Modelling Biological Invasions with Application to Biological Methods of Crop Protection

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IN order to suppress the negative impact of fungal diseases and pests, biological methods of crop protection use different ways of field spatial structuring and introduction of a natural enemy into a plant-pest system. Actually, predator introduction and epidemic spread are the same phenomenon - *invasion*, when a species colonizes and persists in an area which it previously had not inhabited [2].

The main goal of the present research is to study the effects of spatial factors on the invasion process and its outcome, that is, to clarify those that can promote the *positive invasions*, stabilization of plant-pest-predator dynamics at a low level of pest density, and prevent *negative invasions*, that is disease spread over the field. We consider the following modes of dispersal: (1) *neighborhood diffusion*, when species expand their ranges by random movement into adjacent areas; (2) *long-distance dispersal*, when individuals tend to disperse far away from the parent colony; (3) *taxis*, the directed movement of individuals in response to a stimulus.

The spatial models of plant-pathogen system and plant-pest-predator community are based on PDE systems of the reaction-diffusion and taxis-reaction-diffusion types. The model of plant-pathogen dynamics allows to analyze the relations between mechanisms of short- and long-distance dispersals, spatio-temporal patterns of the negative invasion, and its rate of spread.

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The model for the tritrophic plant-pest-predator system considers both random and directed spatial movements of pest and predator populations. We assume that taxis of both consumer species is stimulated by heterogeneity of food density, and it is modelled according to the main assumption that acceleration of consumers is proportional to prey density gradient [1,3]. Because of this approach, the model is capable of exhibiting spatial patterns and a variety of dynamics: heterogeneous oscillations, quasi-periodic dynamics, and chaos despite the fact that local predator-prey interactions are described by the simple Lotka-Volterra functional response [3].

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