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DETERMINATION OF DISEASE DEVELOPMENT IN PLANTS ON THE BASIS OF PROGNOSIS

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Abstract. Determining the development of diseases in plants based on prognosis is widely used in modern agricultural technologies. This approach is based on a variety of data to predict the occurrence and spread of plant diseases. The article describes the types of forecasting and the stages of the forecasting scheme one by one.
Key words: prognosis, destruction, pathogen, biological property, range, humidity, fungal diseases, epidemic modeling, simulation.

Introduction

To create a system of protective measures in plants, it is very important to forecast their diseases. Anticipating the development of the disease means predicting the nature of the expected disease in order to take timely measures to prevent or limit it [1]. The main goal of the forecast is to reduce the volume of extermination measures (mainly, the number of chemical treatments) without reducing the overall effectiveness of plant protection.

Literature analysis and methodology

Many scientists have carried out scientific research on determining the development of diseases in plants based on the prognosis. They cover the fields of ecology, agriculture, genetics, biology and data analysis. J.C. Zadox is known for developing plant disease forecasting systems. He conducted research on the epidemiology of plant diseases in the field of plant pathology and worked extensively on the prediction of fungal diseases in plants. Pierre-Henri Dodet conducts scientific work on forecasting plant diseases in agriculture. He is one of the scientists who developed disease forecasting systems based on environmental and meteorological factors. Nanneke Koenders is one of the scientists who specializes in predicting the development of plant pathogens, and has conducted scientific research on disease detection based on modern technologies, including spectral and thermal imaging, and artificial intelligence.

H. Bertrand worked on the forecasting of plant diseases with the help of modern technologies. He studies the prediction of plant pathogens using artificial intelligence and data analysis techniques. Marc G. Gent conducts research on plant disease epidemiology and has developed methods based on ecological modeling and meteorological data analysis to predict disease development.

Result and discussion

For forecasting, it is necessary to know the biological characteristics of the pathogen (the pathogen's development cycle, reproduction characteristics, its storage methods, etc.), and the resistance of cultivated crop varieties [2]. To take into account the environmental factors affecting the pathogen and the development of the disease (pathogen's temperature range, reaction to humidity, growth characteristics of disease-causing fungi, etc.), it is necessary to

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have the necessary information for this. That is, it is necessary to know the meteorological conditions of a certain region in the past season and the weather forecast for the future.
It is necessary to take into account the following main factors in forecasting systems.
1. Weather information
Many plant diseases depend on weather conditions. For example, factors such as humidity, air temperature and precipitation affect the development and spread of pathogens. Moisture and rain are the main factors for fungal diseases, which are often aggravated by rainy and humid weather. Temperature - some diseases develop in a certain temperature range[3]. For example, bacterial diseases can spread at low temperatures.
2. Data analysis (Data analytics)
With the help of artificial intelligence and Big Data technologies, past data (historical records of disease outbreaks, planting history, agrotechnical measures, etc.) are analyzed and future risks are predicted. This method uses large databases and advanced algorithms.
3. Plant monitoring
Field monitoring is carried out using drones, satellites and IoT devices. With the help of these technologies, a large amount of information about the state of plants is collected and their changes are monitored. Based on the obtained data, the level of plant health and disease risk is determined [4].
4. Epidemic modeling
The prevalence of diseases can be predicted by mathematical modeling. These models are used to predict pathogen reproduction rates, ecosystem impacts, and potential disease outbreaks. For example:
The fungal disease model is the probability of disease spread based on environmental conditions and plant condition.
Viral and bacterial disease models – these models predict the distribution of disease vectors and the course of disease development.
5. Agricultural simulation systems
Special programs are used to simulate plant diseases. For example, a simulation program assesses disease risk based on crop planting and management strategies.
6. Real time monitoring
Real-time sensors or IoT devices monitor plant diseases and make predictions based on the data. This technology makes it possible to act before the symptoms of the disease appear.
7. Artificial intelligence and machine learning (AI/ML) algorithms
AI technologies are used in the analysis of disease development factors and processes. Machine learning algorithms collect data from fields or through images of plants, which are then used to predict disease development in plants.
Forecasting is divided into three types: Long-term (strategic), long-term and short-term.
Long-term forecasts describe the average level of harmfulness of the most dangerous diseases expected in the next 5-10 years, the expected range of deviations in the development of each disease by year, the probability of the emergence of new races. In particular, changes in pathogen and disease domains, taking into account ongoing climate change and changes in crop production technology. Long-term forecasts are developed by scientific institutions[5]. Based on these forecasts, a plant protection strategy (volume of production of plant protection products, planning of personnel training, change of varieties, etc.) is developed.

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Long-term forecasts are developed for the coming year or growing season. This is a prediction of the development of the disease and possible losses in the coming year. Such forecasts are necessary for the selection of preventive measures and for planning the scope of catastrophic protection measures in a specific situation. When making a long-term forecast, the following factors are taken into account: the quantity and quality of the wintering pathogen; disease susceptibility of host plants; the degree of manifestation of the disease in the last season; weather conditions affecting the development of the disease; weather forecast for the upcoming growing season.

A reliable long-term forecast can only be made if information about the intensity of disease development and weather conditions (temperature, humidity, amount of precipitation, time of precipitation, etc.) is known for a sufficiently long period of time. possible - at least 9.. .10 previous years. The longer the observation period, the more reliable the long-term prognosis. There are several ways to make long-term forecasts. One of them (meteopathological) is based on the relationship between the degree of development of the disease and weather factors[6]. Weather factors are taken into account not separately, but together. In each climate zone, a general index of weather factors is calculated for the predicted disease each year. Then, by entering its value into the prognostic formula obtained on the basis of long-term (9...10 years) data on a specific type of disease in a certain climate zone, the expected intensity of the development of this disease is determined. First, an initial long-term forecast is made - until the end of the calendar year, and then (3...4 months before the start of the growth period) - an updated long-term forecast is made.

A short-term forecast is made for a certain disease for a period of one week to one month. The main goals of short-term forecasting are to predict the exact times of primary and subsequent infections and to inform agricultural producers about it in time. The preparation of a short-term forecast is based on accurate information about the biology of the pathogen: the form and place of its storage in the winter, the conditions under which the primary infection of plants is possible, the influence of weather factors (mostly temperature). , humidity, precipitation) on the development of the pathogen and the dynamics of the disease [7]. For short-term forecasting, information about the quantitative stock of the pathogen and the places where it can be stored is very important. For example, to predict the timing of the appearance of stripe or stem rust, the infection of fall crops in the fall, the probability of aeciostage formation in an intermediate plant (zirk), and the airborne introduction of urediniospores. It is considered that the disease started earlier.

Short-term forecasting is impossible without meteorological observations, because the pathogen, plant and weather are the three main components of any disease. When making a short-term forecast, it is necessary to conduct parallel observations in these three areas.

The scheme of making short-term forecasts of plant diseases includes the following stages (passing from one stage to another is carried out only after recording the necessary data from the previous stage).

1. Phenological observations of the plant before determining the beginning of the sensitive phase.

2. Taking into account the stocks of the infectious agent and its viability (this stage often corresponds to the first one). Reaching the phenophase of the plant in which the disease can be manifested and determining the presence of the pathogen ready for infection shows that only favorable environmental conditions are necessary for the beginning of the infectious process.

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3. Conducting meteorological observations and recording the critical situation in which infection may occur (usually this is a certain temperature range and a period of plant moisture or the level of relative air humidity in a certain period of time).
4. Determination of the date of the primary infection (specific result of the previous stage).
5. Determining the duration of the incubation period and setting its end date. Knowing the date of the primary infection, the duration of the incubation period can usually be determined after recording the average daily temperature during the first 3 ... 4 days. This is definitely done after infection. The end of the incubation period is determined 3-5 days before the actual manifestation of the disease, depending on the technique used.
6. Signals and recommendations for plant protection. Short-term forecasts are usually provided by district and inter-district forecasting and signaling points on the emergence of pests and diseases included in the system of the republican plant protection service, although for some objects this is within the capabilities of the agrotechnical service of large enterprises.

CONCLUSION

Prognostication of plant diseases is very important in agrotechnical processes, so that timely measures can be taken to prevent disease and reduce damage. Detecting the spread of diseases through technologies and algorithms makes it possible to increase productivity in agriculture and ensure environmental safety.

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