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A Rule Based System for the Diagnosis of Coffee Diseases

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***Abstract**: Coffee beans are grown in more than 60 countries. The coffee tree is different from the rest of the trees in terms of the climate it needs to grow. This affects the taste of the grain. In order to produce the fruit tree, it takes 3 to 5 years to start the production process. Arabic coffee is considered one of the best and best coffee types in the world, for several reasons, the most important of which is the volcanic mountainous soil rich in nutrients necessary for the better growth of this tree, giving it a taste more aromatic than the other. The coffee tree has many diseases that threaten its production. In this research, we proposed an expert system for diagnosis of coffee tree diseases and this system of experts was designed and implemented using CLIP. A group of farmers, people interested in coffee tree production and agricultural teachers tested the proposed system of experts and found it very useful.*

Keywords: Expert System, CLIPS, coffee, Diseases

1. INTRODUCTION

Coffee is the name given to several species of plant in the genus Coffee which are cultivated for their beans (seeds) that are used to make the stimulatory drink. Coffee plants are small evergreen trees or shrubs often with multiple stems and smooth leaves. The leaves are oval in shape and dark, glossy green. Coffee plants produce clusters of cream-white flowers and a fruit, commonly referred to as a berry, which normally possesses two seeds. The fruit is green to begin with but ripens to a crimson red and turns black when dry, can reach a height of 15 m, or reaching only 4–5 m. The trees can live for 20–30 years **[1]**.

Figure 3: Figure shows coffee tree

There are two types of coffee, Arabica and Robusta, Arabica is grown in higher altitudes than Robusta. The cool and equable temperature, ranging between 15 degree C to 25 degree C, is suitable for Arabica while for Robusta, hot and humid climate with temperature ranging from 20 degree C to 30 degree C is suitable.

Coffee seeds are generally planted in large beds in shaded nurseries. The seedlings will be watered frequently and shaded from bright sunlight until they are hearty enough to be permanently planted. Planting often takes place during the wet season, so that the soil remains moist while the roots become firmly established. Depending on the variety, it will take approximately 3 to 4 years for the newly planted coffee trees to bear fruit. The fruit, called the coffee cherry, turns a bright, deep red when it is ripe and ready to be harvested **[2]**.

Coffee beans are usually cured, roasted and ground before being brewed with hot water to produce the coffee beverage, the ground beans are often dehydrated to produce instant coffee.

It accounts for exports worth an estimated $15.4 billion in 2009/2010 when around 93.4 million bags of coffee were shipped. For many countries, coffee exports are not only vital for foreign exchange but also account for a significant proportion of tax income and gross domestic product is shown in Figure2 **[3]**.

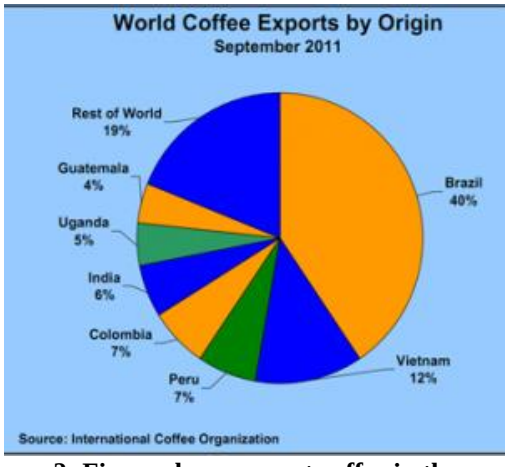

Figure 2: Figure shows export coffee in the world.

Benefits of coffee

- Coffee can help people feel less tired and increase energy levels because it contains a stimulant called

caffeine blocks an inhibitory neurotransmitter in your brain.
- Coffee contains several important nutrients, including riboflavin, pantothenic acid, manganese, potassium, magnesium and niacin.
- Several observational studies show that coffee drinkers have a much lower risk of type 2 diabetes.
- Coffee drinkers have a much lower risk of getting Alzheimer's disease.
- May lower risk of certain types of cancer such as liver and colorectal cancer.
- Coffee may cause mild increases in blood pressure, which usually diminish over time. Coffee drinkers do not have an increased risk of heart disease and have a slightly lower risk of stroke [4].

2. MATERIALS AND METHODS

Many of the agricultural practices of coffee beans, including attention to soil moisture, because the lack of moisture negatively affects the normal growth of coffee should be grown green manure crops during the period from May to June and their incorporation in the soil before flowering and suppression of weed growth coverage of drilling during the first year of cultivation (October and November) and the formation of a base of small plants with dry leaves to maintain moisture during the months of drought.

Integrated weed control measures, which include the sprinkler before rain and the removal of seasonal herbs in the middle of the rainy season and spraying after the monsoon rains will give satisfactory control to the weeds. The shadow umbrella must be maintained two-layer consisting of temporary dadaps and permanent shade trees so that they organize Shade every year instead of once in 3-4 years to minimize damage to coffee bushes, maintaining optimum pH is a prerequisite for nutrition management in coffee.

After the maturity of cherry beans over several months, after flower blooms for about a month. During maturity, the cherry moves from light green to pink, red, dark red, purple, and finally, black. This process takes about five to six months after the harvest. The coffee is processed either in the wet way to produce "coffee beans / coffee beans" or dry way to obtain "cherry coffee."

3. LITERATURE REVIEW

There are many expert systems that are developed for diagnosing human medical problems like [40-45, 47, 49-51, 53], plant and trees problem like: general plant [11], mango [12], Black pepper [13], banana [14, 46] onion [24], potato [38], Pineapple [48], watermelon [52] and other kinds of diseases. But there is no specialized expert system for diagnosing coffee diseases available free.
Although many plant diseases have common symptoms. The proposed expert system was developed specifically to help farmers diagnose coffee tree diseases.

Our proposed expert system is dedicated to the diagnosis of coffee tree diseases. Currently the expert system diagnoses 9 coffee tree problems. The proposed diagnostic expert system is offering an easy way, helping farmers to know how to diagnose and deal with diseases of coffee tree by giving them some advices about what to do.

4. REPRESENTATION OF KNOWLEDGE

He main sources of knowledge for this system are the farmers or the agricultural engineers and specialized web sites for fruits and vegetables of these diseases. The captured knowledge was converted to Knowledge Base syntax for CLIPS (facts, rules, and objects). The experts system currently has 9 bases covering 9 coffee tree diseases.

4.1 Coffee Leaf Rust

Disease symptoms

- Formation of pale yellow spots on the underside of the leaves.
- As the spots expand, they become powdery and yellow to orange in color and may reach 20 mm in diameter.
- Occasionally the whole leaf becomes covered with rust spots.
- Older rust spores become brown at the center surrounded by powdery orange spots.
- Leaf drop occurs, which if severe, can lead to dieback and berry loss and a loss of both yield and quality.
- Berries tend to be very small, not fully ripe and turn black.

Figure 3: the disease of Leaf Rust

Survives and Spread

Dry urediniospores can survive about 6 weeks, so there is always some viable inoculum to infect the newly formed leaves at the start of the next rainy season, the disease is spread by spore dispersal or Infection Urediniospores (Secondary cycles of infection occur continuously during favorable weather) or sporulation

Favorable conditions

Rain, wind, presence of free water and continuous free moisture conditions favors the development of disease.

4.2 Black Rot

Disease symptoms

- Usually occurs during monsoon months in endemic areas with high humidity and hanging mist.
- Blackening and subsequent rotting of young leaves, berries and shoots.
- Diseased leaves get detached from branches and hang out by means of slimy fungal strands

Figure 4: the disease of Black Rot

Survives and Spread

Under favorable conditions infection starts at the place where the leaves come in contact with branches that harbor the sclerotic, spread of the fungus is mostly by contact from leaf & bush to bush through vegetative mycelium, infected leaves get detached and carried by wind to other plants and cause further infection.

Favorable conditions

Wind and heavy rain lead to development of disease.

4.3 Brown-eye spot

Disease symptoms

- Leaves show circular necrotic spots with dark brown margin & light brown or pale center.
- Necrotic spots increase in size, central portion turns light grey due to sporulation by the fungus and collapses leaving a hole at the center.
- Infected leaves turn yellow causing pre-mature defoliation.

Figure 5: the disease Brown-eye spot

Survives and Spread

Avoid over-watering, maintain 50% shade cover, space plant bags to allow air movement and proper fertilizer application these factors are working to survive the life of the plant, the disease is spread by fungi that are spores and are spread by wind and rain.

Favorable conditions

Soil too wet, too much shade or too much sun, lack of air movement, Lack of nitrogen and potassium lead to development of disease.

4.4 Brown root

Disease symptoms

- Infected plants show gradual yellowing of leaves and defoliation followed by death of the entire plant.
- Stem near the ground level becomes spongy and soft. Root system shows development of thick brown encrustation adhered with small stones.
- The brown fungal encrustation gives the name brown root disease.
- Interior of the roots show dark brown to black wavy lines.

Figure 6: the disease Brown root

Survives and Spread

Decreasing root contact reduces spread of the fungus, disease spreads by means of root contact.

Favorable conditions

Differences in local conditions, such as soil type, plant density and diversity, and the balance of microorganisms in the soil.

Berry blotch 4.5

Disease symptoms

- Dark brown, irregular, slightly sunken, necrotic spots appear on exposed surface of the green berries.
- Necrotic spots enlarge in size & cover a major portion of berry surface.
- Skin of the infected berries show a purple halo around the necrotic spots.
- Infected tissues turn brown to black, shrivel, become dry and stick fast to the parchment.

Figure 7: the disease Berry blotch

Survives and Spread

Infections caused by Cercospora infection that penetrate to the seed may cause the pulp to adhere to the parchment during processing, causing damage to the product, diseased cherries may be subject to attack and further degradation by opportunistic bacteria or fungi.

Favorable conditions

Exposure of the developing berries to sun in the absence of adequate overhead shades and hot humid conditions are the main predisposing factors for disease development.

4.6 Flowering parasite

Disease symptoms

- Dense strand of leafless yellow vines twining the
- Produce white flowers & form seeds during dry weather from Nov-Jan.

Figure 8: the disease Flowering parasite

Survives and Spread

Complete removal of the parasite from the infected coffee plants and burning assures good control, Primary infection comes from seeds and secondary spread occurs through neighboring infected plants.

Favorable conditions

The weather is dry or neighboring plants are infected

4.7 Berry borer

Disease symptoms

- Beetle on a bean (top), damage to berries (center).
- Fruit dropping from plants.
- Small holes evident on red cherries.
- Forms a brown or grey deposit on top of the hole.


Figure 9: the disease Berry borer

Survives and Spread

The spread of the disease does beetle insect, removal of dropped berries and debris on plantation floor can help reduce sources of new infections, remove any berries remaining on plants after harvest, insecticide application is only effective if applied when the female beetle is still in the entry tunnel and has not yet penetrated deep into the berry

Favorable conditions

The most affected areas in the crops are the shady and moist ones because the insect is very sensitive to desiccation, and waits for the rains to leave the fruit.

4.8 Mealybug

Disease symptoms

- White waxy colonies are usually found on the underside of tender leaves and in soft stem areas around berries.
- They are found on young roots near the main root, especially where soil is loose around the trunk.

Figure 10: the disease Mealybug

Survives and Spread

Use of insecticide sprays, especially highly toxic organophosphate spray, these kill almost all insects and survive the life of the plant.

Favorable conditions

Dry season when water is lacking.

4.9 Dieback

Disease symptoms

- Severe leaf loss and branch dieback.
- Root dieback.
- Cherries ripen prematurely and become hard and black.
- Floral buds on the infected branches fail to open

Figure 11: the disease Dieback

Survives and Spread

If there are too many cherries and not enough leaves, all the food goes from the leaf to the developing cherry, leaves then drop off, if plants are not well cared for with adequate watering and nutrients, the plants will succumb and die.

Favorable conditions

Insufficient nutrition, insufficient shade, insufficient irrigation

5. Limitations

The current system of experts specializes in diagnosing only the following 9 diseases: Coffee Leaf Rust, Black Rot, Brown-eye spot, Brown root, Berry blotch, Flowering parasite, Berry borer, Mealybug, Dieback

6. Conclusion

In this paper, a proposed expert system was introduced to help farmers and students diagnose on disease. Farmers and students can get a faster and more accurate diagnosis

7. Future Work

This system of experts is a basis for the future. It is planned to add more coffee diseases and make it easier for users from anywhere and at any time.

8. EXPERT SYSTEM IMAGES

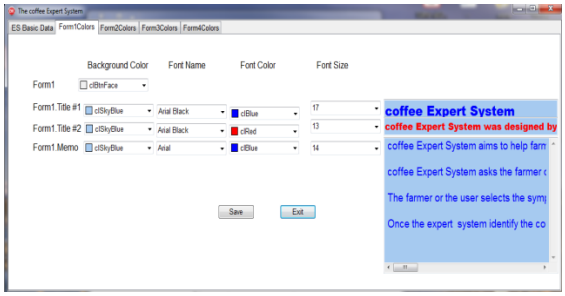

Figure 12: Main interface adjustment screen

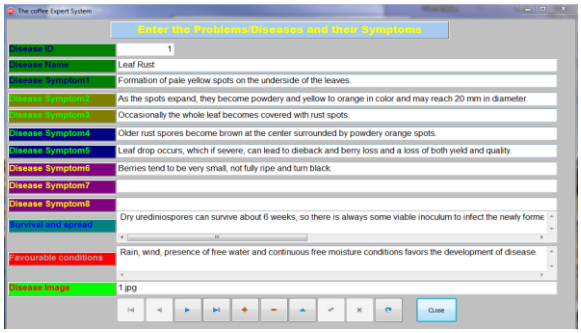

Figure 13: Screen Add Disease Interface

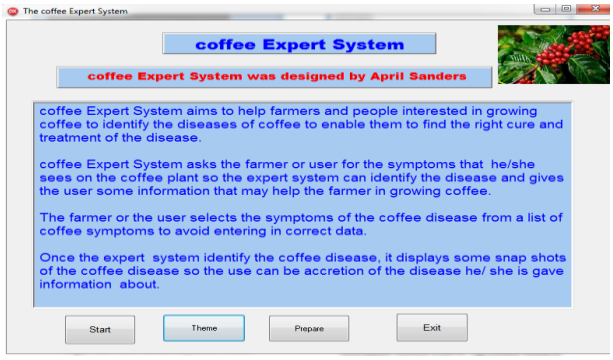

Figure 14: The main screen format of the expert system

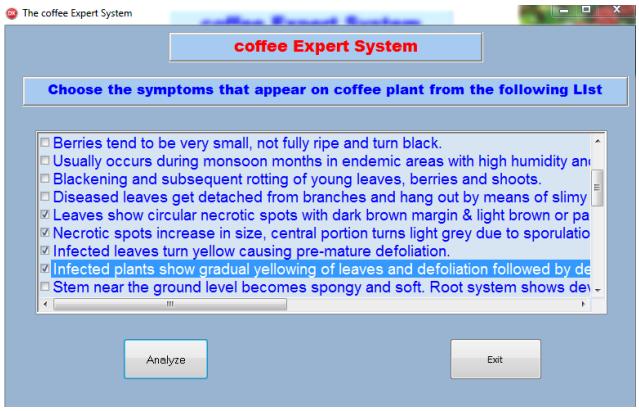

Figure 15: Screen selection symptoms

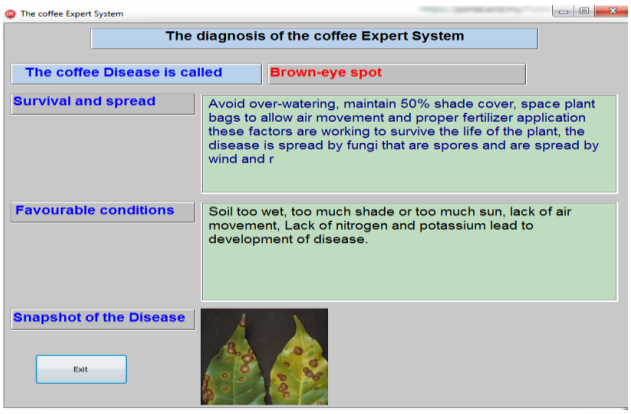

Figure 16: Displays the diagnostic interface and recommendations.

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