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Mango Pests Identification Expert System

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Abstract: *Mango is an economically significant fruit crop cultivated in various tropical and subtropical regions around the world. However, the productivity and quality of mangoes can be severely impacted by a range of pests. This research paper introduces an innovative approach to identify mango pests using an expert system. The expert system integrates knowledge from entomology and plants to provide accurate identification of common mango pests. The paper outlines the development and implementation of the expert system using Clips shell, which utilizes rule-based techniques to analyze symptoms associated with mango pests. By inputting observed symptoms, such as leaf spots, fruit damage, leaf mild and stem cankers the system can accurately identify the specific pest species affecting the mango tree. For each pest, the paper discusses their specific symptoms and Favorable conditions that affect the mango plant. By understanding the identification and symptoms of these pests, mango growers and agricultural professionals can implement appropriate pest management strategies to mitigate the economic losses caused by these insects. The research presented in this paper aims to contribute to the body of knowledge on mango pest management, facilitating sustainable mango production and ensuring the availability of high-quality mangoes in global markets.*

Keywords: Mango, pests, expert system, symptoms, pest identification, pest, sustainable agriculture, Clips.

1. INTRODUCTION

Computer-based methods are increasingly being applied to enhance the management of crop pests, including in the context of mango cultivation. Artificial Intelligence (AI) is a field of computer science dedicated to creating intelligent machines capable of performing tasks that are traditionally associated with human intelligence. The pursuit of intelligent machines has fascinated humans throughout history, and with the advancements in computer technology and several decades of AI research, we are witnessing the realization of this vision.

This research explores how AI and computer-based methods are revolutionizing pest management in mango cultivation which in return has a potential impact on improving crop productivity and reducing pest-related losses. By harnessing the expertise of farmers and agronomists and integrating it into computer systems, we can create expert systems specifically tailored to address the unique challenges posed by mango pests. These expert systems employ sophisticated algorithms and models that utilize available knowledge bases, real-time data, and user inputs to provide accurate and timely recommendations for pest control and prevention strategies.

Mango trees, like any other plants, can be susceptible to various pests that can negatively impact their growth and productivity. Here is a summary of some common pests that affect mango trees:

1. **Mango Fruit Fly:**
The mango fruit fly is a significant pest that attacks the fruit. Female flies lay eggs in the immature fruit, and the hatched larvae feed on the pulp, causing the fruit to rot and drop prematurely.

2. **Mango Leafhopper:**
Leafhoppers are sucking insects that feed on the sap of mango leaves. Their feeding causes leaf curling, yellowing, and a decline in tree vigor. They can also transmit diseases.

3. **Mango Mealybug:**
Mealybugs are small insects that suck the sap from mango leaves, causing them to curl, turn yellow, and drop prematurely. The honeydew they excrete promotes the growth of sooty mold, further affecting the tree's health.

4. **White Mango Scale:**
White mango scale is a common pest that affects mango trees. Here's some information about the white mango scale.

By understanding the symptoms associated with these mango pests and implementing appropriate management strategies, farmers can protect their mango orchards from significant economic losses and maintain the health and productivity of their mango trees. So, our Expert system can help farmers identify the pests that affect their mango trees and get the aimed benefits.

2. EXPERT SYSTEMS

The expert system consists of consists of the user interface, the explanation facility, the knowledge base, and the inference engine.as shown in **Figure 1.**

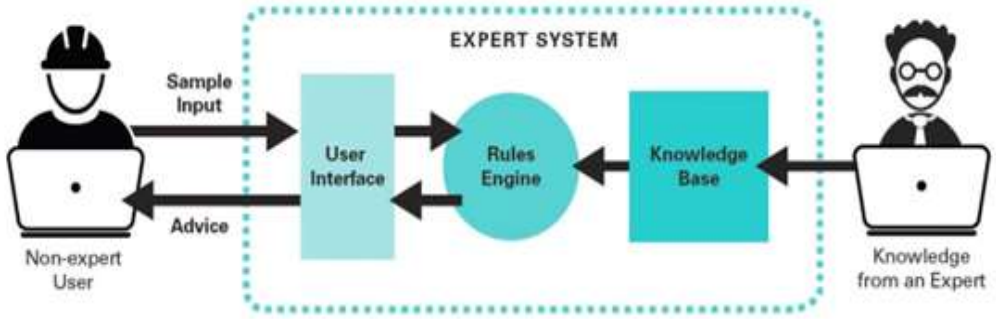


Figure 1: Components of Expert Systems

1. Knowledge Base

The knowledge base comprises specialized and reliable knowledge specific to a particular domain. Intelligence requires knowledge, and the effectiveness of any expert system heavily relies on the availability of highly accurate and precise knowledge.

What is Knowledge? Data represents a collection of facts, while information organizes data and facts related to the task domain. When combined with past experience, data and information form what we refer to as knowledge.

2. Inference Engine

The Inference Engine plays a crucial role in deducing correct and flawless solutions by employing efficient procedures and rules. In knowledge-based expert systems, the Inference Engine acquires and manipulates knowledge from the knowledge base to derive specific solutions. In rule-based expert systems, it:

- Repeatedly applies rules to the facts derived from previous rule application.
- Incorporates new knowledge into the knowledge base when necessary.
- Resolves rule conflicts that arise when multiple rules are applicable to a particular case.

3. User Interface

The user interface facilitates interaction between the user of the expert system and the system itself. It is often implemented using Natural Language Processing to accommodate users familiar with the task domain, without requiring expertise in Artificial Intelligence. The user interface explains how the expert system arrived at a particular recommendation, which can be presented in various forms, such as:

- Natural language displayed on the screen.
- Verbal narrations in natural language.

- Listing of rule numbers displayed on the screen. The user interface ensures the traceability and credibility of the deductions made by the expert system.

3. PROPOSED EXPERT SYSTEM

The proposed system performs two main functions:

1. Identifies the mango pest according to farmer inputs of symptoms
2. Informs the farmer with favorable conditions for the identified pest.

The expert system is designed using Clips and these are some main characteristics of Clips:

1. **Knowledge Representation:** CLIPS provides a powerful language for representing knowledge in the form of rules and facts. Rules are used to define the logical relationships and conditions for making inferences, while facts represent the data or information that the expert system operates on.
2. **Rule-Based Inference Engine:** CLIPS utilizes a rule-based inference engine to perform reasoning and make logical deductions based on the defined rules. The inference engine applies the rules to the facts and makes conclusions or recommendations based on the matching conditions.
3. **Modular and Extensible:** CLIPS provides a modular and extensible framework that allows developers to organize and structure their expert systems. It supports the creation of reusable rule sets, templates, and functions, making it easier to build and maintain complex expert systems.
4. **User Interface:** CLIPS provides a command-line interface for interacting with the expert system. It allows users to input facts, execute rules, and receive explanations or recommendations from the system. Additionally, CLIPS can be integrated with other programming languages or user interfaces to create more user-friendly applications.
5. **Explanation Facility:** CLIPS includes an explanation facility that enables the system to provide explanations for its reasoning process. It can display the rules fired, facts used, and intermediate results, helping users understand how the system arrived at its conclusions.
6. **Cross-Platform Support:** CLIPS is designed to be platform-independent and can be run on various operating systems, including Windows, macOS, and Linux. This allows for portability and compatibility across different environments.

In the proposed system Delphi is used to develop the user interface by which the farmer chooses the symptoms and then the expert system analyses the given data and output the pest that is related to the selected symptoms. Figure 2 shows the interface of the system.

3. IMPLEMENTATION

Pest types that are analyzed by the expert system are listed at Table 1, the table also identify the favorable condition for the pest to grow in.

Table 1: Mango pest analyzed types.

Pest	Symptoms	Favorable Conditions
Hopper Pest	- leafspot - Orange rusty spots - large regularly shaped patches - leaf lamina underneath	Medium Rainy Weather
Meal Bug pests	- leafspot - Small, dark spots on flowers - spots coalesce to cover entire panicle. - leaf-mild	Low Rainy with Low Humidity Weather
Fruit fly pests	- White, silk-like threads - leaf-shread - leafspots-marg	High Rainy with High Humidity Weather

	- fruiting-bodies	
White MangoScale	- Normal plant-growth - distorted shoots - stem cankers - leafspots-halo	Low Humidity Weather

```
(defrule disease1
(LeafSpot)
(Orange rusty spots)
(large regularly shaped patches)
(leaf lamina underneath)
(not (disease identified))
=>
(assert (disease identified))
(printout fdatao "1"  crlf )
)

(defrule disease2
(LeafSpot)
(Small, dark spots on flowers)
(spots coalesce to cover entire panicle)
(leaf-mild)
(not (disease identified))
=>
(assert (disease identified))
(printout fdatao "2"  crlf )
)

(defrule disease3
(White, silk-like threads)
(leaf-shread)
(leafspots-marg)
(fruiting-bodies)
(not (disease identified))
=>
(assert (disease identified))
(printout fdatao "3"  crlf )
)

(defrule disease4
(plant-growth)
(distorted shoots)
(stem cankers)
(leafspots-halo)
(not (disease identified))
=>
(assert (disease identified))
(printout fdatao "4"  crlf )
)
```

Figure 2: Some Rule samples of the expert system

Expert System Interface

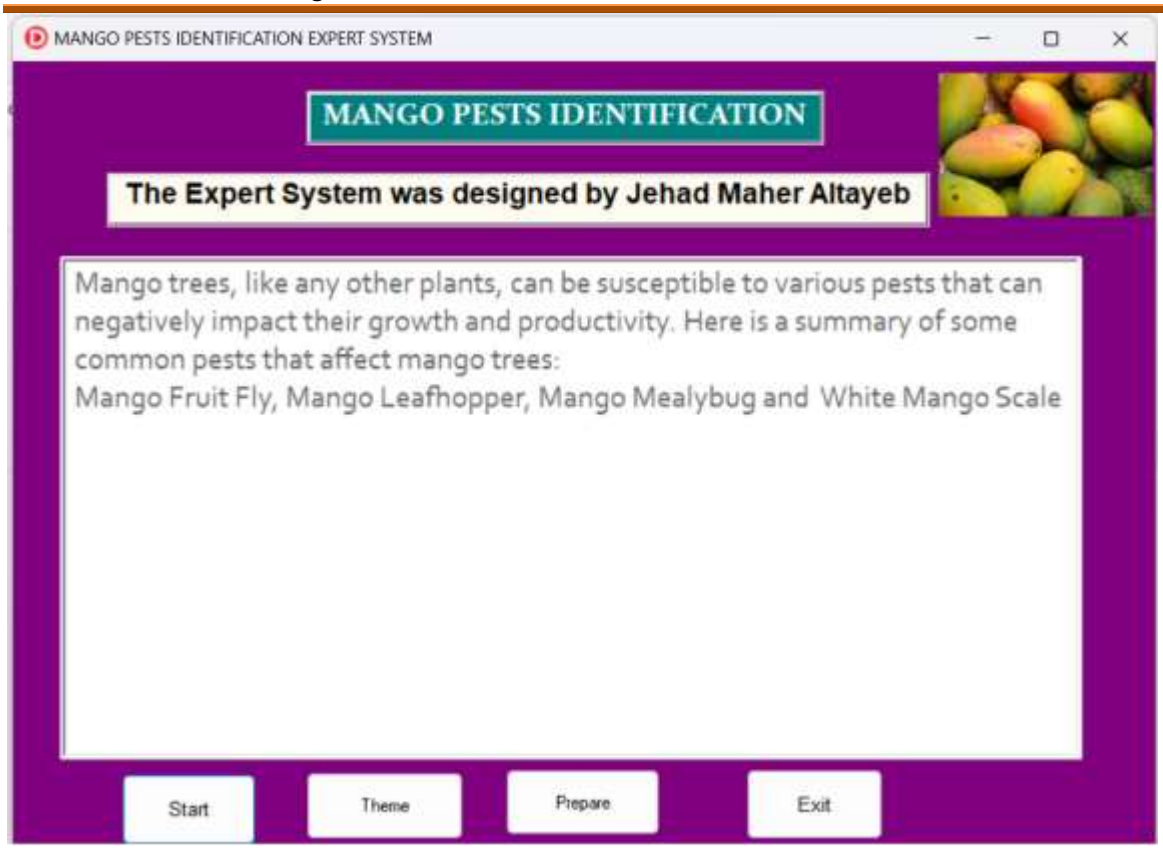


Figure 3: User Interface

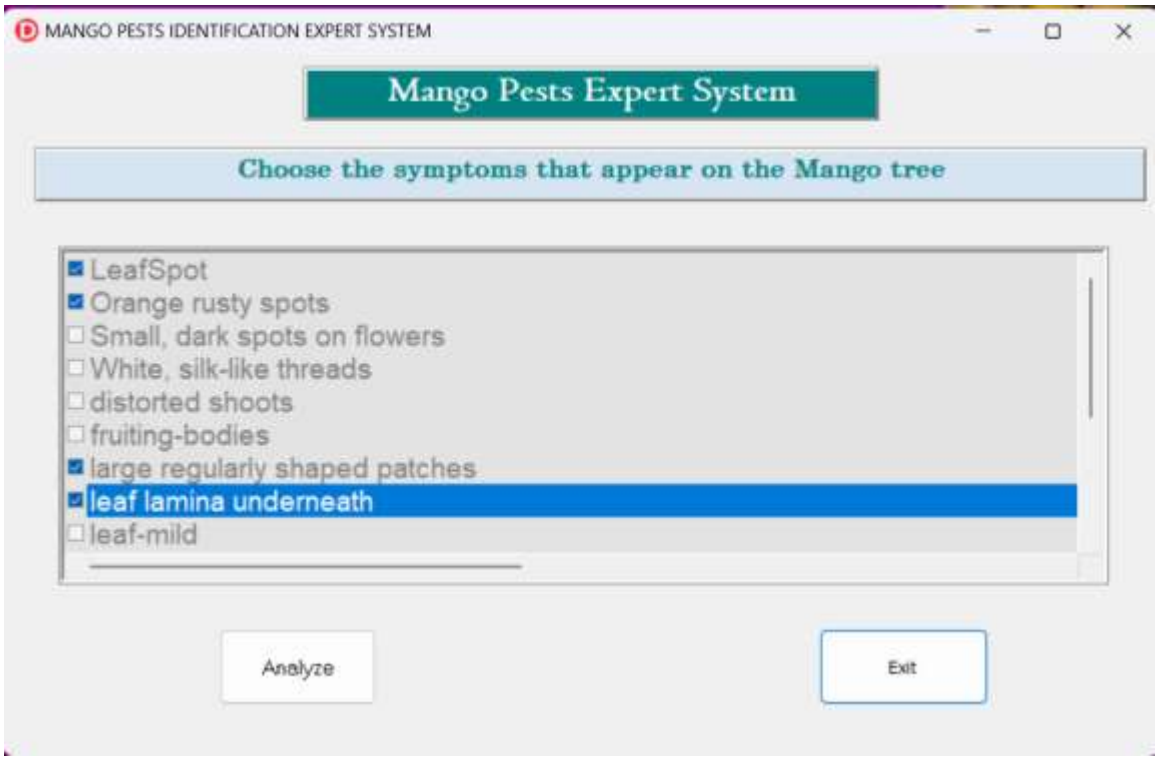
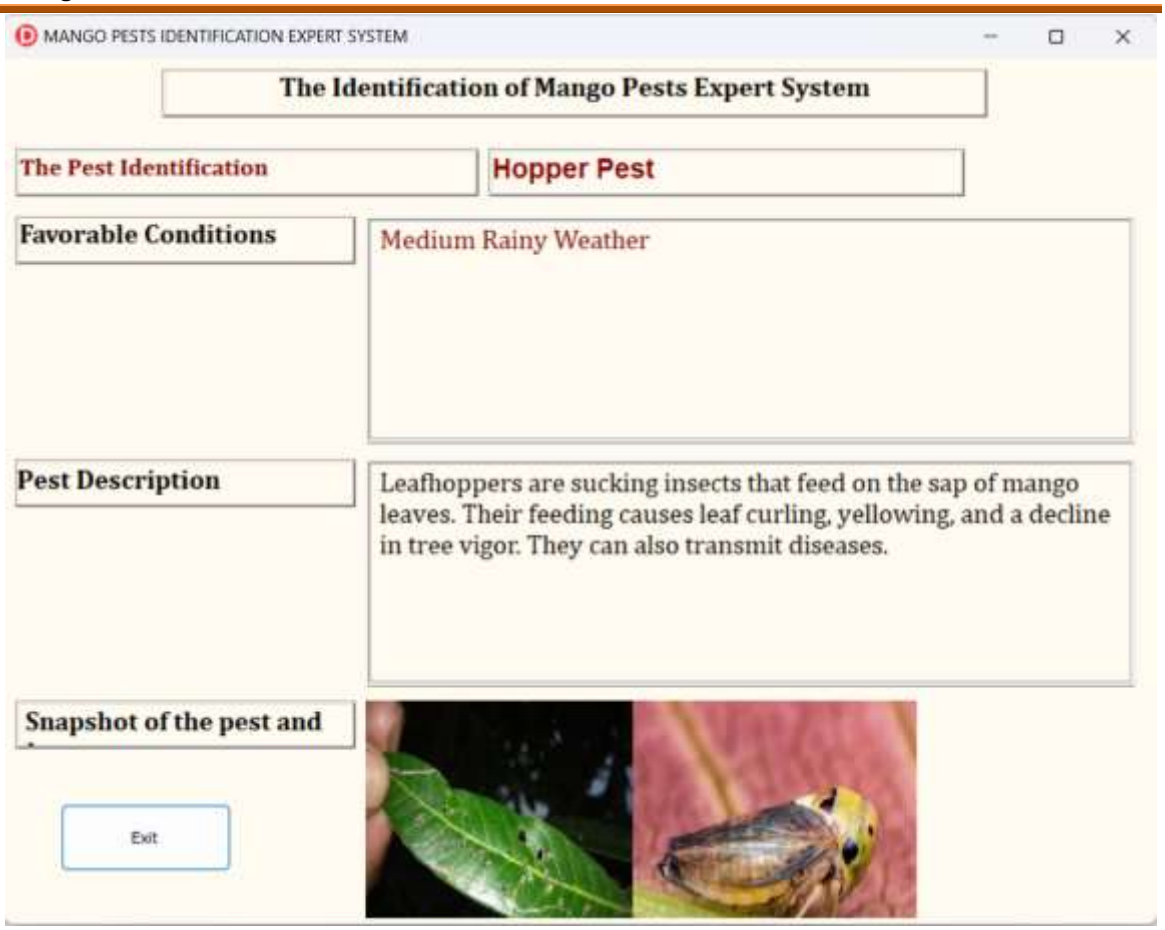


Figure 4: Selection of symptoms

Figure 5: Results of the expert system



4. CONCLUSION

The development of an expert system for mango pests identification using the CLIPS language has shown promising results. The utilization of CLIPS' rule-based inference engine and pattern matching capabilities has allowed for accurate and efficient identification of various mango pests based on their symptoms and characteristics. By integrating domain-specific knowledge about mango pests into the knowledge base, the expert system has demonstrated the ability to mimic human expertise in diagnosing pest infestations. The user interface of the expert system provides a user-friendly and intuitive platform for farmers and agricultural practitioners to interact with the system. Overall, the development of the mango pests identification expert system using the CLIPS language has shown great potential in assisting farmers and agricultural practitioners in timely and accurate identification of pest infestations. By leveraging the power of artificial intelligence and expert knowledge, this system can contribute to improved crop management practices, reduced crop losses, and increased agricultural productivity. Further research and refinement of the system could enhance its performance and make it an invaluable tool for mango growers and the agricultural industry.

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