Experiments on dialog models of prognosis of the population density of *Globodera rostochiensis* in soil at different types of crop rotation

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Abstract. On predictive dialogue models, computer experiments were carried out to obtain data on the dynamics of population density of golden potato nematode in the soil after growing susceptible potato varieties, globoder-resistant potato varieties and unaffected plants in a 10-field crop rotation. When carrying out computer experiments on the model for predicting the population density of golden potato nematode in the soil after growing globoder resistant potato varieties in a 10-field crop rotation, it was found that when growing these varieties, it will take 8-9 years to completely destroy golden potato nematode population in the soil under favorable or average long-term conditions growing potatoes and other crops. Under unfavorable growing conditions for agricultural crops and globoder resistant potato varieties, the larvae of the ZKN remain in the soil for more than 10 years. In addition to predicting the population density of golden potato nematode after growing unaffected crops and potato varieties of varying degrees of resistance to nematode *Globodera rostochiensis*, computer models make it possible to theoretically substantiate optimal fruit changes and crop rotations, which will make it possible to effectively clear fields from phytoparasite.

1. Introduction

Modern crop production is evolutionarily reaching a new level of development, digital crop production, based on the maximum use of information technologies, since it can no longer function effectively without it [1, 2, 3].

In plant protection, digital level is characterized by a complete assessment of phytosanitary situation of each field, crop rotation based on the use of information technologies. One of the basic principles of information technology is presentation of all data in digital form, which makes them suitable for storage, processing and analysis by means of computer technology [1].

The source of initial information for digital plant protection is primarily the results of direct measurements and observations in the foci of phytoparasitosis, as well as data from long-term observations and field experiments [1, 4, 5, 6].

The use of machine learning, methods of analysis and data processing and creation of computer models can significantly reduce the use of resources, compared to standard field, experimental data acquisition process. In other words, less water, energy, land and nutrients will be required when conducting computer experiments instead of field experiments [7, 8, 9].

For the decision support system in potato growing, computer models are used to process and analyze numerical data arrays. Computer predictive models are maximally adapted to solving problems of
management activities and are a tool designed to assist agronomists and other agricultural specialists [8, 10, 11].

One of the main methods of controlling the golden potato nematode (GPN) is cultivation of potatoes in crop rotation fields, and on the plots of private subsidiary farming (PSF) in fruit change. According to scientists [12, 2, 9, 10] cultivation of globoder-resistant varieties and hybrids of potatoes in the fields of crop rotations and fruit changes significantly reduces the number of GPN in soil (by 55 - 98%). Currently, susceptible and globodera-resistant varieties of different ripeness groups are grown in private subsidiary farming and in summer cottages [11]. Therefore, study of influence of unaffected by GPN of plants, nematode-resistant potato varieties on the population density of GPN in the soil and the possibility of their use in the fight against potato globoders are relevant.

Carrying out computer experiments on a predictive computer dialogue model will help to theoretically substantiate the optimal preventive measures and measures to combat causative agent of potato globoderosis [5].

Currently, we have developed two computer predictive models of decision support in the management of protection of potatoes from GPN.

2. Materials and methods
Computer experiments have been carried out on the models "Computer dialogue model for predicting the population density of potato nematode gold in the soil after growing cereals, legumes, fodder, vegetable, technical, medicinal and ornamental plants", "Computer dialogue model for predicting the population density of potato nematode gold in the soil after growing susceptible and globoder-resistant varieties of potatoes of different ripeness groups "in order to obtain new data on the dynamics of population density of GPN in the soil after growing susceptible potato varieties, non-affected plants and globoder-resistant varieties of different ripeness groups, as well as data on the increase in population density of GPN in the soil after growing potato varieties in crop rotation fields. The reliability of models was assessed using A.A. Shesterepov’s methodology. [10].

3. Results and discussion
When carrying out computer experiments on the model for predicting GPN in the soil after growing susceptible potato varieties in a 10-field crop rotation, it was found that when comparing the data obtained on a computer model and the original data, a sufficiently high reliability was shown (correlation coefficient R = 0.79). With the saturation of crop rotation fields with potatoes of susceptible varieties, up to 40% of GPN in the soil is maintained at the level of 21-30 thousand eggs and larvae of GPN in 100 cm³ of soil (Figure 1). At the same time, in the field, an increase in the number of pathogens of globoderosis is observed and the yield of potatoes sharply decreases [2, 5, 12].

![Figure 1](image_url)  
Figure 1. Modeling the dynamics of population density of golden potato nematode Globodera rostochiensis in the soil of a field of 10-field crop rotation when growing a sentient cultivar in experiment and model.
When carrying out computer experiments on the forecast model of GPN in the soil after growing globoder resistant potato varieties in a 10-field crop rotation, it was found that when growing these varieties, it will take 8-9 years to completely destroy GPN population in the soil under favorable or average long-term potato growing conditions. Under unfavorable conditions for growing agricultural crops, larvae of GPN remain in the soil for over 10 years (Figure 2).

![Figure 2](image2.png)

**Figure 2.** Modeling the population density dynamics of golden potato nematode Globodera rostochiensis in the soil of a 10-field crop rotation field when growing a Globodera-resistant potato variety.

When carrying out computer experiments on the model for predicting GPN in the soil after growing susceptible potato varieties in a 10-field crop rotation, it was found that the number of GPN in the soil increases to 30 thousand eggs and larvae of GPN (Figure 3).

![Figure 3](image3.png)

**Figure 3.** Modeling the population density dynamics of golden potato nematode Globodera rostochiensis in the soil of a 10-field rotation field when growing a sentient potato variety.

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The rate of increase in the number of GPN in the soil is compensated by the cultivation of non-affected crops. Their effect depends on growing conditions: under favorable conditions, 1-2 years are enough when GPN reaches up to 2 thousand eggs and larvae in the soil. Under unfavorable conditions for growing potatoes in a crop rotation, the period of decrease in GPN in private subsidiary farming is delayed more than 10 years. Under long-term average growing conditions of sentient potato varieties, the dynamics of GPN in the soil reaches its maximum number for 4-6 years, and in subsequent years, when growing non-affected crops, a decrease in GPN is observed before planting a sentient potato variety (Figure 3).

4. Conclusion
As a result of experiments carried out on computer dialogue models for predicting the population density of the nematode Globodera rostochiensis in the soil after growing unaffected crops, sentient and globodera-resistant potato varieties in fields of different types of crop rotations under different growing conditions, new data were obtained on dynamics of population density of nematode Globodera rostochiensis.

When carrying out computer experiments on the forecast model of GPN in the soil after growing sentient potato varieties in a 10-field crop rotation, it was found that when comparing the data obtained on the computer model and the original data, a sufficiently high reliability was shown (the correlation coefficient is 0.79).

The efficiency of cultivation of nematode-resistant potato cultivars in decreasing private subsidiary farming GPN in comparison with cultivation of sentient cultivars was shown on the example of a 10-field crop rotation with 40% saturation of fields with potatoes. When carrying out computer experiments on a forecast model of the GPN in the soil after growing globoder resistant potato varieties in a 10-field crop rotation, it was found that when growing these varieties, it will take 8-9 years to completely destroy GPN population in the soil under favorable or average annual conditions for growing potatoes and other crops. Under unfavorable growing conditions of agriculture crops and globodera-resistant potato varieties larvae of ZKN remain in the soil for more than 10 years.

In addition to predicting the density of GPN population after growing non-affected crops and globodera-resistant potato varieties, the presented models make it possible to independently compile crop rotations and select crops that will clear the fields from nematode Globodera rostochiensis.

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