Modelling plant-nematodes interactions to understand plant tolerance

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Oral Contribution

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Root-knot nematodes (RKN) of the genus Meloidogyne spp. cause considerable yield losses in numerous crops worldwide. The dynamics and outcomes of crop–pest interactions depend on the ecological conditions, including the phenotypes of the interacting species, their physiology and the abiotic environment. In theoretical ecology, most mathematical models that describe these interactions either focus on plant physiology and do not consider pest dynamics, or conversely are based on the pest life cycle but neglect plant physiology and defense response. We are particularly interested in understanding the mechanisms that underlie plant tolerance, that is the ability of plants to sustain RKN infestation with limited yield losses.

To address this, we built a mechanistic model of plant–RKN interactions that explicitly couples plant physiology and pest demography, including both the known effect of pests on crop and crop on pests. Based on a mechanistic description of resource acquisition and transport, the plant model represents both vegetative and reproductive phase. The RKN model includes the free-living larval stage and the nematode development stages within the plant root. The model was calibrated on two plant species, tomato and pepper, with or without nematode inoculation. Model calibration is a challenge, as it relies on heterogeneous and fairly scarce data. Indeed, plant experiments focusing on roots are necessarily destructive, hence the scarcity of data and the need to incorporate data from different experimental sources. The model was then used to analyse the complex interplay between plant physiological traits, phenology and nematode biology that affects system dynamics. Eventually, the model will

help to identify the plant traits that characterize susceptible and tolerant plants, opening new perspectives for varietal selection.