

Proposed Expert System for Pear Fruit Diseases

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Abstract : There is no doubt that plant diseases are numerous in the world of agriculture. These diseases cause a lot of trouble to most farmers who take the craft of agriculture as their daily sustenance. Among these common diseases, we single out the diseases that affect the pear fruit, which is affected by about eleven 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 pear diseases using CLIPS Expert System language The system was used to design and implement the proposed expert system. The system facilitates the diagnosis of pear-related diseases. There is no doubt that this expert system will help farmers and those involved in the agricultural field to diagnose pear-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 11 diseases that affect pear and the eleven diseases are: Scab, Seedling blight, Crown gall, White root rot, Collar rot, Powdery mildew, Leaf spot, Canker, Viral diseases, Phytoplasma disease, Bitter rot. **Results:** The expert system was evaluated by farmers and praised for helping them with it. **Conclusion:** The expert system for diagnosing pear diseases is effective and usable.

Keywords: Expert Systems, CLIPS, pear diseases.

INTRODUCTION

There are many plant diseases in the world of agriculture. These diseases cause a lot of trouble to most farmers. One of these common diseases is the diseases that affect the pear fruit, which is affected by about eleven different diseases with different symptoms for each disease. Pear trees are affected by a large number of diseases, and they can It is infected with it, whether it is a home tree or planted for commercial purposes. Not all diseases affect pear trees once. As they appear in a regular sequence depending on the weather and the evolution of the cause, and disease management for one season can improve the quantity and quality of the fruits produced by the tree [1].



Figure 1: Scab Pear Diseases 1

Today technology works to facilitate life for humans in all areas of life, and among these facilities are the expert systems that have become part of It is not part of human life as it contains several systems and areas, for example: Artificial Intelligence (AI), which refers to systems or devices that simulate human intelligence to perform tasks and which can improve themselves based on some human information, and other areas, and by reference To expert systems and their importance to humans, an integrated expert system has been established in the agricultural field that works to diagnose pear diseases using CLIPS expert system language was used to design and implement the proposed expert system. There is no doubt that this expert system will help farmers and those involved in the agricultural field in diagnosing diseases related to Pear fruit [2].

MATERIAL AND METHOD

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

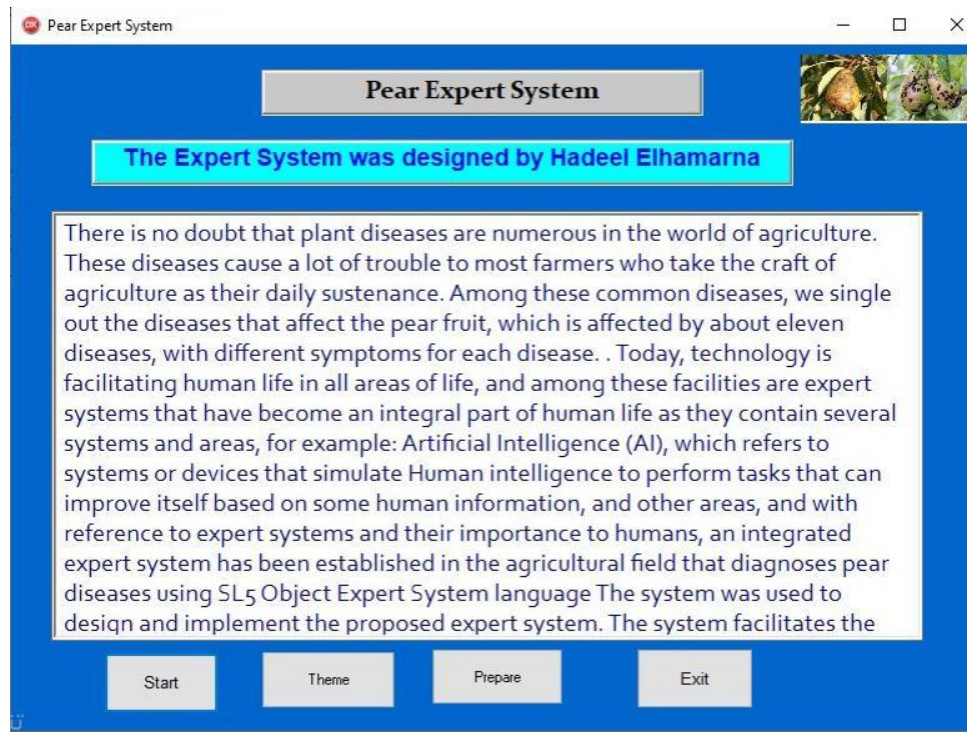


Figure 1 Part 1: Program Interface 1

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.

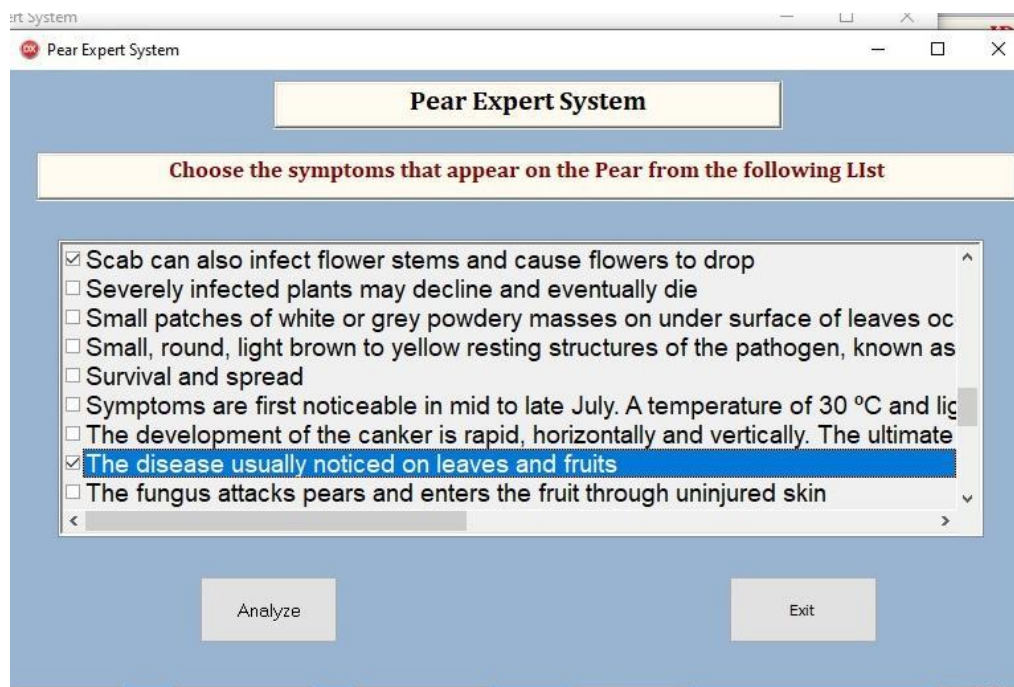


Figure 1 Part 2: Program Interface 2

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 Survival and spread and Favourable conditions, then a picture of that disease attached to its data.

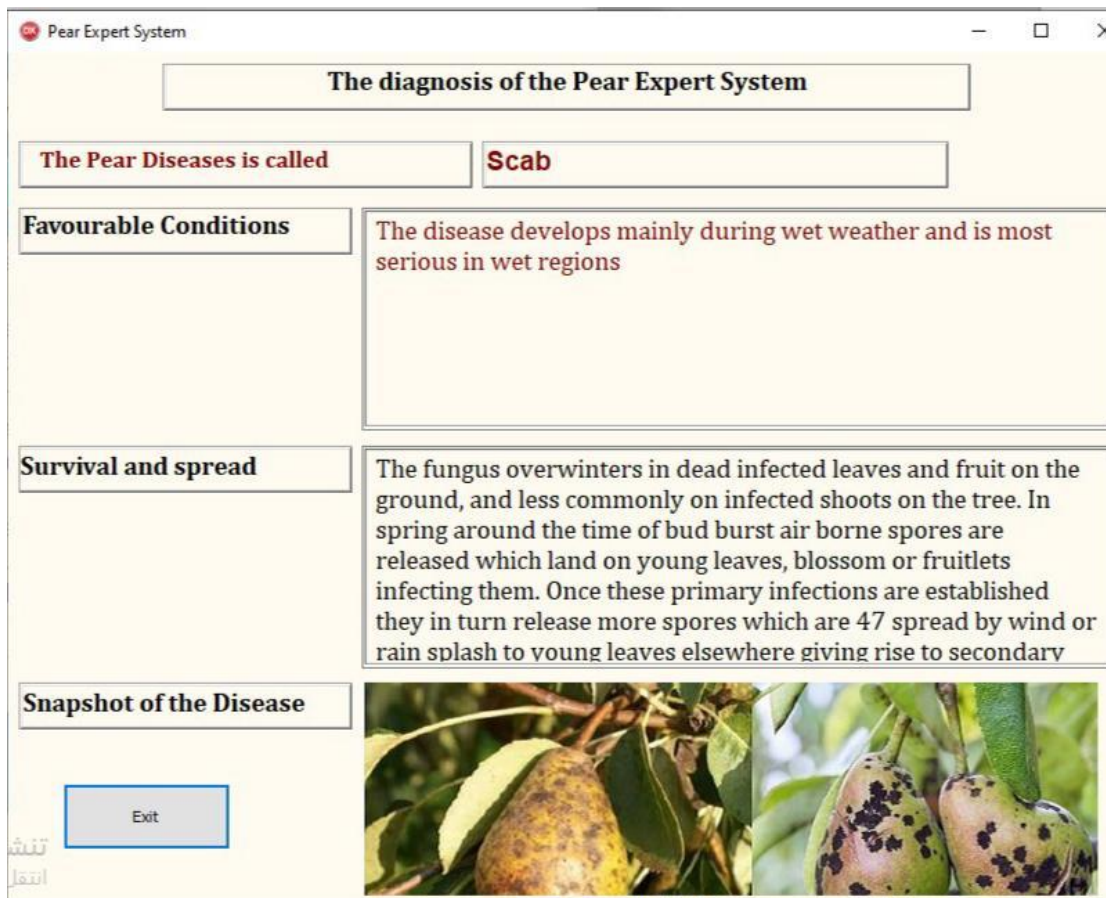


Figure 1 Part 3: Program Interface 3

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

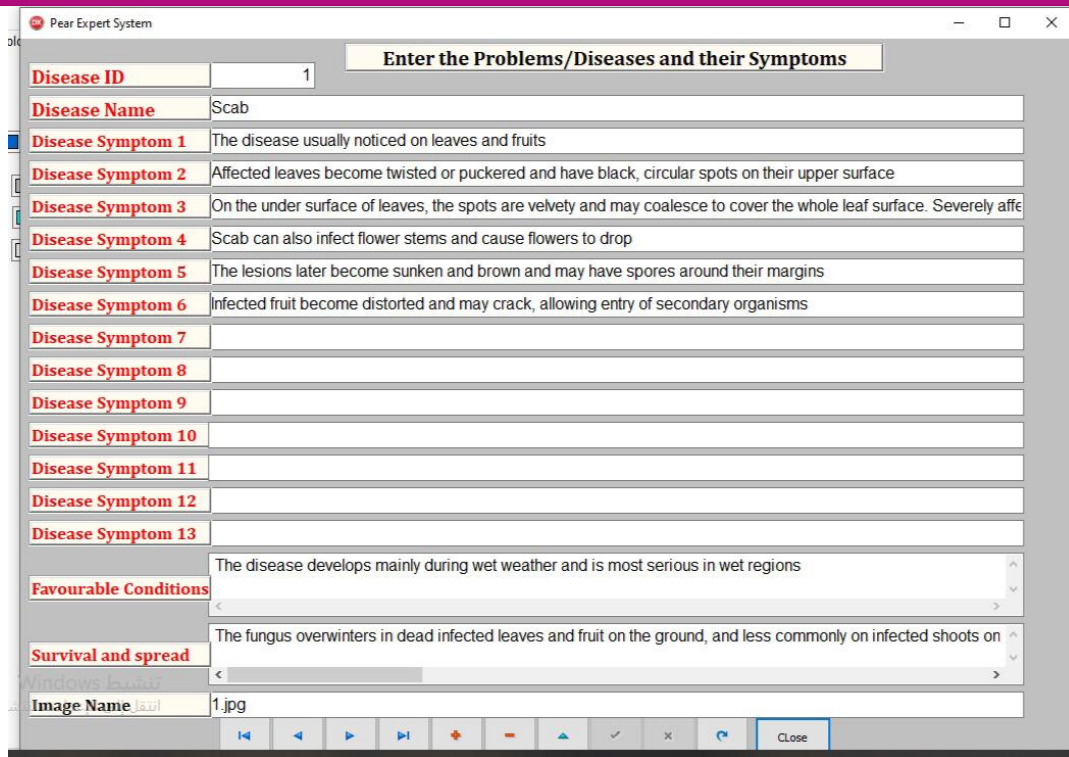


Figure 1 Part 4: Program Interface 4

LITERATURE 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 found an expert system that works on improving crops, and developing an expert system for agricultural management of citrus and citrus using CDs, the Cherry Tomato Expert Systems Project, and in this sense it may be our expert system is the first of its kind as it concerns pear diseases.

KNOWLEDGE REPRESENTATION

As we said earlier, the expert system diagnoses 11 diseases of the pear fruit, 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:

Scab

Disease symptoms

The disease usually noticed on leaves and fruits, affected leaves become twisted or puckered and have black, circular spots on their upper surface. On the under surface of leaves, the spots are velvety and may coalesce to cover the whole leaf surface. Severely affected leaves may turn yellow and drop, Scab can also infect flower stems and cause flowers to drop, The lesions later become sunken and brown and may have spores around their margins, Infected fruit become distorted and may crack, allowing entry of secondary organisms [6].



Figure 2: Pear Diseases 2

Seedling blight

Disease symptoms

The most distinct symptoms and signs occur at the collar of the tree, Small, round, light brown to yellow resting structures of the pathogen, known as sclerotic, can be found appressed to or in the soil adjacent to infected trees, If conditions are moist, a white web-like mycelial growth may also be present, Affected cortical tissues in the collar of the tree are often shredded [7].



Figure 3: Seedling blight 1

Crown gall

Disease symptoms

Galls are usually restricted to the roots, lower stems and lower branches of infected plants. In some cases, however, crown gall may occur in the upper branches. Galls are somewhat spherical, lumpy and rough, varying in size from 1/2 inch to several inches in diameter, Affected plants may be stunted, produce small chlorotic leaves and become more sensitive to environmental stresses (particularly winter injury), Severely infected plants may decline and eventually die, This organism enters susceptible plants through fresh wounds made during transplanting, cultivating, grafting and pruning [8].



Figure 4: Crown gall

White root rot

Disease symptoms

Infection can occur on large roots or at the tree collar, in fruit trees, the base of the trunk at soil level can show signs of a dark, wet rot, especially if kept moist by weeds or wet weather, as the disease progresses, the infected tissue becomes rotten. Trees develop a generally unthrifty appearance with leaf yellowing, cessation of root growth, small leaves, premature leaf fall and small, shrivelled fruit, infected trees will eventually die [9].

Collar rot

Disease symptoms

Phytophthora collar rot attacks the lower portion especially tree trunks extending to the roots, most infections start at the junction of a lateral root with the trunk, infected bark becomes brown and is often soft and mushy or slimy when wet, Dark streaks often occur near the cambium and extend beyond the canker margin. If a canker enlarges for several years, only the marginal areas show the typical colour and texture of newly killed tissue. The development of the canker is rapid, horizontally and vertically, The ultimate effect of collar rot is to girdle the affected limb, roots, or trunk, resulting in the death of that organ or of the entire tree [10].



Figure 5: Collar rot

Bitter rot

Disease symptoms

The fungus attacks pears and enters the fruit through uninjured skin, infected fruit are characterized by a firm rot which forms a circular light brown spot. With age the spots become almost black and have a saucer-shaped depression, the organism overwinters in decayed fruit and in cracks on the old bark. A broken limb or twig will serve as an overwintering site Symptoms are first noticeable in mid to late July, A temperature of 30 °C and light rain favour development of the rot [11].

Leaf spot

Disease symptoms

Leaf spots appear on the leaves in late spring and early summer, Leaf spot Disease symptoms Initially, they are 3-5 mm to 1/4 inch in diameter, round, brown, and occasionally have a purple border, As spots age, they often turn tan to ash grey, Some spots undergo

secondary 50 enlargement, becoming irregularly shaped, Heavily infected leaves often abscise, resulting in defoliation, Fruit infections result in small, dark, raised pimple-like lesions associated with the lenticels [12].



figure 6: Leaf spot

Viral diseases

Disease symptoms

trees infected with apple mosaic virus develop pale to bright cream spots on spring leaves as they expand, These spots may become necrotic after exposure to summer sun and heat, Other viral diseases are symptomless in most commercial cultivars, but may cause symptoms in certain cultivars, scion/ rootstock combinations, and ornamental varieties, Symptoms of apple chlorotic leaf spot virus may include chlorotic leaf spots, leaf distortion, chlorotic rings and line patterns, reduced leaf size, and stunting [14].



Figure 8: Viral diseases

Canker

Disease symptoms

Lesions resulting in canker formation usually are associated with Canker Disease symptoms a wound in the bark, Leaf symptoms first occur early in the spring when the leaves are unfolding, They appear as small, purple specks on the upper surface of the leaves that enlarge into circular lesions 1/8 to 1/4 inch (3-6 mm) in diameter, The margin of the lesions remains purple, while the center turns tan to brown. In a few weeks, secondary enlargement of these leaf spots occurs, Heavily infected leaves become chlorotic and defoliation occurs, On the fruits, a series of concentric bands of uniform width form which alternate in color from black to brown. The flesh of the rotted fruits remains firm and leathery, Black pycnidia are often seen on the surface of the infected fruit [13].



Figure 7: Canker

Phytoplasmal disease

Disease symptoms

Poor shoot and spur growth, dieback of shoots, upper rolling of leaves, reduced leaf and fruit size, and premature leaf drop characterize pear decline, Sudden tree collapse can result from tissue damage at the graft union on highly susceptible rootstocks such as *Pyrus serotina* or *P. ussuriensis*, but slow decline of trees is more common, Trees on tolerant rootstocks may show mild to moderate symptoms that occasionally become severe if very high psylla populations occur in conjunction with other tree stress, Transmission: The phytoplasma organism that causes pear decline is carried by pear psylla, Psylla transmits the disease when it feeds on the pear foliage, The expression of disease depends on rootstock susceptibility, tree vigor, and psylla numbers, The organism apparently does not multiply in pear trees as well as it does in pear psylla [15].



Figure 9: Phytoplasma disease

Disease cycle:

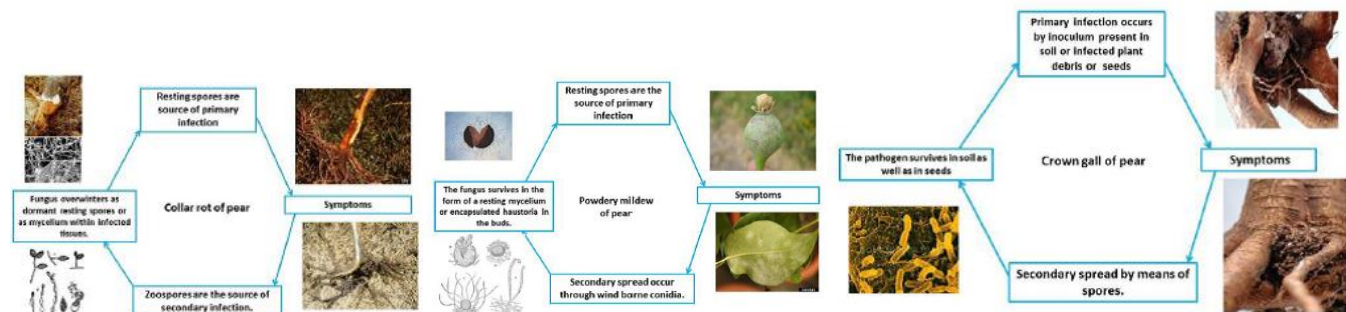


Figure 10: Disease cycle [16]

LIMITATIONS

The system contains a program project that diagnoses 11 diseases that affect pear and the eleven diseases are: Scab, Seedling blight, Crown gall, White root rot, Collar rot, Powdery mildew, Leaf spot, Canker, Viral diseases, Phytoplasma disease, Bitter rot.

SYSTEM EVALUATION

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

CONCLUSION

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

EXPERT SYSTEM SOURCE CODE

```
defrule disease1)
(The disease usually noticed on leaves and fruits)
(Affected leaves become twisted or puckered and have black, circular spots on their upper surface)
On the under surface of leaves, the spots are velvety and may coalesce to cover the whole leaf surface. Severely affected leaves )
(may turn yellow and drop)
(Scab can also infect flower stems and cause flowers to drop)
(The lesions later become sunken and brown and may have spores around their margins)
(Infected fruit become distorted and may crack, allowing entry of secondary organisms)
((not (disease identified))
```


<=

((assert (disease identified)
(printout fdatao "1" crlf)
(

defrule disease2)

(The most distinct symptoms and signs occur at the collar of the tree)

Small, round, light brown to yellow resting structures of the pathogen, known as sclerotia, can be found appressed to or in the)
(soil adjacent to infected trees

(If conditions are moist, a white web-like mycelial growth may also be present)

(Affected cortical tissues in the collar of the tree are often shredded)

(Survival and spread)

(The fungus survives in soil. Primary infection occurs by soil and secondary by conidia through rain or wind)

((not (disease identified)

<=

((assert (disease identified)
(printout fdatao "2" crlf)
(

defrule disease3)

Galls are usually restricted to the roots, lower stems and lower branches of infected plants. In some cases, however, crown gall)
(may occur in the upper branches. Galls are somewhat spherical, lumpy and rough, varying in size from 1/2 inch to several inches

Affected plants may be stunted, produce small chlorotic leaves and become more sensitive to environmental stresses (particularly)

((winter injury

(Severely infected plants may decline and eventually die)

(This organism enters susceptible plants through fresh wounds made during transplanting, cultivating, grafting and pruning)

((not (disease identified)

<=

((assert (disease identified)
(printout fdatao "3" crlf)
(

defrule disease4)

(Infection can occur on large roots or at the tree collar)

(In fruit trees, the base of the trunk at soil level can show signs of a dark, wet rot, especially if kept moist by weeds or wet weather)

As the disease progresses, the infected tissue becomes rotten. Trees develop a generally unthrifty appearance with leaf yellowing,)

(cessation of root growth, small leaves, premature leaf fall and small, shrivelled fruit. Infected trees will eventually die

((not (disease identified)

<=

((assert (disease identified)
(printout fdatao "4" crlf)
(

defrule disease5)

(Phytophthora collar rot attacks the lower portion especially tree trunks extending to the roots)

(Most infections start at the junction of a lateral root with the trunk)

(Infected bark becomes brown and is often soft and mushy or slimy when wet)

Dark streaks often occur near the cambium and extend beyond the canker margin. If a canker enlarges for several years, only the)

(marginal areas show the typical color and texture of newly killed tissue

The development of the canker is rapid, horizontally and vertically. The ultimate effect of collar rot is to girdle the affected limb,)

(roots, or trunk, resulting in the death of that organ or of the entire tree

((not (disease identified)

<=

((assert (disease identified)
(printout fdatao "5" crlf)
(

defrule disease6)

(Disease appears when the buds develop into new leaves and shoots)

(Small patches of white or grey powdery masses on under surface of leaves occur)

(Leaves grow longer and narrower than normal leaves and the margin is curled)

(Twigs are covered with powdery mass)

(Affected fruits remain small and deformed and tend to develop roughened surface)

((not (disease identified)

<=

((assert (disease identified)

(printout fdatao "6" crlf)

(

defrule disease7)

(Leaf spots appear on the leaves in late spring and early summer)

(As spots age, they often turn tan to ash grey. Some spots undergo secondary 50 enlargement, becoming irregularly shaped)

Heavily infected leaves often abscise, resulting in defoliation. Fruit infections result in small, dark, raised pimple-like lesions)

((associated with the lenticels

<=

((assert (disease identified)

(printout fdatao "7" crlf)

(

defrule disease8)

(Lesions resulting in canker formation usually are associated with a wound in the bark)

(Leaf symptoms first occur early in the spring when the leaves are unfolding)

They appear as small, purple specks on the upper surface of the leaves that enlarge into circular lesions 1/8 to 1/4 inch (3-6 mm))

(in diameter

The margin of the lesions remains purple, while the center turns tan to brown. In a few weeks, secondary enlargement of these)

(leaf spots occurs

(Heavily infected leaves become chlorotic and defoliation occurs)

(On the fruits, a series of concentric bands of uniform width form which alternate in color from black to brown)

((not (disease identified)

<=

((assert (disease identified)

(printout fdatao "8" crlf)

(

defrule disease9)

(Trees infected with apple mosaic virus develop pale to bright cream spots on spring leaves as they expand)

(These spots may become necrotic after exposure to summer sun and heat)

Other viral diseases are symptomless in most commercial cultivars, but may cause symptoms in certain cultivars, scion/)

rootstock combinations, and ornamental varieties. Symptoms of apple chlorotic leaf spot virus may include chlorotic leaf spots,

(leaf d

Pear stem grooving virus produces symptoms on 'Virginia Crab' such as chlorotic leaf spots, stem grooving and pitting, union)

(necrosis, and swelling of the stem above the graft union

Under specific climatic conditions, the disease appears in noncertified 'Bosc', to some extent in 'Anjou', and occasionally in)

('Comice' and 'Bartlett', causing a fruit pitting stone pit and deformity. Light or moderate fruit symptoms may be confused with

Transmission of ApMV to C. quinoa and C. sativus was obtained under greenhouse conditions. C. quinoa reacted with mottling,)

(whereas C. sativus showed chlorotic local lesions followed by systemic yellowing and stunting

((not (disease identified)

<=

((assert (disease identified)

(printout fdatao "9" crlf)

(

defrule disease10)

Poor shoot and spur growth, dieback of shoots, upper rolling of leaves, reduced leaf and fruit size, and premature leaf drop)

(characterize pear decline. Sudden tree collapse can result from tissue damage at the graft union on highly susceptible rootstocks

Trees on tolerant rootstocks may show mild to moderate symptoms that occasionally become severe if very high psylla)

(populations occur in conjunction with other tree stress. Transmission

The phytoplasma organism that causes pear decline is carried by pear psylla. Psylla transmits the disease when it feeds on the)

(pear foliage. The expression of disease depends on rootstock susceptibility, tree vigor, and psylla numbers. The organism appears

((not (disease identified)

```
<=  
((assert (disease identified)  
( printout fdatao "10" crlf)  
(  
defrule disease11)  
(The fungus attacks pears and enters the fruit through uninjured skin)  
Infected fruit are characterized by a firm rot which forms a circular light brown spot. With age the spots become almost black and )  
(have a saucer-shaped depression  
The organism overwinters in decayed fruit and in cracks on the old bark. A broken limb or twig will serve as an overwintering )  
(site  
(C and light rain favor development of the rot: Symptoms are first noticeable in mid to late July. A temperature of 30)  
(not (disease identified)  
<=  
((assert (disease identified)  
( printout fdatao "11" 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)  
((" 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)  
(close fdata)  
(
```

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