The use of mathematical modeling tools to predict the yield of genetically modified crops

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Introduction

Genetically modified plants are of great practical importance and are of scientific interest. The spatial heterogeneity of the distribution of insect pests is one of the most intensively studied areas of theoretical biology and mathematical modelling. This phenomenon is widespread in nature; in fact, it would be difficult to imagine an ecological system uniformly distributed in space. Spatial heterogeneity can be caused by various reasons. The development of new methods of mathematical modelling to solve the problem of predicting the dynamics of genetically modified populations, including a set of interrelated models, their numerical implementation in the form of software packages based on the direction of population movement, slowing effects and the types of their interaction are an important problem in the field of mathematical modelling of complex systems and are of interest to a large area of research.

Description of the problem

An applied problem of using transgenic crops to suppress insect pests in the field is the need to reduce the risk of pests adapting to the Bt-toxin produced by transgenic crops, taking into account the limitations of the spatial configuration of the system and the above scenario, the High-Asylum Strategy is recommended for monitoring development of pest resistance to Bt plants. “High dose” means that the toxicity level of Bt plants is high enough to kill almost all the larvae. A small percentage of surviving (Bt-resistant) individuals should be suppressed by ghb gthtvto transgenic fields or near special zones not modified by plants (shelters), which are the source of Bt-susceptible individuals, which when mated with Bt-resistant should reduce the percentage of the last offspring.

It is reasonable to assume that the easier it is for pests to get into "shelters", the faster they lose their resistance to poison and, in order to simplify the achievement of "shelters" by the pest as much as possible, we will reduce their size, maintaining a ratio of 20% of the main field. In work the type of arrangement of shelters is considered when four sections of a square shape with "ordinary" corn are located in the center of the transgenic field, when at the border a) there is ordinary corn, b) transgenic. Figure 1 shows the dynamics of pests in four shelters.

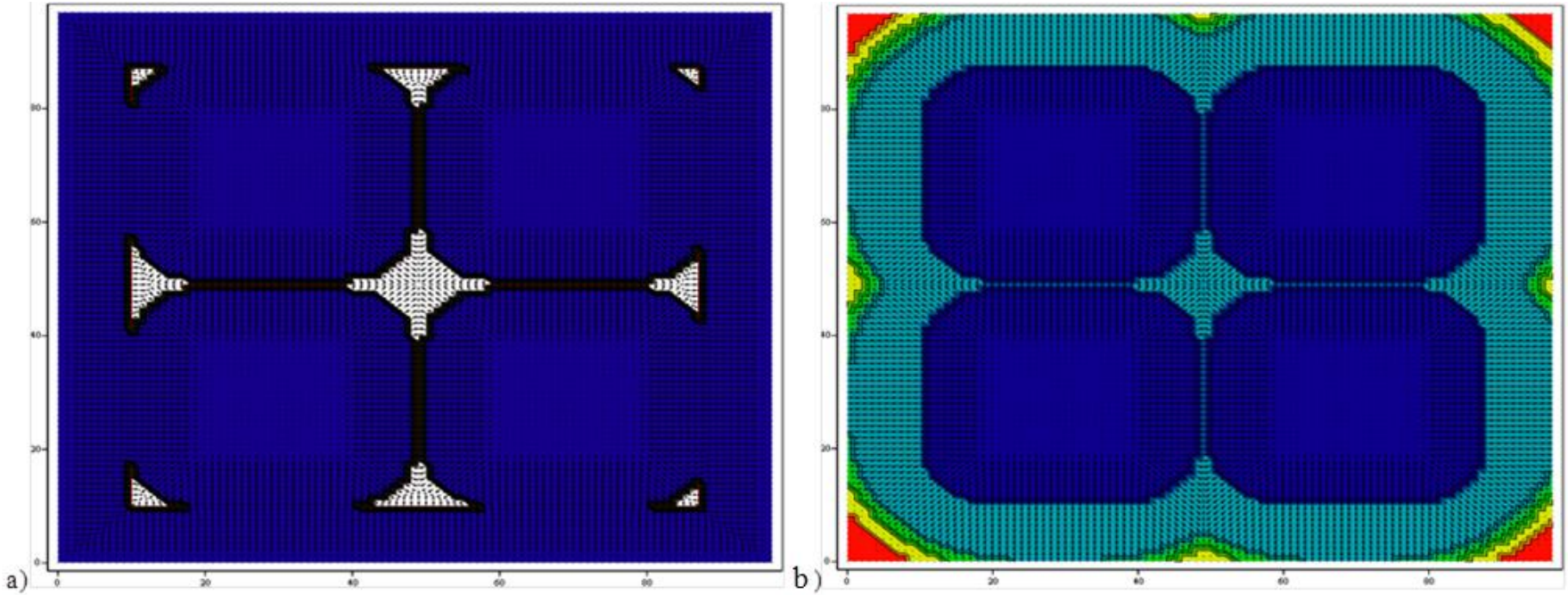

Figure 1. The location of the four square plots of the "ordinary" culture on the transgenic field

In figure 1 a) it is seen that at first plots with “ordinary” agricultural crops are eaten up, then - with transgenic and only after that areas that are inaccessible between them (highlighted in white). If the borders are from a transgenic variety, as shown in figure 1 b), the pests move directly from the "shelters" to the main part of the field (here the intensity of the palette from blue to red indicates an increase in concentration to the field borders). This is more clearly seen in figure 2.

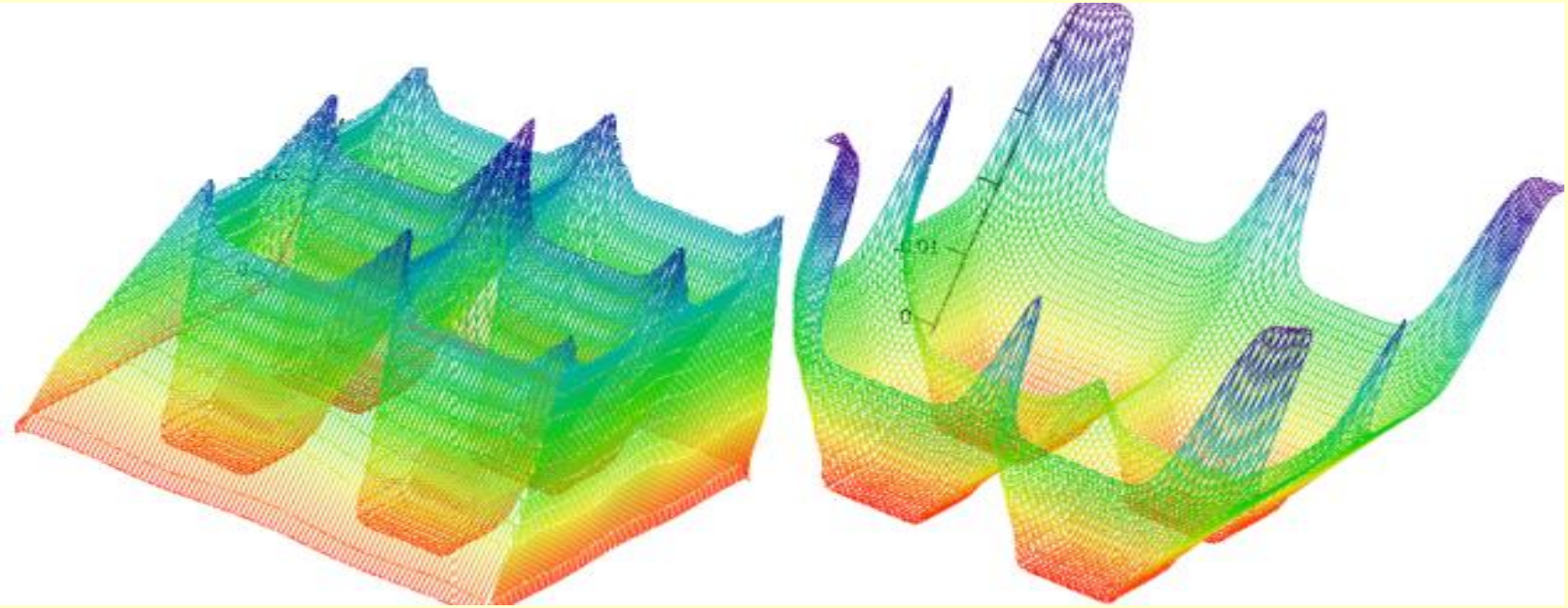

Figure 2. Eating a plant resource on a transgenic field with four rectangular "shelters"

Conclusion

Despite a significant number of publications, many of the effects that are important for improving the accuracy and reliability of long-term forecasts related to spatial heterogeneity of the environment, interspecific competition, taxis, slowing down and adaptation of plant resources were not taken into account in mathematical models.

The different concentration of plants on the field may depend on the following factors: processes with a lag effect characteristic of annual crops and causing uneven growth and development of plants, as well as spotting that occurs due to different sizes of transgenic and ordinary crops, their species and competition between them. The development of effective mathematical models, modeling systems and analytical methods for studying them and obtaining sufficiently accurate predictions of the concentration of harmful organisms would reduce the cost of the crop.