

An Expert System for Citrus Diseases Diagnosis

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Abstract: Background: Citrus, genus of plants belonging to the rue family (Rutaceae), and yielding pulpy fruits covered with fairly thick skins. Economically important plants in this group include the lemon (*C. × limon*), lime (*C. × aurantiifolia*), sweet orange (*C. × sinensis*), sour orange (*C. × aurantium*), tangerine (*C. reticulata*), grapefruit (*C. x paradisi*), citron (*C. medica*), and shaddock (*C. maxima*)[1]. **Objectives:** The main goal of this expert system is to get the appropriate diagnosis of disease and the correct treatment by presenting suggestions on Citrus diseases to the user with pictures to be accurately diagnosed. **Methods:** in this paper the design of the proposed Expert System which was produced to help farmers in diagnosing many of the Citrus diseases such as Citrus canker, Citrus scab, Citrus tristeza disease, Gummosis, Greening or Huanglongbing, Sooty mould, Powdery mildew and Anthracnose. the proposed expert system presents an overview about Citrus diseases are given, the cause of diseases is outlined and the treatment of disease whenever possible is given out. CLIPS Object Expert System language was used for designing and implementing the proposed expert system. **Results:** The proposed Citrus diseases diagnosis expert system was evaluated by agricultural engineers and they were satisfied with its performance. **Conclusions:** The Proposed expert system is very useful for agricultural engineer, specialists in plant pathology, and researchers on Citrus plant.

Keywords: Artificial Intelligence, Expert Systems, CLIPS, Citrus diseases, Plant, agricultural engineering, Citrus.

1. INTRODUCTION

An expert system incorporates a knowledge base containing accumulated experience and an inference or rules engine a set of rules for applying the knowledge base to each particular situation that is described to the program. The system's capabilities can be enhanced with additions to the knowledge base or to the set of rules. Current systems may include machine learning capabilities that allow them to improve their performance based on experience, just as humans do [2].

Plant diseases are one of the most important reasons that lead to the destruction of plants and crops. Detecting those diseases at early stages enable us to overcome and treat them appropriately. This process requires an expert to identify the disease, describe the methods of treatment and protection. Identifying the treatment accurately depends on the method that is used in diagnosing the diseases. Expert systems help a great deal in identifying those diseases and describing methods of treatment to be carried out taking into account the user capability in order to deal and interact with expert system easily and clearly (show Fig1).

This requires that the user should be competent in using expert systems. An expert system was developed using two different methods of plant diagnosis: Step by step descriptive and graphical representational methods. Present expert system plays the role of an agricultural engineer and provides the user with different methods of diagnostic and treatment. An initial evaluation of the system shows a positive impact on the expert system with graphical representational method [3].

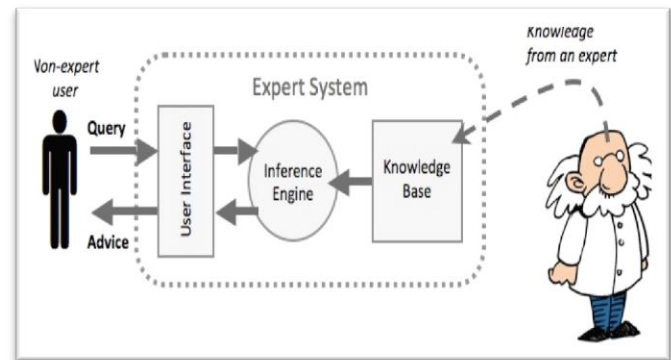


Figure 1: The figure presents the Main Components of an

2. EXPERT SYSTEM.

The most commonly reported symptoms of suspected citrus disease are related to discoloration of the leaves. More than 60 percent of reports submitted through the Save Our Citrus program cite spotted or blotched leaves, or leathery leaves with yellow or clear veins. While these symptoms are telltale signs of citrus greening disease, abnormal looking citrus leaves can also be the result of other factors such as unfavorable weather or overwatering. Additionally, other severe citrus diseases such as citrus canker and sweet orange scab can cause lesions on the leaves (as seen in Fig2) [4].



Figure 2: Example Snapshot of citrus disease.

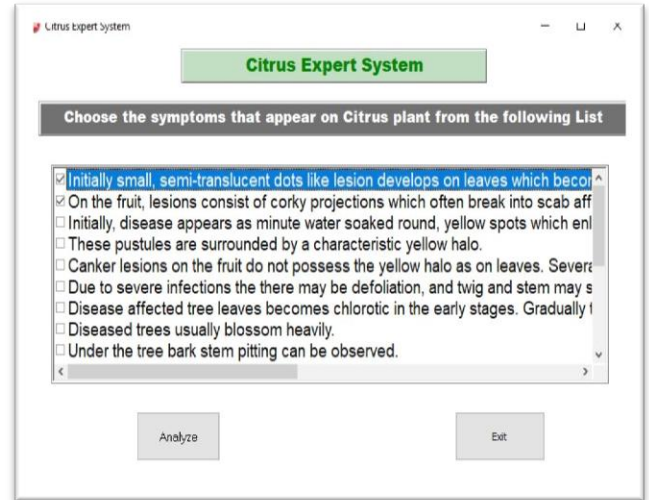


Figure 4: Symptoms selection

3. MATERIALS AND METHODS

An expert system is programmed by Clips language with graphical user interface, which is based on the theory of rules that lead to the facts (Show Fig3).

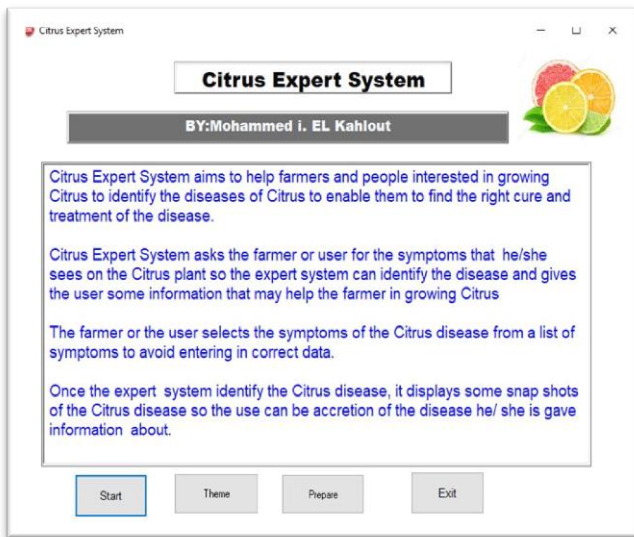


Figure 3: Main Window for EX. System

In this sense, the system was provided with prior knowledge of citrus diseases, which was based mainly on agricultural experts and engineers. This system allows the user to choose the symptoms that he sees in the plant (Show Fig4).

Accordingly the plant disease is determined with a clear picture of the disease for user confirmation. The system provides the specific causes of the disease and what methods of treatment and prevention are followed (show Fig5).

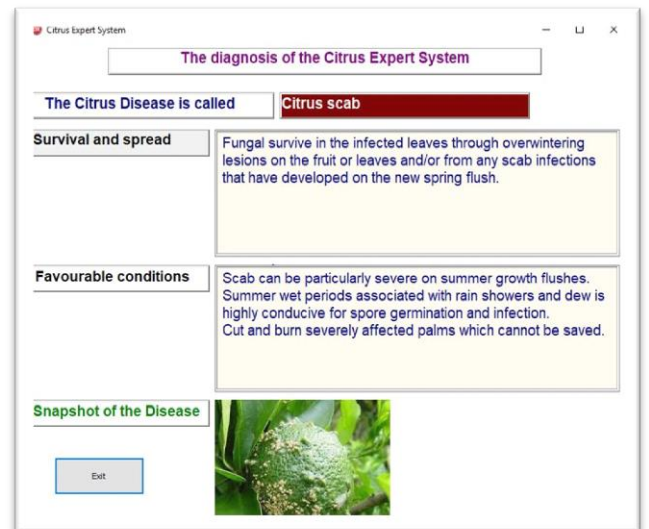


Figure 5: The figure of starting window.

4. LITERATURE REVIEW

There are many expert systems designed to diagnose of Human[22-36,38-40,42,45-50,52-57,64] and plant diseases[15-21,43,51,62,65-72], In this topic there are a lot of researches which talked about citrus diseases, but reduced the talk of one disease of citrus diseases such as "Citrus Research and Education Center" Which is specialized in Citrus Huanglongbing and so on[6]. In this paper we talked about eight Diseases with an expert system and symptoms in addition to supported images and methods of prevention and treatment.

5. KNOWLEDGE REPRESENTATION

The main sources of the knowledge for this expert system is Agricultural engineer and specializes websites for plants diseases. The captured knowledge has been converted into CLIPS Knowledge base syntax (Facts, Rules and Object). Currently the expert system a lot of rules which cover eight Citrus diseases.

- **Citrus scab**

Conidia are produced on the surface of scab pustules. These spores spread to new susceptible tissue. There are two kinds of spores, clear oval shaped and colored spindle shaped. The clear oval shaped type are spread by splashing rain and perish as soon as they dry, while the spindle-shaped form remain viable for a short time and are dispersed by wind for short distances [7].



Figure 6: The figure Citrus scab

- **Citrus canker**

A disease affecting Citrus species caused by the bacterium *Xanthomonas axonopodis*. Infection causes lesions on the leaves, stems, and fruit of citrus trees, including lime, oranges, and grapefruit. While not harmful to humans, canker significantly affects the vitality of citrus trees, causing leaves and fruit to drop prematurely; a fruit infected with canker is safe to eat, but too unsightly to be sold [8].



Figure 7: The figure Citrus canker

- **Citrus tristeza**

viral species of the genus *Closterovirus* that causes the most economically damaging disease to its namesake plant genus, Citrus [14].



Figure 8: The figure Citrus tristeza

- **Gummosis**

Nonspecific condition where sap leaks from a wound in the tree. It usually occurs when the tree has a perennial or bacterial canker, or is attacked by the tree borer [9].



Figure 9: The figure Gummosis

- **Huanglongbing (HLB)**

Citrus greening is the most severe citrus disease, currently devastating the citrus industry worldwide. The presumed causal bacterial agent *Candidatus Liberibacter* spp. affects tree health as well as fruit development, ripening and quality of citrus fruits and juice. Fruit from infected orange trees can be either symptomatic or asymptomatic [10].



Figure 10: The figure Huanglongbing.

- **Anthracnose**

Generally found in the eastern part of the United States, anthracnose is caused by fungi in the genus *Colletotrichum*, a common group of plant pathogens that are responsible for diseases on many plant species. Infected plants develop dark, water soaked lesions on stems, leaves or fruit [11].



Figure 11: The figure Anthracnose

- **Sooty moulds**

The presence of sooty mould fungi usually indicates that a plant has become affected by a sap-sucking pest. Sooty moulds do not attack the plant directly, but their growth is unsightly and can reduce plant vigour by preventing photosynthesis [12].



Figure 12: The figure Sooty moulds

- **Powdery mildews**

Powdery mildews are a group of related fungi which attack a wide range of plants, causing a white, dusty coating on leaves, stems and flowers [13].



Figure 13: The figure Powdery mildews

6. LIMITATIONS

The current proposed expert system is specialized in the diagnosis only the following eight Citrus diseases Citrus canker, Citrus scab, Citrus tristeza disease, Gummosis, Greening or Huanglongbing, Sooty mould, Powdery mildew and Anthracnose.

7. SYSTEM EVALUATION

As a preliminary evolution, Eng. Husain Abed El Rahman and other agricultural engineer students tested this proposed Expert System and they were satisfied with its performance, efficiency, user interface and ease of use.

8. CONCLUSION

In this paper, a proposed expert system was presented for helping Agricultural engineer in diagnosing plants with eight different possible Citrus diseases. Agricultural engineer and can get the diagnosis faster and more accurate than the traditional diagnosis. This expert system does not need intensive training to be used, it is easy to use and has user friendly interface. It was developed using CLIPS Expert System language.

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