The design about early warning of vegetable disease in facility agriculture

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Abstract. In order to study the intelligent early warning methods for vegetables in facilities agriculture, taking radish root disease as an example, early warning model of the decision tree was constructed through agricultural vegetable planting data. The model intelligently analyzes the temperature, humidity and soil conditions in the greenhouse and gives an early warning result. Finally, the model was tested and has good prediction results. This method has important practical significance for early warning of vegetable disease, reducing the use of pesticides, improving food safety and reducing soil pollution.

1. Preface

Disease is an important factor which restricts the production of vegetable in facility agriculture. In greenhouses, especially in winter, because of warmth, humid, no aeration, and weak light, it is very likely to cause vegetable diseases. Spreading of diseases reduce the quality and outputs of vegetables, and result in economic loss. Currently, diseases and pests of vegetable in greenhouse are predicted mainly through thermometer or hygrometer or even farmer’s experience. Especially, for preventing disease and keeping healthy of vegetable, farmers even regularly spray pesticide before the occurrence of the disease. It not only cannot meet the consumer's demand for green organic, but also lead to high cost of planting, food safety crisis and soil pollution. Traditional mode of production is needed to be reformed.

Therefore, for strengthening the foresight of the management of vegetable diseases in greenhouse, it is necessary to establish an early warning platform for vegetable disease in facilities agriculture. The technique of early-warning is an important way to avoid vegetable diseases. Nowadays, some researchers made some studies in early warning arithmetic. Base on international and domestic agricultural outlook, ShiWei Xu\textsuperscript{[1]} developed a monitoring and early-warning system of china agriculture from economics view. Lingxian Zhang\textsuperscript{[2]} built an early warning method of vegetable disease by support vector machine. Siqi Ji\textsuperscript{[3]} construct early warning of vegetable diseases by decision tree C4.5 algorithm in facility vegetable diseases. LiMing\textsuperscript{[4]} built the framework of early warning for greenhouse vegetable diseases that was set up with the basis of classical early warning method, the logical course of new early warning method, and the key techniques of modern early warning method. Taking primary infections of cucumber downy mildew for example, the framework was evaluated. Based on Beijing's data for 4 years, Zhao\textsuperscript{[5]} built an early-warning system for disease diagnosis. Marvin\textsuperscript{[6]} used weather and other environmental conditions to foretell food safety hazards. Li\textsuperscript{[7]} set up the framework of early warning for greenhouse vegetable diseases with the basis of classical early
warning method, the logical course of new early warning method, and the key techniques of modern early warning method. Cao[8] built an early warning model of crop disease early warning by neural network based on web service technology.

Taking radish root disease as an example, this article constructs an early warning model by decision tree, which is more concise and effective. The research can provide a reference for the construction of large-scale early warning system.

2. Related Concept

2.1 Early Warning

Vegetable early-warning system which is called communication systems including sensors, event detection, decision subsystems. These techniques work together to provide disease warning information for greenhouse vegetables for minimizing the impact of adverse environmental factors [9].

2.2 Decision-making Tree

Decision-making tree is a useful decision support method that can construct tree-like graphs or decision models and their possible consequences, including opportunistic event results, resource costs, and utility. It is a way to display an algorithm that only contains conditional control statements. A decision-making tree consists of three types of nodes: decision nodes: usually represented by squares; chance nodes: usually represented by circles; end nodes: usually represented by triangles[10].

In this paper, we will use C4.5 algorithm of decision-making tree on Matlab 2014b platform. The early warning system will be built in the order as Figure 1 shows:

![Figure 1. The early warning system](image)

3. Prepare Data

3.1 Types of Disease Prediction

The common diseases of following vegetables can be diagnosed by this system, including Cabbage, bean, kale, cucumber, leek, radish, eggplant, pepper, tomato, onion. This paper will provide a clear description of the way of early warning by an example of clubroot of radish.

3.1.1 The introduction of radish’s clubroot. Sick radish cannot be eaten, the yield and quality would be reduced destructively if they were attacked by clubroot. The disease is caused by fungal infection of plasmodiophora brassicae woronin. Normally the average temperature for clubroot development ranged from 9 °C to 30°C , the average soil moisture content ranged from 45% to 98%, and the average soil PH value ranged from 5.4 to 6.5, this diseases can happen at any time.

3.1.2 300 training data. According to scientific literature and agricultural database, 300 pieces of data can be got, including serial number, disease or not, temperature, soil moisture content and soil PH value. The data table is as illustrated in the table below.
| number | disease or not | temperature | soil pH | soil moisture |
|--------|----------------|-------------|---------|--------------|
| 1      | 1              | 40          | 6       | 63           |
| 2      | 1              | 47          | 70      | 5.5          |
| 3      | 2              | 10          | 6.3     | 90           |
| 4      | 1              | 5           | 509     | 50           |
| 5      | 2              | 22          | 5.8     | 100          |
| 300    | 1              | 17          | 5.8     | 97           |

Among them, 270 records are used as model training and 30 records are used to test accuracy of the model.

4. Decision Tree

4.1 Relevant concepts

Decision-making tree algorithm is a mining method of approximating the value of discrete functions. It is a classic classification technique, which first processes the data, uses the inductive algorithm to build readable rules and decision trees, and then uses the decision to analyze the new data. Essentially, a decision-making tree is the process of classifying data through a series of rules.

4.2 Code Implementation

All code is run in Matlab 2014b.

Decision tree classifier is built by following code:

classregtree(P_train,T_train);
view(ctree);
T_sim = eval(ctree,P_test);
if T_sim == 2;
    output='The disease of clubroot are apt to happen!';
else
    output='Safety.';
end;

So, the decision tree can be built by the 270 recodes data, as following figure shows,
Figure 2. The decision tree according to training data

For example, if current environment temperature is 10, soil PH is 6.3 and soil moisture is 90%. The red lines in Figure 3 represent the class label of leaf node is ‘2’, it means that in this environment will lead to disease.

Figure 3. The decision tree

In practice, we have tried two methods of building decision trees. Method 1, build a decision tree based on accumulated agricultural experimental data, disadvantage is that the acquisition of data is more difficult. Due to the distribution of data, the decision tree established is different from the theoretical incidence conditions. We need to further correct decision tree. Method 2, According to the disease conditions of the research literature, the data is constructed, and then the data is used to construct a decision tree. The decision tree obtained by this method is consistent with the onset conditions of the literature and does not need to be corrected. In this paper, the second method is chosen. In fact, the corresponding method can be selected according to the research purpose.
5. Model Test

Next, we will test the model through 30 pieces of data from the database. The forecast result is as follows:

| Total number of training sets:300 | Safety:246 | Radish stem disease:54 |
|----------------------------------|------------|------------------------|
| Total number of test sets:100    | Safety:86  | Radish stem disease:14 |
| The total number of normal warning result:85 | Misdiagnosis:1 | Correct rate: 98.84% |
| Early warning result is Radish stem disease:14 | Misdiagnosis:0 | Correct rate: 100% |

It can be seen that the early warning model of turnip root swelling constructed by decision tree has high accuracy, and can be used for other vegetables as Figure 4 shows.

![Figure 4. Structure of the early warning platform](image-url)

However, the comprehensiveness of data affects the construction of decision tree. So it is also an important factor affects the accuracy of algorithm and it is the next question that needs further study.

6. The Conclusion

This paper constructed an early warning model of radish root disease based on decision tree algorithm, and tested the performance of the model. The accuracy of the model was good. It was of practical significance to reduce pesticide application and inhibit soil pollution in facility vegetable planting.

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