International Journal of Academic Engineering Research (IJAER)
ISSN: 2000-001X
Vol. 3 Issue 4, April – 2019, Pages: 14-21

Developing an Expert System for Papaya Plant Disease Diagnosis

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Abstract: *The papaya is a plant that grows in tropical climates and also known as pawpaws or papaws, it has many health benefits like reducing risk of heart disease, diabetes, cancer, aiding in digestion, improving blood glucose control in people with diabetes, lowering blood pressure, and improving wound healing. With these big health benefits and with taken into consideration that it's available at most times of the year.*
The farmers have to take care of this plant. Because of that we developed an expert system to help farmers and people interested in growing papaya to identify the diseases of papaya then they can find the right cure to treat the plant. The expert system was developed using CLIPS and Delphi languages and has been experimented by farmers and people interested in growing papaya and has given satisfactory results.

Keywords: Expert System, Papaya Plant Disease, Diagnosis

1. INTRODUCTION

Papayas grow in tropical climates and are also known as papaws or pawpaws. Their sweet taste, vibrant color, and the wide variety of health benefits they provide make them a popular fruit.

The possible health benefits of consuming papaya include a reduced risk of heart disease, diabetes, cancer, aiding in digestion, improving blood glucose control in people with diabetes, lowering blood pressure, and improving wound healing.

Papayas are a soft, fleshy fruit that can be used in a wide variety of culinary ways. Here we will explore more on the health benefits, uses, how to incorporate more of them into your diet, and what nutritional value papayas have[1].

Figure 1: The figure shows papaya [2]

Artificial intelligence (AI) is a science and technology based on disciplines such as computer science, biology, psychology, linguistics, mathematics, and engineering. The goal of AI is to develop computers that can think, see, hear, walk, talk and feel. A major thrust of AI is the development of computer functions normally associated with human intelligence, such as reasoning, learning, and problem solving.

The most important applied area of AI is the field of expert systems. An Expert System (ES) is a knowledge-based system that employs knowledge about its application domain and uses an inferencing (reason) procedure to solve problems that would otherwise require human competence or expertise. The power of expert systems stems primarily from the specific knowledge about a narrow domain stored in the expert system's knowledge base.

It is important to stress to people that expert systems are assistants to decision makers and not substitutes for them. Expert systems do not have human capabilities. They use a knowledge base of a particular domain and bring that knowledge to bear on the facts of the particular situation at hand [3].

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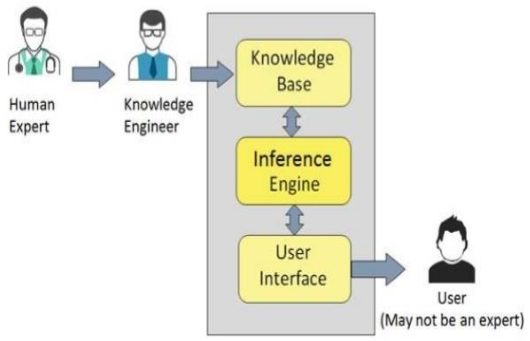

Figure 2: The figure shows Expert System component [4]

2. MATERIALS AND METHODS

The purposed expert system was created using a tool designed by Abu-Naser using Delphi and is connected with CLIPS to help create an interface and help users to create expert systems easily. As we see in figure 3 this is our expert system which is specialized in identifying the papaya diseases by selecting the symptoms as shown in Figure 4.

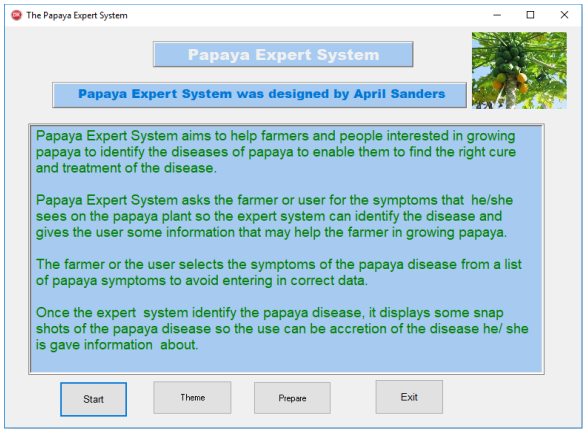

Figure 3: The figure shows papaya expert system

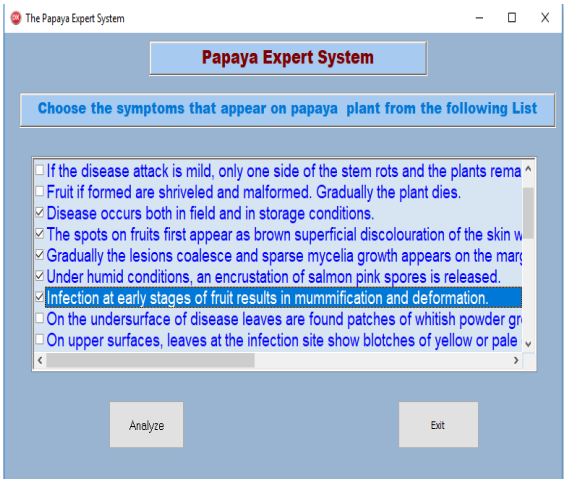

Figure 4: The figure shows a sample dialogue between the expert system and the user

After analyzing the symptoms by the expert system, the system identifies the disease and presents it to user as shown in Figure 5.

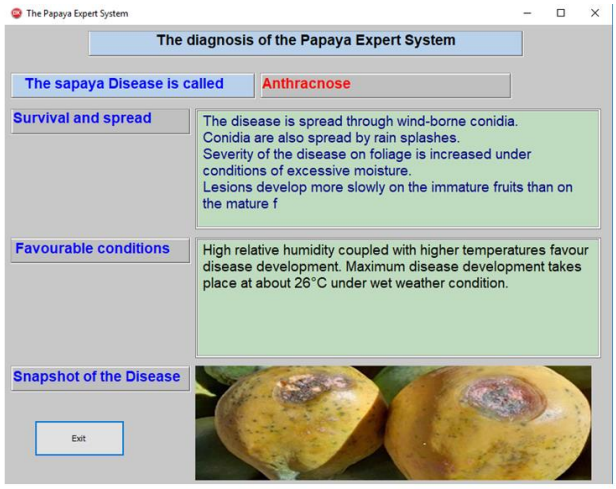

Figure 5: The figure shows how the users get the diagnosis and recommendation

3. LITERATURE REVIEW

There are many expert systems that are developed for diagnosing human medical problems like [45-50, 52, 54-56, 58], plant and trees problem like: general plant [4], mango [17], Black pepper [18], banana [19, 51] onion [29], potato [43], Pineapple [53], watermelon [57] and other kinds of diseases. But there is no specialized expert system for diagnosing sesame diseases available free. Although many plant diseases have common symptoms. The proposed expert system was designed and developed specifically to aid farmers in diagnosing papaya diseases. Some of these Expert Systems are specialized in one specific disease and others in five diseases; but the current proposed expert system is specialized in the diagnosis of six papaya diseases: Foot rot of Papaya, Anthracnose, Powdery mildews, Papaya ring spot disease, Papaya mosaic disease, Papaya leaf curl disease.

4. KNOWLEDGE REPRESENTATION

The main sources of the knowledge for this expert system is a Specialized websites for papaya diseases. This knowledge has been converted into CLIPS Knowledge base syntax (Facts, Rules and Functions)[5].

4.1 Foot rot of Papaya

Disease symptoms

- It is characterized by the appearance of water-soaked patches on the stem near the ground level.
- These patches enlarge rapidly and girdle the stem, causing rotting of the tissues, which then turn dark

brown or black. Such affected plants withstand strong wind and topple over and die.

- If the disease attack is mild, only one side of the stem rots and the plants remain stunted.
- Fruit if formed are shriveled and malformed. Gradually the plant dies.

Survival and spread

- Resting spore, Oospore, germinates and release zoospores which along with irrigation water spread throughout the field.

Favourable conditions

- High relative humidity and rainy condition favors the severe disease development in sick soil.

Figure 6: The figure shows foot rot papaya

4.2 Anthracnose

Disease symptoms

- Disease occurs both in field and in storage conditions.
- The spots on fruits first appear as brown superficial discolouration of the skin which develops into circular, slightly sunken areas and 1 to 3 cm in dia.
- Gradually the lesions coalesce and sparse mycelia growth appears on the margins of the spots.
- Under humid conditions, an encrustation of salmon pink spores is released.
- Infection at early stages of fruit results in mummification and deformation.

Survival and spread

- The disease is spread through wind-borne conidia.
- Conidia are also spread by rain splashes.
- Severity of the disease on foliage is increased under conditions of excessive moisture. Lesions develop more slowly on the immature fruits than on the mature fruits.

Favourable conditions

- High relative humidity coupled with higher temperatures favour disease development. Maximum disease development takes place at about 26°C under wet weather condition.

Figure 7: The figure shows Anthracnose.[6]

4.3 Powdery mildews

Disease symptoms

- On the undersurface of disease leaves are found patches of whitish powder growth.
- On upper surfaces, leaves at the infection site show blotches of yellow or pale green usually near vein, surrounded by normally colored tissue.
- Occasionally, fungus may attack the stem of young seedling when grown under reduced light condition. The spots enlarge and cover the entire leaf area. Severely infected leaves may become chlorotic and distorted before falling. Affected fruits are small in size and malformed.
- Fungus grow superficially on the undersurface of the leaves with drawing nutrients from the cell of leaf surface by specialized absorbing structure known as haustoria.

Survival and spread

- The powdery mildew fungus overwinters in dormant buds. When conditions are favorable for growth of the fungus in spring, spores are produced, released, and cause new infections. Secondary spread of the disease can occur if spores are produced in these new infections.

Favourable conditions

- The development of powdery mildew in papaya is favour by relative humidity around 80-85% and temperature range of 24-26°C.

Figure 8: The figure shows powdery mildews[7]

4.4 Papaya ring spot disease

Disease symptoms

- Infected plant initially shows cholorsis on youngest leaves followed by vein clearing, rugosity and prominent mottling of laminae.
- Malformation and reduction of the lamina which may become extremely filliform.
- Characteristically elongated dark green streak develop on petiole and upper half of the stems, infected fruits show circular concentric rings causes upto 56-60 % yield loss.
- Pathogen belongs to Potyvirus group of Potyviridae family.

Transmission and favourable conditions

- Disease is aphid transmitted and aphids are more active during warmer conditions.
- PRSV is also easily transmitted via mechanical inoculation but there are no confirmed reports of PRSV transmission through seeds.

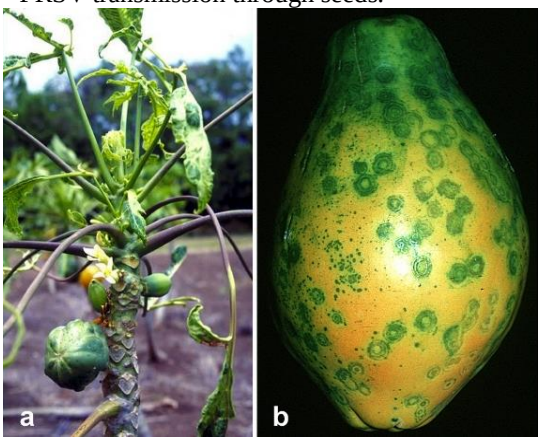

Figure 9: The figure shows papaya ring spot disease.

4.5 Papaya mosaic disease

Disease symptoms

- Causes leaf mosaic and stunting in papaya.
- Young seedlings in the greenhouse show vein-clearing and downward cupping of the leaves about 5 days after inoculation.
- A mottle or mosaic develops after 15-20 days.
- Symptoms appear on the young leaves of the plants.
- The leaves are reduced in size and show blister like patches of dark-green tissue, alternating with yellowish-green lamina.
- The leaf petiole is reduced in length and the top leaves assume an upright position.

Transmission and favourable conditions

- The fungus survives in soil and inoculum present in the soil is source of primary infection. Secondary infection occurs by means of conidia through rain splash or wind.
- Papaya mosaic diseases is mechanically transmissible viruses associated with other viral disease, from papaya mosaic virus in being aphid-borne and restricted in host range to papaya and cucurbits.

Figure 10: The figure shows papaya mosaic disease[8]

4.6 Papaya leaf curl disease

Disease symptoms

- Curling, crinkling and distortion of leaves, reduction of leaf lamina, rolling of leaf margins inward and downward, thickening of veins.
- Leaves become leathery, brittle and distorted. Plants stunted.Affected plants does not produce flowers and fruits.
- Spread by whitefly Bemisia tabaci.

- Sometimes all the leaves at the top of the plant are affected by these symptoms. In advanced stages of the disease, defoliation takes place and the growth of the plant is arrested.
- PLCV is in the family Geminiviridae. It is not transmitted mechanically. The virus vector is the silverleaf whitefly, Bemisia tabaci.

Transmission and favourable conditions

- The virus cannot be transferred mechanical means as in the case of mosaic disease. The virus readily transmitted through grafting and white fly (Bemisia tabaci)

Figure 11: The figure shows papaya leaf curl disease[9]

5. LIMITATION

The current expert system is specialized only in the previously mentioned papaya diseases: Foot rot of Papaya, Anthracnose, Powdery mildews, Papaya ring spot disease, Papaya mosaic disease, Papaya leaf curl disease.

6. SYSTEM EVALUATION

This expert system offers a user interface that makes it easy for users to know which disease that their plant got.

After experiment the system by expert people and a group of farmers, they provided a good feedback on system performance. Where they don't find any difficulty while using the system and the system gave them a good result.

7. CONCLUSION

In this paper we introduced an expert system that helps farmers to detect papaya diseases by showing a simple list of symptoms. The farmer should choose the symptoms that appear on their plant and then the system will analyze these symptoms and display which disease that their plant got based on the rules that was written with CLIPS language.

8. FUTURE WORKS

We seek to develop this work by creating an expert system that can identify more than plant diseases and more symptoms for each disease by taking a picture of the plant without need to write or choose the symptoms.

9. SOURCE CODE

```
(defrule disease1
(papaya-symptom 1 yes)
(papaya-symptom 2 yes)
(papaya-symptom 3 yes)
(papaya-symptom 4 yes)
(not (papaya disease identified))
=>
(assert (papaya disease identified))
(printout fdatao "1"  crlf )
)

(defrule disease2
(papaya-symptom 5 yes)
(papaya-symptom 6 yes)
(papaya-symptom 7 yes)
(papaya-symptom 8 yes)
(papaya-symptom 9 yes)

(not (papaya disease identified))
=>
(assert (papaya disease identified))
(printout fdatao "2"  crlf )
)

(defrule disease3
(papaya-symptom 10 yes)
(papaya-symptom 11 yes)
(papaya-symptom 12 yes)
(papaya-symptom 13 yes)
(not (papaya disease identified))
=>
(assert (papaya disease identified))
(printout fdatao "3"  crlf )
)

(defrule disease4
(papaya-symptom 14 yes)
(papaya-symptom 15 yes)
(papaya-symptom 16 yes)
(papaya-symptom 17 yes)
(not (papaya disease identified))
=>
(assert (papaya disease identified))
(printout fdatao "4"  crlf )
)
(defrule disease5
(papaya-symptom 18 yes)
(papaya-symptom 19 yes)
```

```
(papaya-symptom 20 yes)
(papaya-symptom 21 yes)
(papaya-symptom 22 yes)
(papaya-symptom 23 yes)
(not (papaya disease identified))
=>
(assert (papaya disease identified))
(printout fdatao "5"  crlf )
)
(defrule disease6
(papaya-symptom 24 yes)
(papaya-symptom 25 yes)
(papaya-symptom 26 yes)
(papaya-symptom 27 yes)
(papaya-symptom 28 yes)
(not (papaya disease identified))
=>
(assert (papaya disease identified))
(printout fdatao "6"  crlf )
)

(defrule endline
(papaya disease identified)
=>
  (close fdatao)
)

 (defrule readdata
  (declare (salience 1000))
  (initial-fact)
  ?fx <- (initial-fact)
=>
  (retract ?fx)
  (open "data.txt" fdata "r")
  (open "result.txt" fdatao "w")
  (bind ?symptom1 (read fdata))
  (bind ?symptom2 (read fdata))
  (bind ?symptom3 (read fdata))
  (bind ?symptom4 (read fdata))
  (bind ?symptom5 (read fdata))
  (bind ?symptom6 (read fdata))
  (bind ?symptom7 (read fdata))

  (assert
    (papaya-symptom ?symptom1 yes)
    (papaya-symptom ?symptom2 yes)
    (papaya-symptom ?symptom3 yes)
    (papaya-symptom ?symptom4 yes)
    (papaya-symptom ?symptom5 yes)
    (papaya-symptom ?symptom6 yes)
    (papaya-symptom ?symptom7 yes)
    )
   (close fdata)
     )
```

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