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A Knowledge Based System for Cucumber Diseases Diagnosis

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Abstract *: The cucumber is a creeping vine that roots in the ground and grows up trellises or other supporting frames, wrapping around supports with thin, spiraling tendrils. The plant may also root in a soilless medium, whereby it will sprawl along the ground in lieu of a supporting structure. The vine has large leaves that form a canopy over the fruits. Among these common diseases, we single out the diseases that affect the cucumber, which is affected by about 22 diseases, with different symptoms for each disease. Today, technology is facilitating human life in all areas of life, and among these facilities are expert systems that have become an integral part of human life as they contain several systems and areas, for example: Artificial Intelligence (AI), which refers to systems or devices that simulate Human intelligence to perform tasks that can improve itself based on some human information, and other areas, and with reference to expert systems and their importance to humans, an integrated expert system has been created in the agricultural field that diagnoses cucumber diseases using CLIPS Expert System language Delphi language. The system was used to design and implement the proposed expert system. The system facilitates the diagnosis of cucumber-related diseases. There is no doubt that this expert system will help farmers and those involved in the agricultural field to diagnose cucumber-related diseases.* ***Objectives****: is to help farmers diagnose pear diseases in the correct way and how to treat these diseases. Method: The system contains a program that diagnoses 22 diseases that affect cucumber.* ***Results****: The expert system was evaluated by farmers and praised for helping them with it.* ***Conclusion****: The expert system for diagnosing cucumber diseases is effective and usable.*

Keywords: Expert Systems, Delphi, CLIPS, cucumber diseases.

INTRODUCTION

Cucumber, Cucumis sativus, is a warm season, vining, and annual plant in the family Cucurbitaceae grown for its edible cucumber fruit. The cucumber plant is a sprawling vine with large leaves and curling tendrils. The plant may have 4 or 5 main stems from which the tendrils branch. The leaves of the plant are arranged alternately on the vines, have 3–7 pointed lobes and are hairy. The cucumber plant produces yellow flowers that are 4 cm (1.6 in) in diameter. The cucumber fruit varies in shape but is generally a curved cylinder rounded at both ends that can reach up to 60 cm (24 in) in length 10 cm (3.9 in) in diameter. Cucumber plants are annual plants, surviving only one growing season and the vines can reach up to 5 m (16.4 ft) in length. Cucumber may also be referred to as gherkin and originates from the foothills of the Himalayas, likely in India.

Figure 1: Cucumber flower

Although technically a fruit, cucumbers are used as a fresh vegetable, consumed fresh in salads. Some varieties are grown specifically for pickling. Yellow varieties are generally cooked before consumption.

MATERIAL AND METHOD

The intended expert system diagnoses 22 “primary” diseases of the cucumber that are related to the fruit. At first, the system gives a simple overview of the system in general. As in Figure 2 below.

Figure 2 : User Interface

When clicking on the “Start” icon, the user will be directed to an interface consisting of a set of symptoms arranged alphabetically in order to facilitate the user in using the system**.** Figure 3 below shows next the user selects symptoms from the list attached to the image below, and these symptoms are initially alphabetized to facilitate diagnosis of the pear disease.

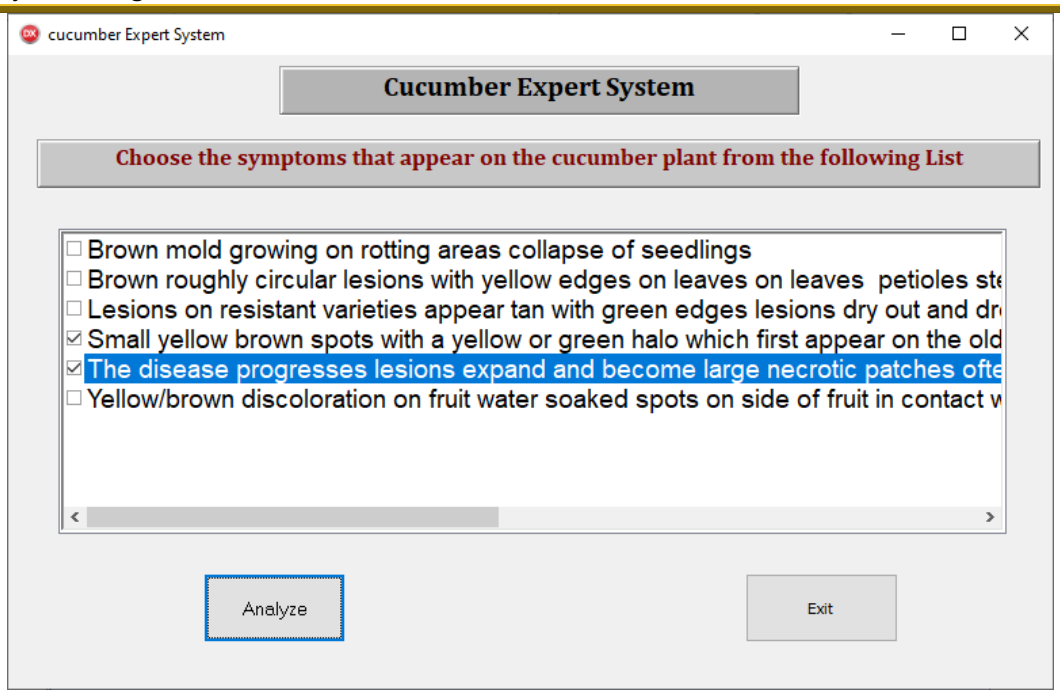

Figure 3: List of symptoms

After identifying the symptoms of the disease, the user presses "Analysis" to go to the new interface of the analysis process, and this interface consists of diagnosis and management of the disease, then a picture of that disease attached to its data.

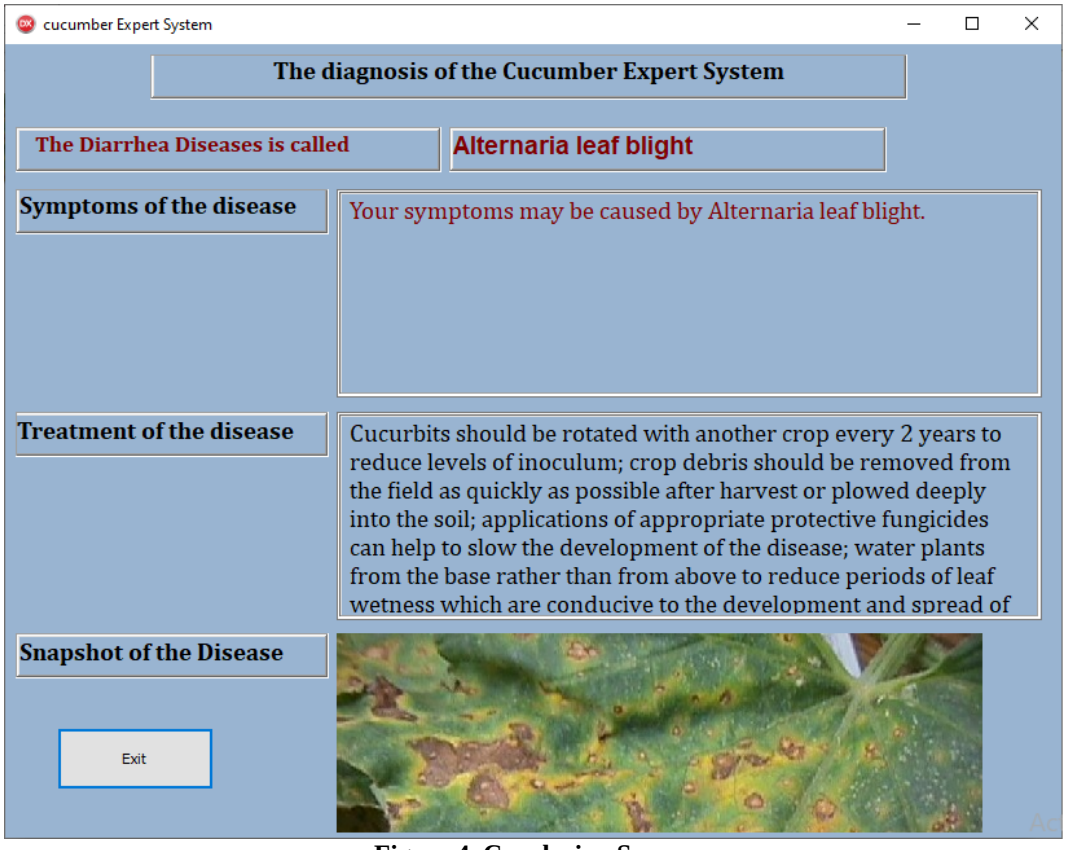

Figure 4 Conclusion Screen

After that, we can add or modify disease symptoms through the "Preparation" page.

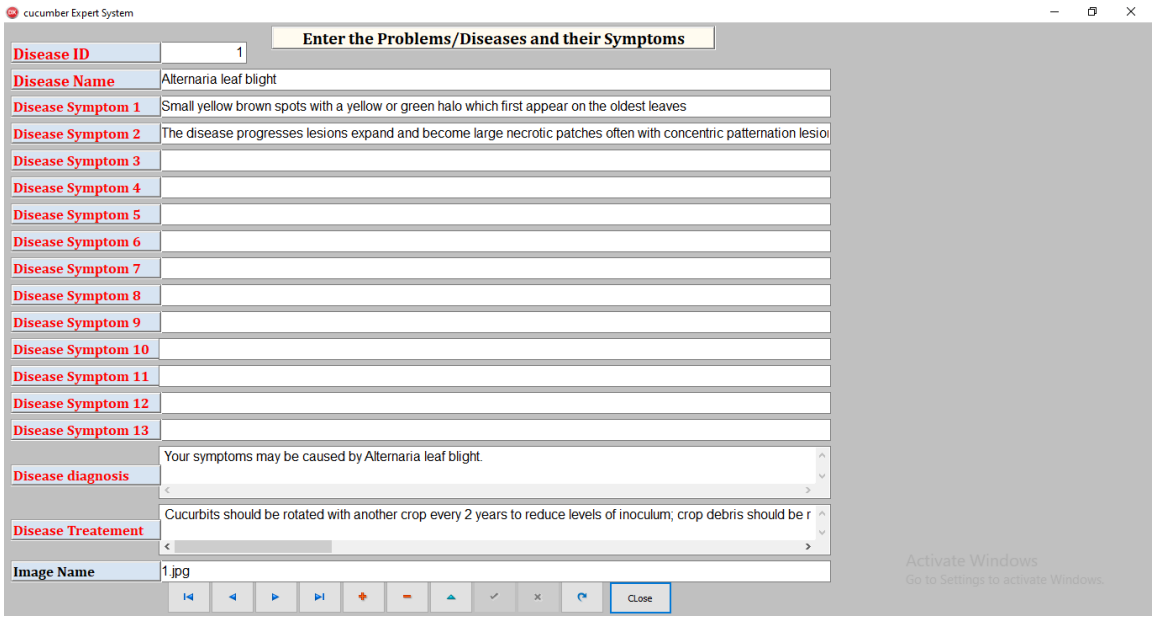

Figure 5: Form to enter diseases and their symptoms

LETERATURE REVIEW

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.

Comments about previous studies

There are many expert systems related to plant diagnosis in general, and after what was researched from several different sources, we did not find an expert system that works on improving crops. That's why we proposed to develop an expert system for diagnosing and treating cucumber diseases.

KNOWLEDGE REPRESTATION

As we said earlier, the expert system diagnoses 22 diseases of the cucumber, all of these diseases have been listed with symptoms and based on these symptoms, the disease will be diagnosed and treated correctly, and in detail these diseases are:

1. Alternaria leaf blight

Symptoms:

Small, yellow-brown spots with a yellow or green halo which first appear on the oldest leaves; as the disease progresses, lesions expand and become large necrotic patches, often with concentric patternation; lesions coalesce, leaves begin to curl and eventually die.

Cause

Fungus

Comments

Disease is prevalent in growing areas where temperatures are high and rainfall is frequent.

Management

Cucurbits should be rotated with another crop every 2 years to reduce levels of inoculum; crop debris should be removed from the field as quickly as possible after harvest or plowed deeply into the soil; applications of appropriate protective fungicides can help to slow the development of the disease; water plants from the base rather than from above to reduce periods of leaf wetness which are conducive to the development and spread of disease.

Figure 6: Alternaria leaf blight

2. Anthracnose

Symptoms

Brown roughly circular lesions with yellow edges on leaves on leaves, petioles, stems and/or fruit; lesions on resistant varieties appear tan with green edges; lesions dry out and drop out of leaves.

Cause

Fungus

Comments

Disease favors warm temperatures.

Management

Plant resistant varieties; use only certified seed; apply appropriate protective fungicides; rotate crops every year.

Figure 7: Post-harvest anthracnose symptoms on cucumber fruit

3. Belly rot (Fruit rot, Damping-off)

Symptoms

Yellow/brown discoloration on fruit; water soaked spots on side of fruit in contact with soil; brown mold growing on rotting areas; collapse of seedlings.

Cause

Fungus

Comments

Disease favors warm, humid conditions.

Management

Till soil deeply prior to planting; use plastic mulch to create a barrier between fruit and soil; plant in sites with good drainage to avoid wet soils; apply appropriate protective fungicides when plants begin to vine.

Figure 8: Belly rot

4. Cercospora leaf spot

Symptoms

Initial symptoms of disease occur on older leaves as small spots with light to tan brown centers; as the disease progresses, the lesions enlarge to cover large areas of the leaf surface; lesions may have a dark border and be surrounded by a chlorotic area; the centers of the lesions may become brittle and crack.

Cause

Fungus

Comments

Fungus survives on plant debris; spread by wind and water splash; occurs mainly in tropical and subtropical growing regions.

Management

Any diseased plants should be removed and destroyed to prevent further spread; crop debris should be removed after harvest or plowed deeply into the soil to reduce inoculum.

Figure 9: **Cercospora leaf spot**

5. Downy mildew

Symptoms

Fluffy purplish mildew on underside of leaves; yellow spots on the upper side of leaves.

Cause

Oomycete

Comments

Disease favors cool, humid conditions.

Management

Do not overcrowd plants; avoid overhead irrigation, water plants from base; apply appropriate fungicide.

6. Fusarium wilt (Cucumber wilt, Foot-rot)

Symptoms

Rotting of seedling stems at soil line; brown lesions on one side of stem; discoloration of tissue inside vine.

Cause

Fungus

Comments

Disease favors warm, moist soil.

Management

Plant fungicide treated seed; rotate crops on 4 year rotation.

Figure 10: **Downy mildew**

7. Gummy stem blight (vine decline, GSB)

Symptoms

Gray/green lesions between veins of leaves; tan or gray lesions on stems.

Cause

Fungus

Comments

Disease may be seed-borne.

Management

Use disease free seed; treat seeds prior to planting; rotate crops every 2 years.

Figure 11: **Gummy stem blight**

8. Powdery mildew

Symptoms

The appearance of white powdery spots on the upper surfaces of leaves, stems and fruits. As the disease progress, white fungal growth covers whole leaves and stem. The infected leaves become yellow, distorted and may drop prematurely.

Cause

Fungus

Comments

The spores are carried by wind from one plant to another. The disease is favored by moderate temperature and shady conditions.

Management

Grow available resistant varieties. If the disease is severe, spray suitable fungicide.

Figure 12: **Powdery mildew**

9. Septoria leaf spot

Symptoms

Initial symptoms of disease are small dark water-soaked spots on the leaves which turn beige to white in dry conditions; lesions develop thin brown borders and the centers may become brittle and crack; small white spots may erupt on the surface of infected butternut and acorn squash and pumpkin fruit.

Cause

Fungus

Comments

Pathogen can survive on crop debris for periods in excess of 1 year.

Management

Scout plants during cool wet conditions for any sign of spots; early application of an appropriate protective fungicide can help limit the development of the disease if spots are found' cucurbits should be rotated with other crops every 2 years to prevent the build-up of inoculum; crop debris should be removed and destroyed after harvest.

Figure 13: **Septoria leaf spot**

10. Target leaf spot

Symptoms

Angular yellow spots appear on older leaves; as the disease progresses, the spots enlarge and become circular with light brown centers and dark margins; as lesions mature, they turn gray and drop out leaving holes in the leaves; if fruits become infected early in their growth then the blossom end may darken and become shriveled.

Cause

Fungus

Comments

Fungus can survive on plant debris for periods in excess of 2 years; disease emergence favored by periods of high humidity and temperature.

Management

Plant resistant varieties; apply appropriate protective fungicide; sanitize equipment regularly.

Figure 14: **Target leaf spot**

11. Verticillium wilt

Symptoms

Symptoms generally appear after fruit set; chlorotic leaves which develop necrotic areas; leaves collapsing; symptoms only on one side of vine; discoloration of vascular tissue in roots.

Cause

Fungus

Comments

Fungus can survive in soil for many years; disease emergence favored by cool or mild weather in Spring.

Management

Do not plant in areas where other susceptible crops have been grown previously; delay planting until temperatures are warmer.

12. Angular leaf spot

Symptoms

Small water-soaked lesions on leaves which expand between leaf veins and become angular in shape; in humid conditions, lesions exude a milky substance which dries to form a white crust on or beside lesions; as the disease progresses, lesions turn tan and may have yellow/green edges; the centers of the lesions dry and may drop out leaving a hole in the leaf.

Cause

Bacteria, Bacterium

Comments

Spread through infected seed, splashing rain, insects and movement of people between plants; bacterium overwinters in crop debris and can survive for 2.5 years.

Management

Use disease-free seed; do not grow plants in field where cucurbits have been grown in the previous 2 years; protective copper spray may help reduce incidence of disease in warm, humid climates; plant resistant varieties.

Figure 15: **Angular leaf spot**

13. Bacterial leaf spot

Symptoms

Initial symptoms of the disease are the appearance of small water-soaked lesions on the undersides of the leaves which lead to the development of yellow patches on the upper leaf surface; the lesions become round and angular and may be mistaken for angular leaf spot; the centers of the lesions become thin and translucent and lesions become surrounded with a wide yellow halo.

Cause

Bacterium

Comments

Bacteria is spread via infected seeds.

Management

Use disease-free seed; do not grow plants in field where cucurbits have been grown in the previous 2 years; avoid overhead irrigation, water plants from the base instead to reduce the spread of bacteria.

14. Bacterial wilt

Symptoms

Individual runners or whole plant begins to wilt and rapidly die; infected runners appear dark green in color but rapidly become necrotic as the disease progresses.

Cause

Bacterium

Comments

Can result in crop losses of of 75%; spread by striped or spotted cucumber beetles; disease can be confirmed by cutting the stem and slowly pulling the two ends apart - infected plants will ooze strings of bacterial exudate.

Management

Control cucumber beetle populations on plants; hand pick adult beetles and destroy; soil and foliar application of appropriate insecticides may help to control populations.

Figure 16: **Bacterial wilt**

15. Aster yellows

Symptoms

Foliage turning yellow; secondary shoots begin growing prolifically; stems take on a rigid, upright growth habit; leaves are often small in size and distorted, may appear thickened; flowers are often disfigured and possess conspicuous leafy bracts; fruits are small and pale in color.

Cause

Phytoplasma

Comments

Disease is transmitted by leafhoppers and can cause huge losses in cucurbit crops.

Management

Remove any infected plants from the field to reduce spread; control weeds in and around the field that may act as a reservoir for the phytoplasma; protect plants from leaf hopper vectors with row covers.

Figure 17: **Aster yellows**

16. Cucumber green mottle mosaic

Symptoms

Early symptoms on young plants include vein-clearing and the development of crumpled leaves; older plants develop bleached and/or chlorotic leaves. As the infection progresses, leaves develop mottling and become blistered and distorted. Leaf symptoms are very difficult to distinguish from other mosaic viruses of Cucurbits. Severity of symptoms varies depending on the strain of the virus.

Cause

Virus

Comments

All Cucurbit species are susceptible to the virus, some cucumber varieties have been developed which have some resistance to the disease and are available in Canada and Europe.

Management

As the virus is spread primarily by infected seed, only disease-free seed from a reputable supplier should be planted. Seedlings and plants infected with the virus should be removed and destroyed to prevent spread. All seedlings/plants within a 3-5 ft radius of the infected plant should also be destroyed. The virus can be spread mechanically via tools and on hands,

good sanitation should be practiced at all times to prevent virus transmission - disinfect all tools and equipment between uses by dipping in a solution of bleach or using a commercially available disinfectant such as Virkon.

17. Cucumber mosaic

Symptoms

Plants are severely stunted; foliage is covered in distinctive yellow mosaic; leaves of plant curl downwards and leaf size is smaller than normal; flowers on infected plants may be deformed with green petals; fruits become distorted and are small in size; fruit is often discolored.

Cause

Virus

Comments

Transmitted by aphids; virus has an extensive host range; virus can be mechanically transmitted via tools etc.

Management

Control of the virus is largely dependant on the control of the aphid vectors; reflective mulches can deter aphid feeding; aphid outbreaks can be treated with mineral oils or insecticidal soap applications; some resistant varieties are available.

Figure 18: **Cucumber mosaic**

18. Squash mosaic

Symptoms

Symptoms vary with variety being grown but plants can show symptoms which include green veinbanding, mottled leaves, blisters, ring spots or potruding veins at leaf margins; some squash varieties may develop leaf enations; infected plants are often stunted and fruits may be malformed with mottled skin.

Cause

Virus

Comments

Virus can be transmitted through infected seed and spread by striped cucumber beetles.

Management

Use only certified disease-free seed.

19. Watermelon mosaic

Symptoms

Symptoms vary widely depending on species, cultivar, virus strain and environmental conditions; symptoms on leaves may include green mosaic patternation, green vein-banding, chlorotic rings and disfigured leaves.

Cause

Virus

Comments

Virus is found in almost all Cucurbit growing regions in the world; virus is spread by over 20 aphid species.

Management

Treatments that control populations of aphid vectors can also reduce the incidence of the virus; spraying plants with mineral oils or insecticidal soaps can help to reduce aphid numbers.

20. Phytophthora blight

Symptoms

The disease can be found in all stages and all parts of the crop. On seedlings, the pathogen causes damping off symptoms where hypocotyl exhibit watery rot or rotting of the stem near the soil line, resulting in plant death. The Mature plants exhibit crown rot symptoms. The post-emergence infection leads to wilting and death of the plant. During the growing season, vine exhibit dark olive water soaked lesion which later become brown resulting in girdling of the stem that leads to quick collapse and death of foliage (vine blight). On leaves shows necrotic spots with chlorotic to olive-green borders. As the disease progress, this spot merges and cover entire leaf. On fruits, disease can occur from fruit set to harvest and storage.

The appearance of water soaked lesions on fruit, particularly near the surface which is touching the soil. Later these lesions expand, resulting in rioting. The infected fruit is covered with white mold numerous sporangia.

Cause

Oomycete

Comments

Rain and overhead irrigation helps in spreading pathogen from plant to plant.
Management
Use disease free seed materials. Follow crop rotation. Spray suitable fungicide.

21. Pythium fruit rot (Cottony leak)

Symptoms

The symptoms first appear in the area of fruit which is in contact with soil as small, water-soaked spots. These spots spread very fast to a large portion of fruit resulting in soft and necrotic area. If the condition is favorable, heavy growth of white fungal mass which resembles the tufts of cotton can be seen on infected area.

Cause

Fungus

Comments

The disease is favored by wet condition. The pathogen spreads via water and soil particles.

Management

Avoid excessive soil moisture. Mulching with suitable materials help in preventing the disease.

22. Scab

Symptoms

The leaves exhibit small water-soaked or pale green spots which later turn white to gray and become angular. A yellowish halo may surround the lesion. The damaged leaves may appear ragged due to tearing and cracking of dead tissue. Symptoms can also be seen on petiole and stem. On fruits, the appearance of small, gray, slightly sunken, oozing, gummy spots which later enlarge, and finally become distinct sunken cavities. Under favorable condition, the pathogen produces dark, olive green, velvety layer of spores on the cavities.

Cause

Fungus

Comments

The pathogen overwinters on the seed, in crop debris and in soil.

Management

Remove and destroy the infected leaves and plant debris. Keep the field free from weeds. Use disease free seeds. Grow available resistant varieties. Follow crop rotation. Spray with suitable fungicides.

SYSTEM EVALUATION

The system was tested by some users who praised the experience because the system makes it easier for them to diagnose cucumber diseases.

CONCLUSION

In conclusion, an expert system has been created that diagnoses cucumber diseases in a thoughtful and professional manner to make it easier for users who grow cucumber in order to treat it in the right way. Delphi and CLIPS Expert System languages were used to design and implement the proposed expert system. The system works with interfaces that Easy to use, smooth and flexible.

The Expert System Source Code:

```
(defrule disease1
(Small, yellow-brown spots with a yellow or green halo which first appear on the oldest leaves; as the disease progresses, lesions expand and become large necrotic patches, often with concentric patternation; lesions coalesce, leaves begin to curl and eventually die.)
(not (disease identified))
=>
(assert (disease identified))
(printout fdatao "1"  crlf )
)
(defrule disease2
```

(Brown roughly circular lesions with yellow edges on leaves on leaves, petioles, stems and/or fruit; lesions on resistant varieties appear tan with green edges; lesions dry out and drop out of leaves.)
(not (disease identified))
=>
(assert (disease identified))
(printout fdatao "2" crlf)
)
(defrule disease3
(Yellow/brown discoloration on fruit; water soaked spots on side of fruit in contact with soil; brown mold growing on rotting areas; collapse of seedlings)
(not (disease identified))
=>
(assert (disease identified))
(printout fdatao "3" crlf)
)
(defrule disease4
(Initial symptoms of disease occur on older leaves as small spots with light to tan brown centers; as the disease progresses, the lesions enlarge to cover large areas of the leaf surface; lesions may have a dark border and be surrounded by a chlorotic area; the centers of the lesions may become brittle and crack.)
(not (disease identified))
=>
(assert (disease identified))
(printout fdatao "4" crlf)
)
(defrule disease5
(Fluffy purplish mildew on underside of leaves; yellow spots on the upper side of leaves.)
(not (disease identified))
=>
(assert (disease identified))
(printout fdatao "5" crlf)
)
(defrule disease6
(Rotting of seedling stems at soil line; brown lesions on one side of stem; discoloration of tissue inside vine)
(not disease identified)
=>
(assert (disease identified))
(printout fdatao "6" crlf)
)
(defrule disease7
(Gray/green lesions between veins of leaves; tan or gray lesions on stems.)
(not disease identified)
=>
(assert (disease identified))
(printout fdatao "7" crlf)
)
(defrule disease8
(The appearance of white powdery spots on the upper surfaces of leaves, stems and fruits. As the disease progress, white fungal growth covers whole leaves and stem. The infected leaves become yellow, distorted and may drop prematurely.)
(not disease identified)
=>
(assert (disease identified))
(printout fdatao "8" crlf)
)
(defrule disease9
(Initial symptoms of disease are small dark water-soaked spots on the leaves which turn beige to white in dry conditions; lesions develop thin brown borders and the centers may become brittle and crack; small white spots may erupt on the surface of infected butternut and acorn squash and pumpkin fruit.)

```
 (not disease identified)
=>
(assert (disease identified))
(printout fdatao "9"  crlf )
)
(defrule disease10
(Angular yellow spots appear on older leaves; as the disease progresses, the spots enlarge and become circular with light brown centers and dark margins; as lesions mature, they turn gray and drop out leaving holes in the leaves; if fruits become infected early in their growth then the blossom end may darken and become shriveled.)
 (not disease identified)
=>
(assert (disease identified))
(printout fdatao "10"  crlf )
)
(defrule disease11
(Symptoms generally appear after fruit set; chlorotic leaves which develop necrotic areas; leaves collapsing; symptoms only on one side of vine; discoloration of vascular tissue in roots. )
 (not disease identified)
=>
(assert (disease identified))
(printout fdatao "11"  crlf )
)
(defrule disease12
(Small water-soaked lesions on leaves which expand between leaf veins and become angular in shape; in humid conditions, lesions exude a milky substance which dries to form a white crust on or beside lesions; as the disease progresses, lesions turn tan and may have yellow/green edges; the centers of the lesions dry and may drop out leaving a hole in the leaf. )
 (not disease identified)
=>
(assert (disease identified))
(printout fdatao "12"  crlf )
)
(defrule disease13
(Initial symptoms of the disease are the appearance of small water-soaked lesions on the undersides of the leaves which lead to the development of yellow patches on the upper leaf surface; the lesions become round and angular and may be mistaken for angular leaf spot; the centers of the lesions become thin and translucent and lesions become surrounded with a wide yellow halo.)
 (not disease identified)
=>
(assert (disease identified))
(printout fdatao "13"  crlf )
)
(defrule disease14
(Individual runners or whole plant begins to wilt and rapidly die; infected runners appear dark green in color but rapidly become necrotic as the disease progresses. )
 (not disease identified)
=>
(assert (disease identified))
(printout fdatao "14"  crlf )
)
(defrule disease15
(Foliage turning yellow; secondary shoots begin growing prolifically; stems take on a rigid, upright growth habit; leaves are often small in size and distorted, may appear thickened; flowers are often disfigured and possess conspicuous leafy bracts; fruits are small and pale in color.
)
 (not disease identified)
=>
(assert (disease identified))
(printout fdatao "15"  crlf )
```

```
)
(defrule disease16
(Early symptoms on young plants include vein-clearing and the development of crumpled leaves; older plants develop bleached and/or chlorotic leaves. As the infection progresses, leaves develop mottling and become blistered and distorted. Leaf symptoms are very difficult to distinguish from other mosaic viruses of Cucurbits. Severity of symptoms varies depending on the strain of the virus. )
 (not disease identified)
=>
(assert (disease identified))
(printout fdatao "16"  crlf )
)
(defrule disease17
(Plants are severely stunted; foliage is covered in distinctive yellow mosaic; leaves of plant curl downwards and leaf size is smaller than normal; flowers on infected plants may be deformed with green petals; fruits become distorted and are small in size; fruit is often discolored.
)
(not disease identified)
=>
(assert (disease identified))
(printout fdatao "17"  crlf )
)
(defrule disease18
(Symptoms vary with variety being grown but plants can show symptoms which include green veinbanding, mottled leaves, blisters, ring spots or potruding veins at leaf margins; some squash varieties may develop leaf enations; infected plants are often stunted and fruits may be malformed with mottled skin.)
 (not disease identified)
=>
(assert (disease identified))
(printout fdatao "18"  crlf )
)
(defrule disease19
(Symptoms vary widely depending on species, cultivar, virus strain and environmental conditions; symptoms on leaves may include green mosaic patternation, green vein-banding, chlorotic rings and disfigured leaves.)
 (not disease identified)
=>
(assert (disease identified))
(printout fdatao "19"  crlf )
)
(defrule disease20
(The disease can be found in all stages and all parts of the crop. On seedlings, the pathogen causes damping off symptoms where hypocotyl exhibit watery rot or rotting of the stem near the soil line, resulting in plant death. The Mature plants exhibit crown rot symptoms. The post-emergence infection leads to wilting and death of the plant. During the growing season, vine exhibit dark olive water soaked lesion which later become brown resulting in girdling of the stem that leads to quick collapse and death of foliage (vine blight). On leaves shows necrotic spots with chlorotic to olive-green borders. As the disease progress, this spot merges and cover entire leaf. On fruits, disease can occur from fruit set to harvest and storage. The appearance of water soaked lesions on fruit, particularly near the surface which is touching the soil. Later these lesions expand, resulting in rioting. The infected fruit is covered with white mold numerous sporangia. )
 (not disease identified)
=>
(assert (disease identified))
(printout fdatao "20"  crlf )
)
(defrule disease21
(The symptoms first appear in the area of fruit which is in contact with soil as small, water-soaked spots. These spots spread very fast to a large portion of fruit resulting in soft and necrotic area. If the condition is favorable, heavy growth of white fungal mass which resembles the tufts of cotton can be seen on infected area. )
 (not disease identified)
```

```
=>
(assert (disease identified))
(printout fdatao "21"  crlf )
)
(defrule disease22
(The leaves exhibit small water-soaked or pale green spots which later turn white to gray and become angular. A yellowish halo may surround the lesion. The damaged leaves may appear ragged due to tearing and cracking of dead tissue. Symptoms can also be seen on petiole and stem. On fruits, the appearance of small, gray, slightly sunken, oozing, gummy spots which later enlarge, and finally become distinct sunken cavities. Under favorable condition, the pathogen produces dark, olive green, velvety layer of spores on the cavities. )
 (not disease identified)
=>
(assert (disease identified))
(printout fdatao "22"  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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