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A Proposed Expert System for Strawberry Diseases Diagnosis

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Abstract: Background*: There is no doubt that strawberry diseases are one of the most important reasons that led to the destruction of strawberry plants and their crops. This leads to obvious damage to these plants and they become inedible. Discovering these diseases after a good step for proper and correct treatment. Determining the treatment with high accuracy depends on the method used in the diagnosis. Correctly, expert systems can greatly help in avoiding damage to these plants. The expert system correctly diagnoses strawberry disease to make it easier for farmers to find the right treatment based on the appropriate diagnosis.* ***Objectives****: The main goal of this expert system is to get the appropriate diagnosis of disease and the correct treatment.* ***Methods****: In this paper the design of the proposed Expert System which was produced to help Farmers and students interested in agriculture strawberry in diagnosing many of the strawberry diseases such as: Leaf Spots, Grey Mold, Red Stele/Red Core, Wilt, Powdery Mildew, Alternaria Spot, Black Root Rot, Anthracnose (black spot), and Angular Leaf Spot. The proposed expert system presents an overview about strawberry diseases are given, the cause of diseases are outlined and the treatment of disease whenever possible is given out. CLIPS language was used for designing and implementing the proposed expert system.* ***Results****: The proposed strawberry diseases diagnosis expert system was evaluated by Farmers and they were satisfied with its performance.* ***Conclusions****: The Proposed expert system is very useful for Farmers with strawberry problem and students interested in agriculture strawberry.*

Keywords*: Artificial Intelligence, Expert Systems, CLIPS, strawberry diseases, Language.*

1. INTRODUCTION

Strawberries are one of the types of plants that have high economic value and promising commercial prospects. Effectively protecting plants from diseases is an important way to improve productivity and improve crop quality. Detecting plant diseases in their early stages can reduce the need to rely on potentially harmful therapeutic chemicals and lower labor costs. Since many greenhouses are quite large, it is not always easy for even the most experienced grower to identify plant diseases before they spread. For this reason, automated disease detection will prove to be a valuable supplement to farmers' labor and skill.
Expert System is a computer application of Artificial Intelligence (AI) which contains a knowledge base and an inference engine; the main components and details are represented in Figure 2.

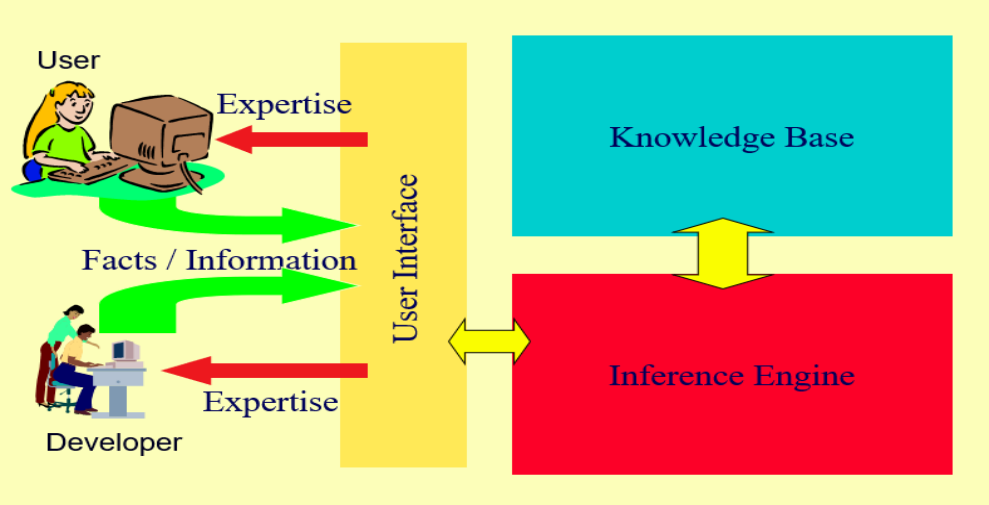

Figure 2: The figure presents the Main Components of an Expert System, Designed by the authors.

The proposed Expert System for strawberry Diseases Diagnosis was implemented using CLIPS language. It is a forward

chinning reasoning expert system that can make inferences about facts of the world using rules, objects and take appropriate actions as a result .It's easy for the knowledge engineer to build the Expert System and for the end users when they use the system.

2. MATERIALS AND METHODS

The proposed expert system diagnoses nine diseases of strawberries and the proposed expert system will ask the user to choose the correct symptoms from the screen. At the end of the dialogue session, the proposed expert system presents the diagnosis and recommendation of the disease to the user. Figure 3 shows an introduction to strawberry with four buttons to start the expert system. Figure 4 shows a sample of the dialogue between the expert system and the user. Figure 5 shows how users obtain the diagnosis and recommendation.

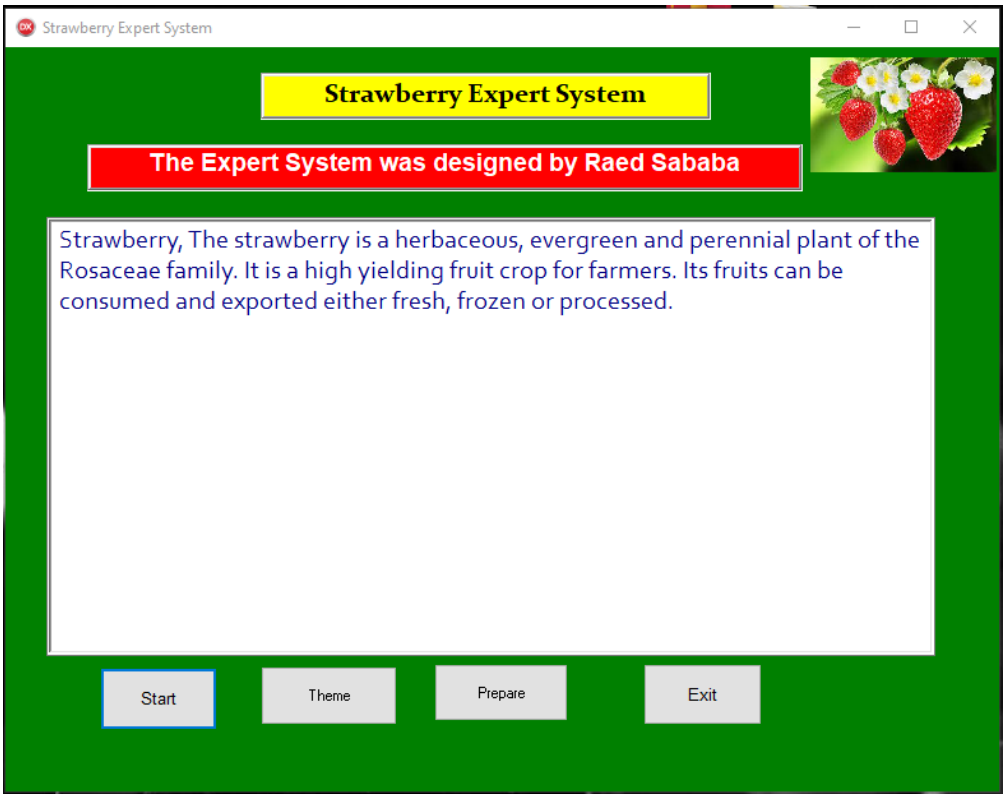

Figure 3: The figure shows the introduction of the expert system project.

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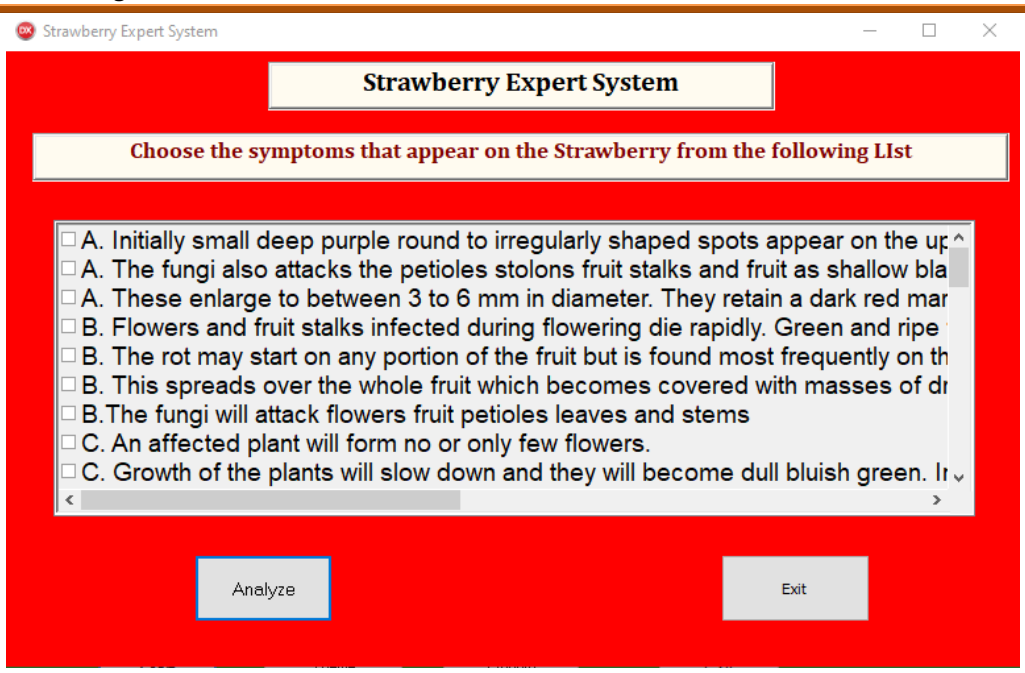


Figure 4: The figure presents shows when the system asks the user.

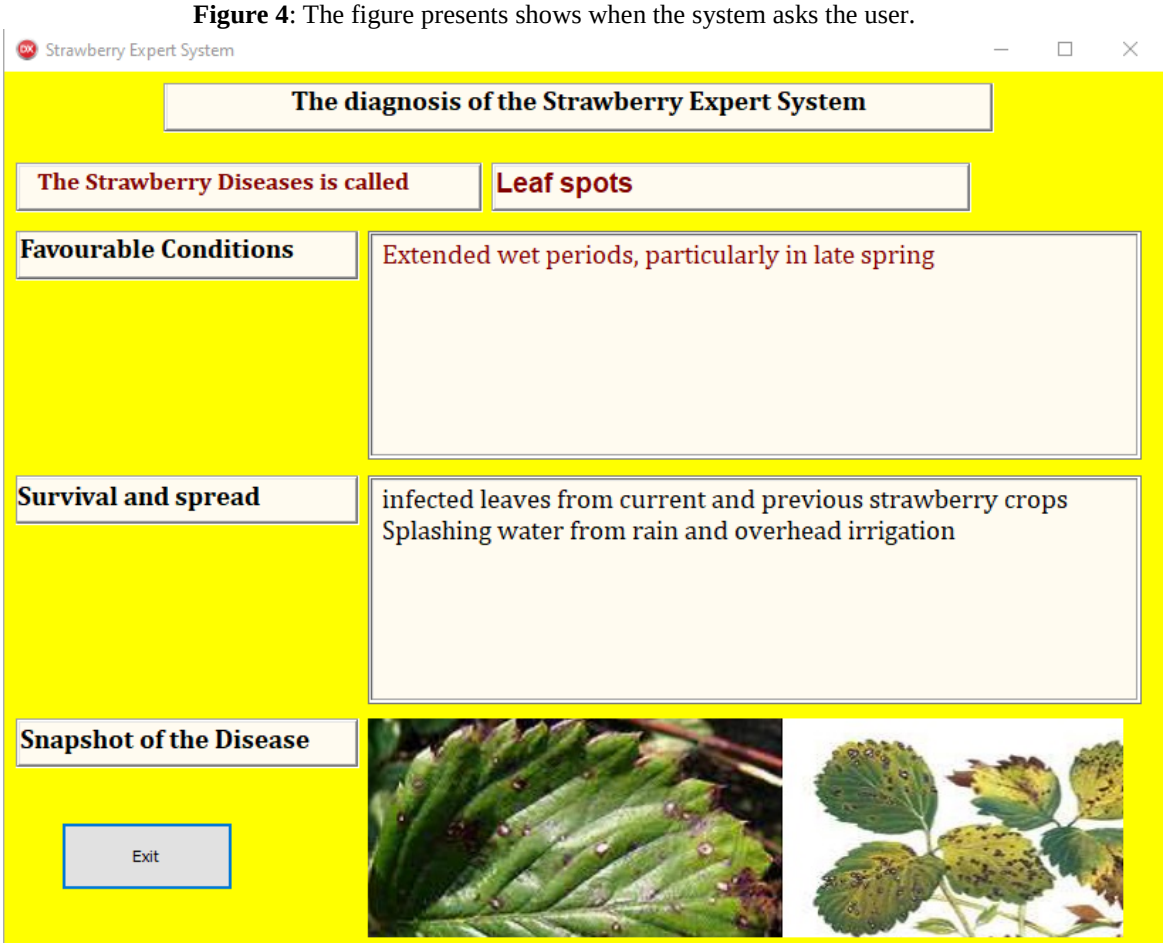


Figure 5: The figure shows diagnosis and recommendation of the expert system.

3. LITERATURE REVIEW

3.1 Previous Studies

There are many expert systems developed in agriculture [2-25] like: papaya plant disease diagnosis, grapes diagnosis and treatment, onion rule based system for disorders diagnosis and treatment, diagnosing tobacco diseases, banana knowledge based system diagnosis and treatment, spinach expert system: diseases and symptoms, knowledge based system for apple problems using clips, diagnosing banana disorders, black pepper expert system, knowledge based system for diagnosing guava problems, an expert system for citrus diseases diagnosis, expert system for sesame diseases diagnosis, expert system for the diagnosis of mango diseases, expert system for diagnosing sugarcane diseases, expert system for the diagnosis of wheat diseases, coffee diseases, diagnosing and treating potatoes problems, safflower disease diagnosis and treatment, castor diseases and diagnosis, coconut diseases diagnosis, plant disease diagnosis, and apple trees.
There are many expert systems implemented for educations [26-28], like: guiding freshman students in selecting a major in Al-Azhar University, selecting exploratory factor analysis procedures, calculating inheritance in Islam. In general health [29-65] like: anemia expert system diagnosis, diagnosing coronavirus (covid-19), short-term abdominal pain (stomach pain) diagnosis and treatment, diagnosing breast cancer, diagnosing skin cancer , ankle problems, hip problems, hair loss diagnosis, chest pain in infants and children, diagnosis of dengue disease, high blood pressure, ankle diseases, thyroid problems, problems of teeth and gums, diagnosing cough problem, lower back pain, rickets diagnoses and treatment, neck pain diagnosis, diagnosing facial-swelling, throat problems, kidney, depression diagnosis, diabetes diagnosis, polymyalgia rheumatic, silicosis, endocrine diagnosis and treatments, arthritis diseases diagnosis, hepatitis, diagnosis of seventh nerve inflammation (bell's palsy) disease, knee problems diagnosis, and uveitis disease diagnosis. In control [69-70,] like: modeling and controlling smart traffic light system. In maintenance [66-68], like: photo copier maintenance, desktop pc troubleshooting, and diagnosing wireless connection problems.

3.2 Comments about previous studies

Although, there are many expert systems in agriculture field, there are no expert system for diagnosing strawberry diseases and treatment. That is why we are proposing expert system for diagnosing and treating strawberry problems.

4. KNOWLEDGE REPRESENTATION

The main sources of knowledge for this expert system are the strawberry grower and the strawberry disease website specialist. The captured knowledge has been converted into CLIPS Knowledge base syntax. The Expert System currently contains nine bases covering nine diseases of strawberries [1]:

1. **Leaf spots:** Leaf spot is one of the most common diseases of strawberries, occurring worldwide in most cultivars. [1]**.**

Figure 6: The figure shows a disease Leaf spots [3].

Favourable conditions:

- wet periods, particularly in late spring

Survival and spread:

- infected leaves from current and previous strawberry crops

- Splashing water from rain and overhead irrigation

2. **Grey mold:** This disease occurs on a wide range of flowers, vegetables and fruit, including strawberries.

Figure 6: The figure shows a disease Grey mold [4].

Favourable conditions:

- Low temperature, high humidity and frequent rain

Survival and spread:

- The fungi over-winters on plant debris and infects flower parts, after which it either rots the fruit or remains inactive until the fruit ripens further. Spores, which are produced continuously throughout the fruiting season, germinate to infect plants.
- By wind and splashing water from rain or overhead irrigation.

3. **Red stele/Red core:** is the most serious disease of strawberry in areas with cool, moist soil conditions.

Figure 7: The figure shows a disease Red stele/Red core [5].

Favourable conditions:

- Found in a wide range of climates. The disease prefers poorly drained soils, high temperatures and plants under moisture stress

Survival and spread:

- Can be introduced with planting material or from a reserve in the soil from trash from previous crops

4. **Wilt:** This disease occurs through the temperate zones of the world. It affects a wide range of crops like tomato, potato and cotton. Most strawberry varieties are susceptible

Figure 8: The figure shows a disease Wilt.

Favourable conditions:

- A period of stress such as sudden increase in temperature, dry conditions or heavy crop load on plants.

Survival and spread:

- Soils in which susceptible crops have been grown
- The pathogen can survive in moist soil for many years
- By water, trash from susceptible crops, weeds, root contact between plants, soil and farm machinery

5. **Powdery mildew:** The disease affects all cultivated strawberries worldwide. No variety is resistant, but each differs in susceptibility.

Figure 9: The figure shows a disease Powdery mildew.

Favourable conditions:

- Warm, humid conditions

Survival and spread:

- Trash from previous and current strawberry crops.

- Wind

6. **Alternaria spot:** Alternaria black spot occurs in fields where strawberry fruit have been damaged by hail, excess mite injury, natural cracking, or other physical or biological sources of wounding. [10]

Figure 10: The figure shows a disease Alternaria spots.

Favourable condition:

- It is favored by warm wet weather

Survival and spread:

- The fungi overwinter on infected plants, plant debris, and weed hosts.
- In the spring, spores are produced and are discharged by splashing rain into air currents. They then land on and infect new leaves.

7. **Black root rot:** Black root rot is a serious and common problem of strawberries. The term “black root rot” is the general name for several root disorders that produce similar symptoms. The disorders are not clearly understood and are generally referred to as a root-rot complex.

Figure 11: The figure shows a disease Black root rot.

Favourable conditions:

- It is favoured by warm, humid and wet conditions.

Survival and spread:

- Black spot is spread from infected plants and fruit by rain splash, overhead irrigation and on the hands of fruit pickers.

8. **Anthracnose (black spot):** Alternaria black spot occurs in fields where strawberry fruit have been damaged by hail, excess mite injury, natural cracking, or other physical or biological sources of wounding.

Figure 12: The figure shows a disease Anthracnose (black spot).

Favourable conditions:

- It is favoured by warm wet weather

Survival and spread:

- This is a major disease of strawberries, affecting most parts of the plant.
- It can cause serious losses throughout the season.
- Plants that are planted in infected soil become infected by splashing water and soil
- Fungus survives in soil for up to 9 months.

9. **Angular leaf spot:** is a severe disease most common on cucumbers. Disease symptoms first appear as water-soaked lesions on underneath surface of leaves that occur between the minor veins of the leaves. These lesions may exude a whitish-liquid under some conditions. As the disease progresses, the infected spots turn brown and the leaf material falls out, leaving angular holes in the leaves.

Figure 13: The figure shows a disease Angular leaf spot.

Favourable conditions:

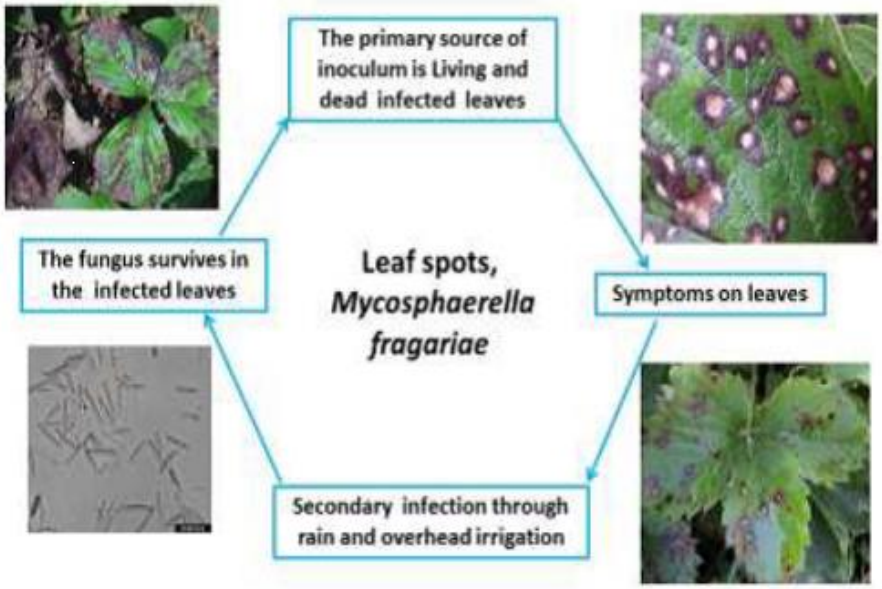
- Spring season is responsible for the development of diseases.

Survival and spread:

- Bacterium survives in crop debris and overwintering plants can survive for long periods on plant debris but cannot live free in soil.
- Bacteria can be spread by splashing water.

Disease cycle:

Leaf spot:



Grey mould:

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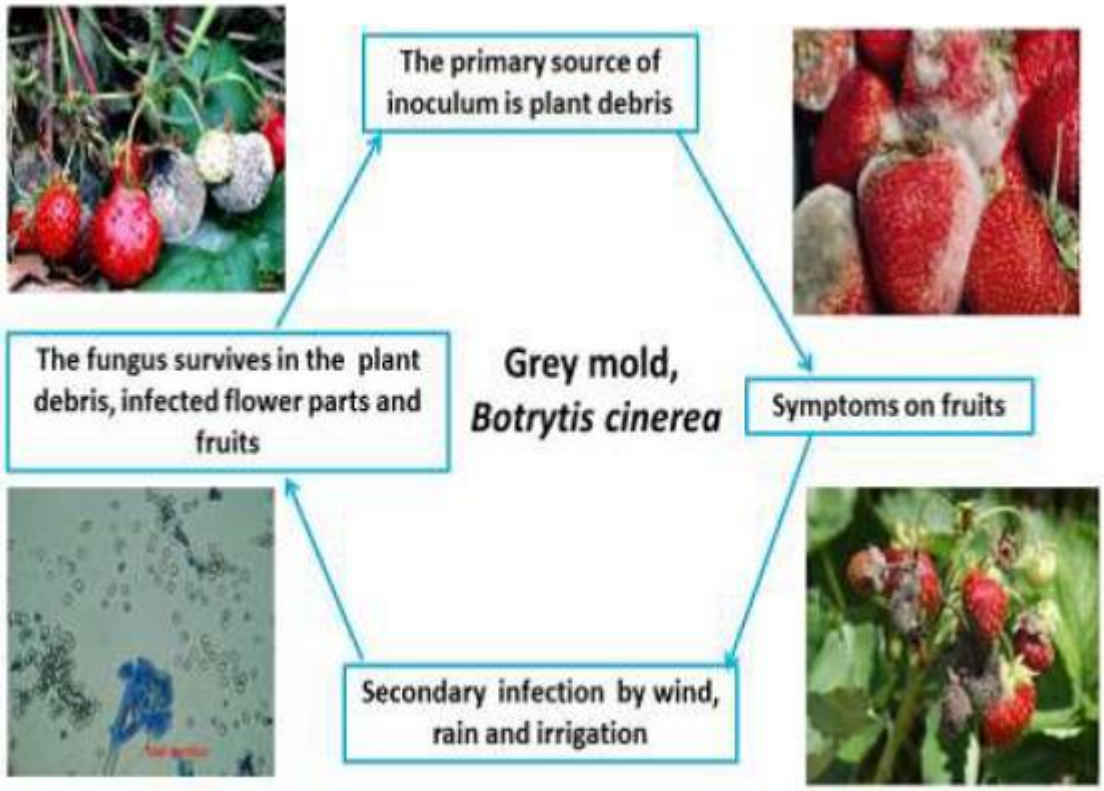
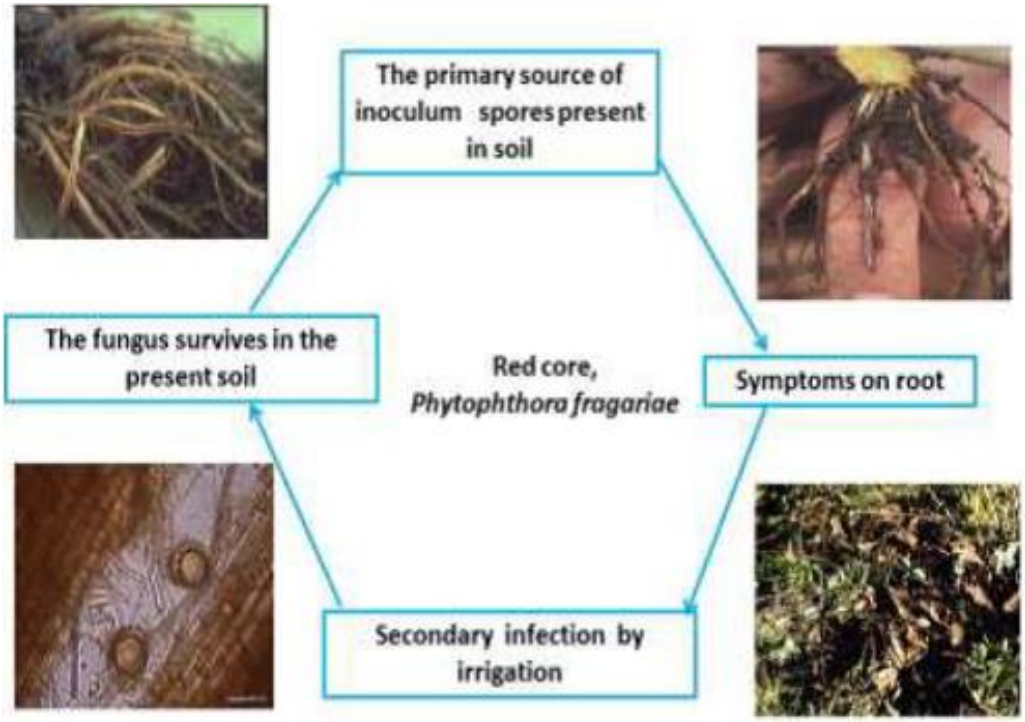
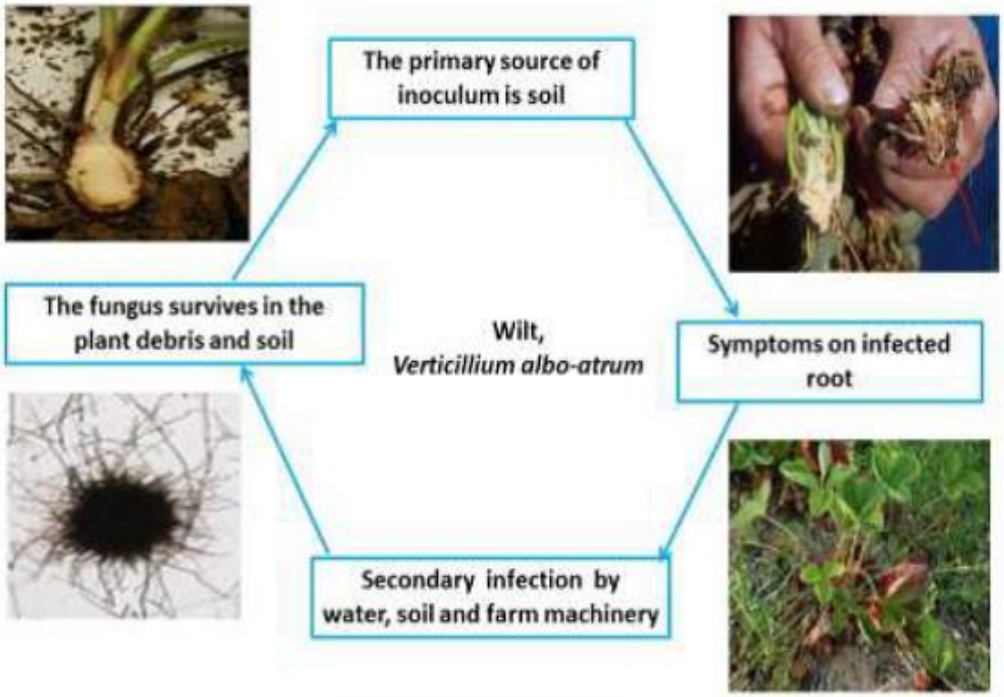


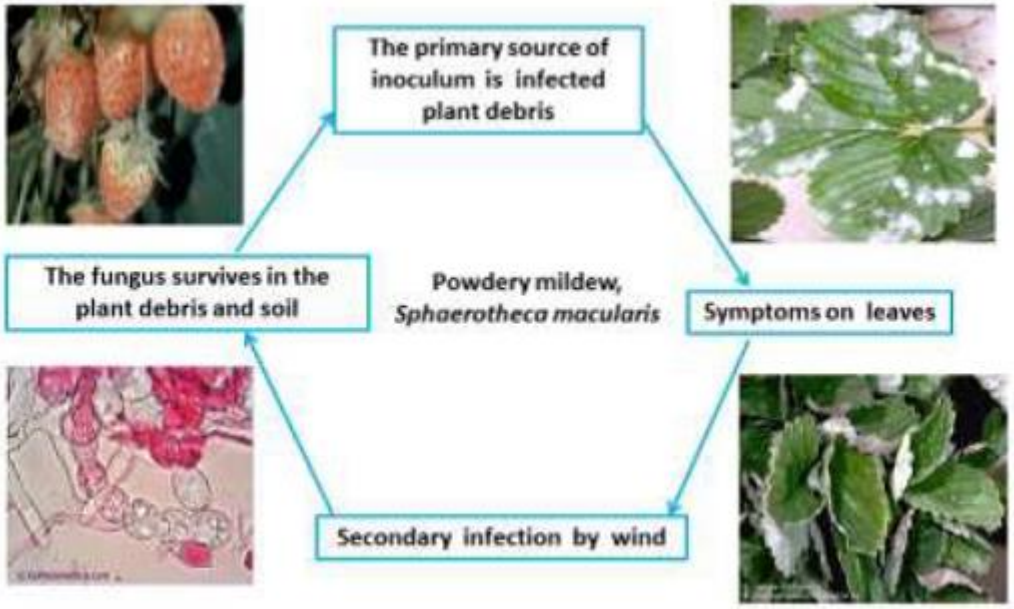
Red stele/Red core:



Wilt:



Powdery mildew:



5. LIMITATIONS

The current proposed expert system is specialized in the diagnosis only the following nine strawberry diseases: Leaf Spots, Grey Mold, Red Stele/Red Core, Wilt, Powdery Mildew, Alternaria Spot, Black Root Rot, Anthracnose (black spot), Angular Leaf Spot.

6. SYSTEM EVALUATION

As a preliminary evaluation, a group of farmers and interested people in farming tested this proposed Expert System and they were satisfied with its performance, efficiency, user interface and ease of use.

7. CONCLUSION

In this paper, a proposed expert system was presented to assist farmers and students interested in agriculture in diagnosing diseases strawberry with nine different strawberry diseases. Farmer of strawberry 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 language.

8. FUTURE WORK

This expert system is considered to be a base of future ones; more strawberry diseases are planned to be added and to make it more accessible to users from anywhere at any time.

9. EXPERT SYSTEM SOURCE CODE

```
(defrule disease1
(A. Initially small deep purple round to irregularly shaped spots appear on the upper leaf surface)
(A. These enlarge to between 3 to 6 mm in diameter. They retain a dark red margin but the centers turn brown then grey and
finally white. Spots may join and kill the leaf)
(A. The fungi also attacks the petioles stolons fruit stalks and fruit as shallow black spots.)
(not (disease identified))
=>
(assert (disease identified))
(printout fdatao "1"  crlf )
)
(defrule disease2
(B.The fungi will attack flowers fruit petioles leaves and stems)
(B. Flowers and fruit stalks infected during flowering die rapidly. Green and ripe fruit develop brown rot)
(B. This spreads over the whole fruit which becomes covered with masses of dry greyish spores)
(B. The rot may start on any portion of the fruit but is found most frequently on the calyx end or on the sides of fruit
touching other rotten fruit)
(not (disease identified))
=>
(assert (disease identified))
(printout fdatao "2"  crlf )
)
(defrule disease3
(C. Red stele affected plants become stunted and wilt in dry weather.)
(C. Older leaves turn yellow or red particularly along the margin.)
(C. The symptom that helps to identify red stele is the brick red discoloration in the center stele of live white roots.)
(C. The red color may extend the length of the root or it may show up for only a short distance above the dead root tip.)
(C. This symptom is obvious only during winter and spring.)
(C. The discoloration does not extend into the crown of the plant.)
(C. Infected plants usually die by June or July.)
(C. Growth of the plants will slow down and they will become dull bluish green. In spring the plants will convalesce
somewhat.)
(C. An affected plant will form no or only few flowers.)
(C. The small fruits will dry out. The root hair of the roots is lacking.)
(C. When cutting the main roots it will appear that the central cylinder has discolored red)
(not (disease identified))
=>
(assert (disease identified))
(printout fdatao "3"  crlf ))
(defrule disease4
(D. Plants carrying a large crop will suddenly wilt usually on a hot day in late spring or summer.)
(D. Some plants do not recover and die within a week.)
```

```
(D. In surviving plants older leaves take on a scorched look while younger leaves remain pale in colour and turgid until they also die off.)
(D. Fruit on affected plants do not mature remain small and have paler appearance.)
(not (disease identified))
=>
(assert (disease identified))
(printout fdatao "4"  crlf ))
(defrule disease5
(E. An early symptom of the disease is upward curling of the leaf margins.)
(E. This is followed by irregular purple blotching on the upper leaf surfaces often along major veins. The leaves feel brittle.)
(E. This disease does not produce the masses of greyish white spores typical of powdery mildew on other crops.)
(E. Powdery mildew can attack fruit at any stage.)
(E. Dull immature and mature berries with prominent planting materials)
(not (disease identified))
=>
(assert (disease identified))
(printout fdatao "5"  crlf ))
(defrule disease6
(F. Lesions or spots are more numerous on upper leaf surfaces and appear circular to irregular in shape.)
(F. These lesions often have definite reddish purple to rusty brown borders that surround a necrotic area.)
(F. Lesion size and appearance often are influenced by the host variety and the ambient temperature.)
(F. The leaf spots sometimes cause severe problems often depending on the variety planted.)
(F. Susceptible varieties can be defoliated partly or compleF. tely by late summer. In years that are particularly favorable for disease development they can be severely weakened.)
(not (disease identified))
=>
(assert (disease identified))
(printout fdatao "6"  crlf ))
 (defrule disease7
(G. Normal strawberry roots are white but naturally turn dark on the surface with age.)
(G. The root system of a plant affected by black root rot is smaller with black lesions or with the roots completely black.)
(G. Such plants become stunted and produce few berries and runners.)
(not (disease identified))
=>
(assert (disease identified))
(printout fdatao "7"  crlf ))
(defrule disease8
(H. Round black or light gray lesions on leaves.)
(H. Numerous spots may develop but leaves do not die.)
(H. Dark brown or black sunken circular lesions on stems petioles and runners)
(H. Plants may be stunted and yellow)
(H. Plants may wilt and collapse)
(H. Internal tissues discolored red)
(H. Youngest plant leaves wilt during water stress in early afternoon and recover in the evening)
(H. Wilting progresses to entire plant)
(H. Plant death)
(H. Reddish brown rot or streak visible when crown is cut lengthways.)
(H. Damp firm dark brown to black rot on buds.)
(H. Dark lesion extending down pedicel which girdles the stem and kills the flower flowers dry out and die.)
(H. Light brown water soaked spots on ripening fruit which develop into firm dark brown or black round lesions)
(not (disease identified))
=>
(assert (disease identified))
(printout fdatao "8"  crlf ))
```

```
(defrule disease9
(K. Very small water soaked lesions on lower surfaces of leaves which enlarge to form dark green or translucent angular
spots which ooze bacteria.)
(K. Lesions may coalesce to form reddish spots with a chlorotic halo)
(not (disease identified))
=>
(assert (disease identified))
(printout fdatao "9"  crlf ))

(defrule endline
(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 (readline fdata))
  (bind ?symptom2 (readline fdata))
  (bind ?symptom3 (readline fdata))
  (bind ?symptom4 (readline fdata))
  (bind ?symptom5 (readline fdata))
  (bind ?symptom6 (readline fdata))
  (bind ?symptom7 (readline fdata))
  (bind ?symptom8 (readline fdata))
  (bind ?symptom9 (readline fdata))
  (bind ?symptom10 (readline fdata))
  (bind ?symptom11 (readline fdata))
  (bind ?symptom12 (readline fdata))
  (bind ?symptom13 (readline fdata))
  (bind ?symptom14 (readline fdata))

  (assert-string (str-cat "(" ?symptom1 ")"))
  (assert-string (str-cat "(" ?symptom2 ")"))
  (assert-string (str-cat "(" ?symptom3 ")"))
  (assert-string (str-cat "(" ?symptom4 ")"))
  (assert-string (str-cat "(" ?symptom5 ")"))
  (assert-string (str-cat "(" ?symptom6 ")"))
  (assert-string (str-cat "(" ?symptom7 ")"))
  (assert-string (str-cat "(" ?symptom8 ")"))
  (assert-string (str-cat "(" ?symptom9 ")"))
  (assert-string (str-cat "(" ?symptom10 ")"))
  (assert-string (str-cat "(" ?symptom11 ")"))
  (assert-string (str-cat "(" ?symptom12 ")"))
  (assert-string (str-cat "(" ?symptom13 ")"))
  (assert-string (str-cat "(" ?symptom14 ")"))

   (close fdata))
```

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