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Article

Digital Analysis of Apricot Diseases and Pests, Their Detection and Evaluation Using An Electronic Program

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Abstract: This article addresses the issues of detecting, analyzing, and evaluating the main diseases and pests occurring in apricot fruit trees using modern digital technologies. The possibilities of using digital image processing, artificial intelligence, computer vision, and electronic software in monitoring the phytosanitary condition of the apricot tree are considered. In addition, methods are proposed for calculating the disease incidence and the intensity of damage on the basis of mathematical formulas. The possibilities of using an electronic program to identify disease symptoms, express the degree of damage as a percentage, store data in an electronic database, and develop appropriate recommendations on the basis of monitoring results have been substantiated.

Keywords: apricot, fruit trees, diseases, pests, digital technologies, artificial intelligence, electronic program, digital monitoring, computer vision, phytosanitary control, disease incidence.

Introduction

At present, the use of modern information and communication technologies is of great importance in increasing production efficiency in agriculture, improving the phytosanitary condition of fruit orchards, and preserving yield [1], [2]. In particular, timely detection of diseases and pests occurring in fruit trees, assessing the degree of their spread, and determining effective protection measures is one of the topical issues [3].

The apricot (Prunus armeniaca L.) is one of the fruit crops widely grown in our country and important from the standpoint of economic and food security [4]. Apricot fruits contain vitamins, minerals, and biologically active compounds necessary for the human body. Therefore, in growing apricots, ensuring the healthy development of trees and combating diseases and pests in a timely manner is important.

Moniliosis, leaf perforation disease, powdery mildew, bacterial diseases, and other phytopathological problems may occur in apricot trees [5]. In addition, apricot aphid, fruit moth, spider mite, and other pests damage the vegetative and generative organs of the tree [6]. As a result, fruit quality decreases, yield declines, and in some cases trees dry out.

In the traditional method, the detection of diseases and pests is often based on visual observations by specialists. Such an approach is time-consuming, and in some cases it becomes difficult to detect the

initial symptoms of a disease [7]. For this reason, developing systems for detecting diseases through digital images and for automated evaluation has important scientific and practical significance [8], [9].

AIM AND OBJECTIVES OF THE RESEARCH

The main aim of the research is to develop a methodology for detecting diseases and pests occurring in apricot fruit trees using digital technologies and electronic software tools and for evaluating their degree of spread and damage.

To achieve this aim, the following objectives were set:

1. To study the main species of diseases and pests occurring in apricot trees;
2. To identify the external morphological symptoms of diseases and pests;
3. To collect digital images of leaves, fruits, and branches;
4. To develop algorithms for processing digital images;
5. To classify diseases and pests with the help of artificial intelligence;
6. To calculate the intensity of disease and damage mathematically;
7. To store and analyze monitoring results through the electronic program.

Materials and Methods

The symptoms of diseases and pests observed on the leaves, fruits, twigs, and other vegetative organs of apricot trees are taken as the research materials.

In the research process, the use of visual observation, digital photography, mathematical-statistical analysis, computer-aided image processing, and artificial intelligence algorithms is envisaged.

The process of detecting diseases is carried out in the following stages:

1. Obtaining digital images from diseased and healthy organs of the apricot tree.
2. Uploading the obtained images to the electronic program.
3. Preliminary processing of the images and reducing unwanted noise.
4. Extracting visual features specific to a disease or pest.
5. Identifying the type of disease or pest using an artificial intelligence model.
6. Mathematical calculation of the degree of damage.
7. Entering the results into the electronic database and generating a report.

Python programming language and the OpenCV library can be used in processing digital images. In classifying diseases and pests, it is advisable to apply artificial intelligence technologies such as TensorFlow or YOLO.

Result

Diseases occurring in apricot trees manifest with various symptoms on the leaves, fruits, twigs, and trunk of the plant.

Moniliosis disease. This disease is caused by fungi belonging to the genus Monilinia. As a result of the disease, flowers, twigs, and fruits are damaged. Brown rot symptoms appear on the fruits, and the marketable quality of the crop decreases.

Leaf perforation disease. Under the influence of the fungus Clasterosporium carpophilum, small spots initially appear on the leaves. Later, the central part of the spots dries up and falls out, as a result of which holes form in the leaves.

Powdery mildew disease. This disease is characterized by the formation of a whitish, powdery coating on leaves and young twigs. Severe damage negatively affects the plant's photosynthesis process.

Bacterial diseases. Some bacteria cause damage to twig and trunk tissues, as well as necrosis and the formation of wounds [10].

The main pests occurring in apricot trees include apricot aphid, fruit moth, spider mite, and other phytophagous organisms. They negatively affect the plant's nutrition, photosynthesis, and fruit-bearing processes [11].

Detection Of Diseases And Pests Using An Electronic Program

It is proposed to develop a special electronic program for the digital assessment of the phytosanitary condition of apricot trees. The program can operate via a mobile phone or a computer.

The program should have the following main functional capabilities:

1. Uploading an image of an apricot leaf and fruit;
2. Automatic analysis of the image;
3. Identifying the type of disease or pest;
4. Calculating the damaged area;
5. Showing the disease incidence as a percentage;
6. Storing data in an electronic database;
7. Presenting results in the form of tables and graphs;
8. Recommending appropriate protective measures to the user.

Convolutional neural networks (CNN) can be used in the program for analyzing images, and YOLO algorithms for detecting objects. In this case, the model is trained on the basis of predefined images of diseases and pests.

To ensure the effectiveness of the program, it is necessary to form a database consisting of high-quality digital images of healthy and diseased leaves, damaged and healthy fruits, and pests [12].

Mathematical Evaluation Of Disease Incidence And Degree Of Damage

The use of mathematical calculation methods is important in determining the disease incidence in apricot trees.

Disease incidence is calculated using the following formula:

$K = (n / N) \times 100$

Where:

a. K — disease incidence, %;
b. n — number of diseased samples;
c. N — total number of examined samples.

For example, if 25 out of 100 apricot leaves are diseased, the disease incidence is determined as follows:

$K = (25 / 100) \times 100 = 25\%$.

A damage score system can be used in determining disease intensity:

$R = [\Sigma(a_i \times b_i) / (N \times amax)] \times 100$

Where:

a. R — intensity of damage, %;
b. a_i — score assigned to the degree of damage;
c. b_i — number of samples with the corresponding score;
d. N — number of examined samples;
e. amax — maximum damage score.

Using these formulas, it is possible to quantitatively assess the phytosanitary condition of apricot trees and to compare results from different observation periods.

Organizing Digital Monitoring In The Electronic Program

The electronic program makes it possible to conduct regular monitoring in apricot orchards. In this case, data are recorded separately for each tree or orchard area.

It is advisable to store the following data in the program:

1. Location of the orchard;
2. Number and age of trees;
3. Observation date;
4. Type of disease or pest identified;
5. Number of damaged organs;
6. Disease incidence;
7. Intensity of damage;
8. Protective measures taken;
9. Results of subsequent observations.

On the basis of these data, it is possible to study the dynamics of the spread of diseases and pests over time, identify high-risk areas, and plan protective measures.

In addition, by integrating geographic information system (GIS) technology into the electronic program, it is possible to create a map of disease distribution in orchards [13].

Discussion

Detecting diseases and pests of apricot trees using digital technologies makes it possible to improve traditional visual observation methods. In particular, artificial intelligence-based image analysis systems are important for the rapid detection of disease symptoms and for processing large volumes of data [14].

However, the accuracy of such systems depends on a number of factors. In particular, image quality, light level, the developmental stage of the leaf, the similarity of disease symptoms, and the quality of training of the artificial intelligence model affect the results.

For this reason, before introducing the electronic program into practice, it is necessary to test it in different regions, on apricot trees of different varieties, and at different developmental stages. The diagnoses given by the program must be verified by a phytopathologist or a plant protection specialist.

Another advantage of the digital monitoring system is that it helps to organize protective measures against diseases and pests in a timely manner. As a result, the possibility arises of reducing unjustified use of chemical preparations and increasing environmental safety and economic efficiency [15].

Conclusion

Detecting and evaluating diseases and pests occurring in apricot fruit trees on the basis of digital technologies is one of the promising directions for modernizing horticulture.

During the research, the possibilities of using digital image processing, artificial intelligence algorithms, and mathematical calculation methods in assessing the phytosanitary condition of apricot trees were substantiated.

With the help of the electronic program, it is possible to detect diseases and pests, calculate disease incidence, evaluate the intensity of damage, store data, and analyze monitoring results.

Improving the proposed digital system and introducing it into production practice serves to control the phytosanitary condition of apricot orchards, preserve yield, and increase the effectiveness of plant protection measures.

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