable crop production. Resistance mechanisms which result in high virus titres but low symptoms expression (tolerant mechanism) **do** put a selection pressure on the virus to evolve a higher multiplication rate. Whether such cultivars have a useful contribution to agricultural production therefore depends on the balance between the positive effects of this resistance on plant performance and the potentially negative effects of increased within-plant virus multiplication rates. Ideally, these issues need to be considered before releasing such cultivars.

Adult and juvenile whiteflies transmit a wide range of begomoviruses

The conclusions, so far, relate to the evolution of within-plant virus multiplication rates. Other possibly evolving virus traits have to be considered to reach generic conclusions about the effect of the use of resistant cultivars on the evolution of plant disease viruses. The results can be applied to develop crop breeding programmes that select as little as possible for resistant cultivars that provoke the virus to evolve more harmful types.

R8222: Adaptive evolution within *Bemisia tabaci* and associated Begomoviruses: A strategic modelling approach to minimising threats to sustainable production systems in developing countries
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