

# Rule Based System for Diagnosing and Treating Potatoes Problems

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**Abstract: Background:** Plant production provides human and animal life with different requirements. The concern of workers in agriculture in general and those interested in plant diseases, in particular, has been focused on protection from all that is expected to have problems of production. As environmental conditions play a critical role in the treatment of diseases, the plant is prepared and rendered more susceptible to production, which is exposed and may result in the loss of the entire crop. **Objectives:** The main goal of this expert system is to get the appropriate diagnosis of potato disease and the correct treatment. **Methods:** In this paper the design of the proposed Expert System which was produced to help farmers, people interested in agriculture and agricultural engineers in diagnosing many of the potatoes diseases such as : Bacterial wilt, Septoria leaf spot, Late blight, arly blight, Common scab, Black scurf/ canker, Viral disease (potato virus X, S, & Y), Potato Spindle Tuber Viroid (PSTVd), Black leg and soft rot, Pink rot and Black heart- disorder. The proposed expert system presents an overview about potatoes diseases are given, the cause of diseases are outlined and the treatment of disease whenever possible is given out. CLIPS with Delphi was used for designing and implementing the proposed expert system. **Results:** The proposed potatoes diseases diagnosis expert system was evaluated by Farmers, Agricultural experts and teachers of Agriculture and they were satisfied with its performance. **Conclusions:** The Proposed expert system is very useful for Farmers, and those interested in agriculture with potatoes disease and recent graduate students.

**Keywords:** agriculture, expert system, potatoes

## 1. INTRODUCTION

Potatoes are the third most important food crop in the world after rice and wheat and the leading vegetable crop in the United States.

A high intake of fruits and vegetables can benefit health and reduce the risk of many lifestyle-related health conditions. Potatoes contain important nutrients, even when cooked that can benefit human health in various ways.

The potato contribute to a healthful lifestyle, including preventing osteoporosis, maintaining heart health, and reducing the risk of infection

Although potatoes can be very easy to grow in different places, there are many diseases, pests and other issues which can affect potato growth. Identifying these problems is the first step to solving them, and catching the problem early can make the disease treatment. so we have developed this expert system to help Agricultural engineer and farmers in diagnosing many of the potatoes diseases, in order to prescribe the appropriate treatment.

Expert System is a computer program designed to simulate the intelligence of an expert in a particular field. It is mainly developed using artificial intelligence concepts, tools and technologies. An expert system is typically designed to provide capabilities similar to those of a human expert when performing a task. Moreover, it can be used to drive vehicles, provide financial forecasts or do things that human experts do [20-59].

An expert system usually has two core components [20-59]:

- Knowledge base -- This component consists of data, facts and rules for a certain topic, industry or skill, usually equivalent to that of a human expert.
- Inference engine -- This component uses the facts and rules in the knowledge base to find and learn new knowledge or patterns.

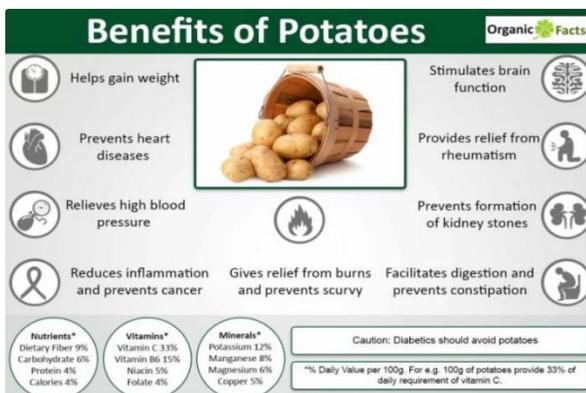


Figure 1: The figure shows benefits of potatoes [1]

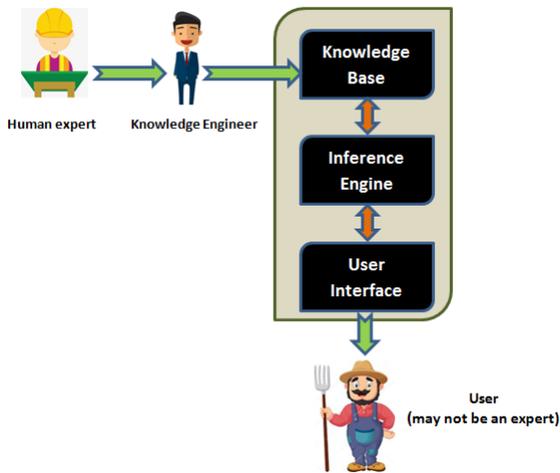


Figure 2: The figure presents the Main Components of an Expert System, Designed by the authors.

The proposed Expert System for potatoes Diseases Diagnosis was implemented using, CLIPS language with Delphi. 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. CLIPS executes any Expert System looks like frames. 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 performs diagnosis for eleven potatoes diseases. The proposed expert system will ask the user to choose the correct Symptoms of potato disease in each screen. At the end of the dialogue session, the proposed expert system provides the diagnosis and recommendation of the disease to the user.

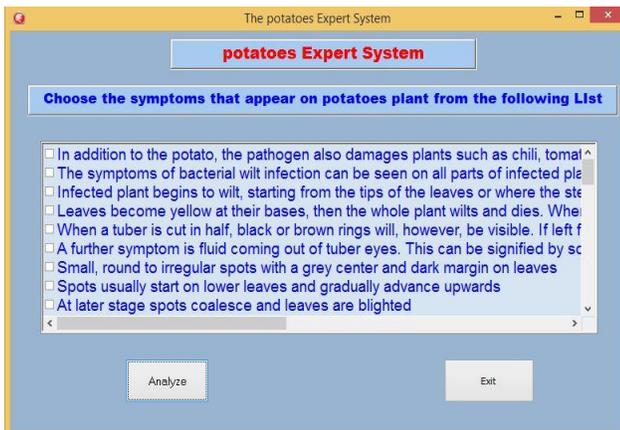


Figure 3 shows a sample dialogue between the expert system and the user.

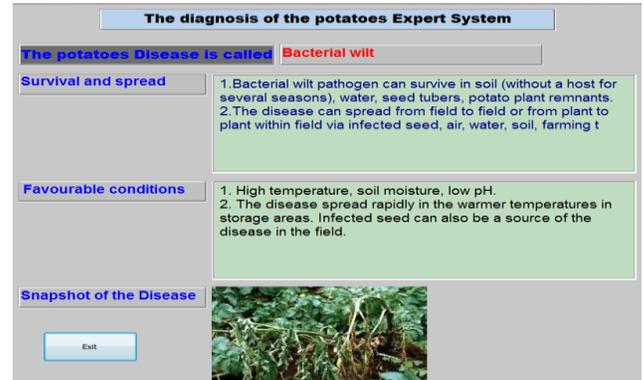


Figure 4 shows how the users get the diagnosis and recommendation

## 3. LITERATURE REVIEW.

There is a lot of Expert System that were designed to diagnose Plant Diseases. But there is no specialized expert system for diagnosis of potatoes diseases available free and use a language CLIPS linked with Delphi. This expert system is easily used by farmers and People concerned. This is due to the coordinated application interface.

Some of these Expert Systems are specialized in one specific disease and others in three diseases. But the current proposed expert system is specialized in the diagnosis of eleven potatoes diseases.

## 4. KNOWLEDGE REPRESENTATION

The main sources of the knowledge for this expert system are Agricultural expert and specializes websites for potatoes diseases. The captured knowledge has been converted into CLIPS syntax. Currently the expert system has 43 rules which cover eleven **Potatoes diseases [1-20]:**

1) **Bacterial wilt:** is caused by a bacterium called *Ralstonia solanacearum*. The disease is mainly spread in two ways: When infected seed is planted in healthy soil or when clean seed is planted on soil that is already infected. The major source of seed for many Kenyan farmers is usually seed that was planted the previous season. If the potatoes are infected, they spread the disease [3].

Other farmers buy potato seed from their neighbors; if the seeds are infected, the disease is introduced into their farms. The disease can also spread if infected crop residue is transferred into an area with healthy soil. If contaminated water from surface run-off flows into an uninfected farm, it can spread the disease. The water used for irrigation can also introduce the disease to a farm, if it is contaminated with the disease causing bacteria. Farm tools such as *jembes* or forks can transmit the disease when contaminated soil attaches itself to the tools. Soil pests such as nematodes and insects can also spread the disease from one area to another [3].



Figure 5: The figure shows the Symptoms of the disease Bacterial wilt



Figure 6: The figure shows the Symptoms of the disease Septoria leaf spot

- 2) **Septoria leaf spot potato:** Septoria leaf spot, also called Septoria blight, is a very common disease in potatoes. It is caused by a fungus (*Septoria lycopersici*) and can affect potatoes and other plants in the Solanaceae family, especially potatoes and eggplant, just about anywhere in the world. Although Septoria leaf spot is not necessarily fatal for your potatoes plants, it spreads rapidly and can quickly defoliate and weaken the plants, rendering them unable to bear fruit to maturity.



Figure 7: The figure shows the Symptoms of the disease Late blight

- 3) **Late blight:** also called **potato blight**, disease of potato and tomato plants that is caused by the water mold *Phytophthora infestans*. The disease occurs in humid regions with temperatures ranging

between 4 and 29 °C (40 and 80 °F). Hot dry weather checks its spread. Potato or tomato plants that are infected may rot within two weeks. The Great Famine in Ireland in the mid-19th century was caused by late blight of the potato plant. Late blight destroyed more than half of the tomato crop in the eastern United States in 1946, leading to the establishment of a blight-forecasting service in 1947. A number of such forecasting services are maintained at universities and governmental organizations across the world.

- 4) **Early blight (target spot)** :of tomato and potato is caused by the fungus *Alternaria solani*. This common disease may also occur on other solanaceous plants, such as pepper and eggplant, as well as certain Brassica spp. Although this disease usually affects older, senescing plants, it can cause complete defoliation when environmental conditions are optimal for disease development.



Figure 8: The figure shows the Symptoms of the disease Early blight (target spot)

- 5) **Common scab:** Common scab of potatoes is a soil-borne disease which is caused by the bacteria-like organism *Streptomyces scabies*. This organism attacks the stems, stolons and roots of the potato, and more importantly, young, rapidly growing tubers, stimulating the growth of unsightly corky tissue. A severe infection can reduce the marketable yield and can damage the eyes of seed potatoes. It can also greatly reduce the market value of the crop.

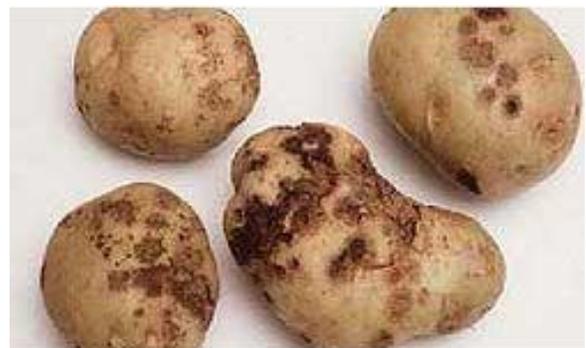


Figure 9: The figure shows the Symptoms of the Common scab

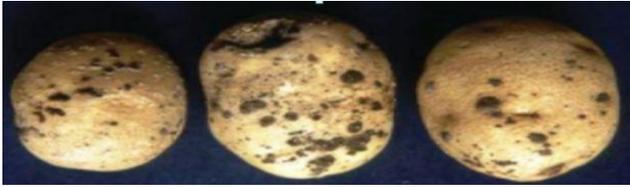


Figure 10: The figure shows the Symptoms of the Black scurf/ canker

6) **Black scurf/ canker:** *Rhizoctonia solani* is a fungal disease causing stem canker, damping off, black scurf, skin netting and tuber growth distortions. Black scurf can be soil and seed borne and survives a long time in soil and on volunteers or crop debris. There is no significant proliferation during storage.

7) **Viral disease (potato virus X, S, & Y):**

**Disease symptoms:**

- Potato virus Y (PVY) is a Potyvirus, causes stipple streak. The necrotic strain generally causes mild foliage symptoms, but necrosis in the leaves of susceptible potato varieties.
- Potato virus S (PVS) is a Carlavirus, if plant infected early in the season, show a slight deepening of the veins, rough leaves, more open growth, mild mottling, bronzing, or tiny necrotic spots on the leaves. PVS is transmitted by aphids non-persistently.
- Potato virus X (PVX) is the type member of the Potyvirus family of plant viruses. Plants often do not exhibit symptoms, but the virus can cause symptoms of chlorosis, mosaic, decreased leaf size, and necrotic lesions in tubers.
- PVX can interact with PVY and PVS to cause more severe symptoms and yield loss than either virus alone. The source of this virus is infected tubers.

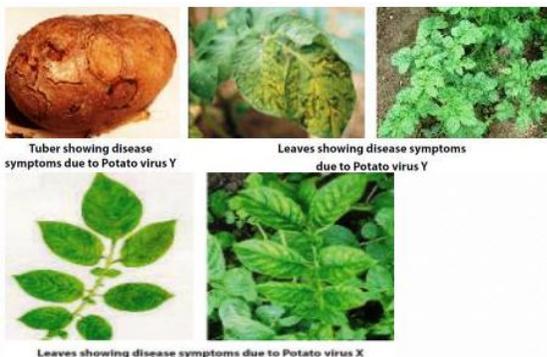


Figure 11: The figure shows the Symptoms of Viral disease (potato virus X, S, & Y)(4)

8) **Potato Spindle Tuber Viroid (PSTVd) :** Potato Spindle Tuber Viroid (PSTVd) is an EU listed

quarantine pathogen of potatoes which causes stunting of the plant and malformation and cracking of tubers. The main host is potatoes but the disease also affects tomatoes and solanaceous ornamentals. The disease is mechanically transmitted by contact between healthy and diseased plants, tractor wheels, tools, etc. Within potato plants, it is found most readily in the upper leaves and tubers.



Figure 12: The figure shows the Symptoms of Potato Spindle Tuber Viroid (PSTVd)

9) **Black leg and soft rot**

**Disease symptoms:**

- Black leg is a rot of the lower stem region. This is encouraged by cool, damp conditions.
- Soft rot occurs when the bacteria gains access to the tuber through wounds & other entry points.
- Symptom can range from cultivator damage to fungal lesions.
- The bacteria dissolve the cell walls and liquefy the tuber inwards. No distinct smell is present in true soft rot.

Survival and spread: The introduction of bacteria is always through a wound in the plant tissue. It can reside in plant residue for short periods. The pathogen may spread through the soil water and infected seed.



Figure 13: The figure shows the Symptoms of Black leg and soft rot

Favourable conditions: Disease is encouraged by cool, humid conditions.

10) **Pink rot:** (*Phytophthora erythroseptica*) can be devastating especially in hot dry years however wet soil is required for infection.



Figure 14: The figure shows the Symptoms of Pink rot

**11) Black heart- disorder:** Blackheart is an internal defect caused by low oxygen and high carbon dioxide levels in the tuber and occurs where the respiration demand for oxygen exceeds the available supply. This might be due to low oxygen levels in the environment, such as field flooding, or high tuber respiration rates, usually in response to temperature extremes. Crops are most vulnerable around harvest time where respiration rates are likely to be higher.

Blackheart is often first visible at the centre of the tuber where a dark grey to black tissue discoloration indicates necrosis. Affected tissue is firm to the touch and may smell of sweet alcohol if warm. Cavities can form within the darkened area, which is usually isolated from the surface. However, blackheart symptoms can reach the surface appearing as dark sunken patches and disease infections are likely where the surface is broken.



Figure 15: The figure shows the Symptoms of Black heart-disorder

## 5. LIMITATIONS

The current proposed expert system is specialized in the diagnosis only the following eleven potatoes diseases : Bacterial wilt, Septoria leaf spot, Late blight, Early blight, Common scab, Black scurf/ canker, Viral disease (potato virus X, S, & Y), Potato Spindle Tuber Viroid (PSTVd), Black leg and soft rot, Pink rot and Black heart- disorder.

## 6. SYSTEM EVALUATION

As a preliminary evolution, many agricultural engineers, Agricultural teachers and other Agriculture students 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 for helping Farmers as well as those interested in agriculture in Potato disease with eleven different possible potatoes

diseases. Farmers as well as those interested in agricultural diseases 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 a user friendly interface. It was developed using CLIPS with Delphi language.

## 8. FUTURE WORK

This expert system is considered to be a base of future ones; more plants 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
(potato-symptom 1 yes)
(potato-symptom 2 yes)
(potato-symptom 3 yes)
(potato-symptom 4 yes)
(potato-symptom 5 yes)
(potato-symptom 6 yes)
(not (potato disease identified))
=>
(assert (potato disease identified))
(printout fdatao "1" crlf)
)
(defrule disease2
(potato-symptom 7 yes)
(potato-symptom 8 yes)
(potato-symptom 9 yes)
(potato-symptom 10 yes)
(potato-symptom 11 yes)
(potato-symptom 12 yes)
(not (potato disease identified))
=>
(assert (potato disease identified))
(printout fdatao "2" crlf)
)
(defrule disease3
(potato-symptom 13 yes)
(potato-symptom 14 yes)
(potato-symptom 15 yes)
(potato-symptom 16 yes)
(potato-symptom 17 yes)
(not (potato disease identified))
=>
(assert (potato disease identified))
(printout fdatao "3" crlf)
)
(defrule disease4
(potato-symptom 18 yes)
(potato-symptom 19 yes)
(potato-symptom 20 yes)
(potato-symptom 21 yes)
(potato-symptom 22 yes)
(not (potato disease identified))
```

```

=>
(assert (potato disease identified))
(printout fdatao "4" crlf )
)
(potato-symptom 23 yes)
(potato-symptom 24 yes)
(potato-symptom 25 yes)
(potato-symptom 26 yes)
(potato-symptom 27 yes)
(not (potato disease identified))
=>
(assert (potato disease identified))
(printout fdatao "5" crlf )
)
(defrule disease6
(potato-symptom 28 yes)
(potato-symptom 29 yes)
(potato-symptom 30 yes)
(not (potato disease identified))
=>
(assert (potato disease identified))
(printout fdatao "6" crlf )
)
(defrule disease7
(potato-symptom 31 yes)
(potato-symptom 32 yes)
(potato-symptom 33 yes)
(potato -symptom 34 yes)
(not (potato disease identified))
=>
(assert (potato disease identified))
(printout fdatao "7" crlf )
)
(defrule disease8
(potato-symptom 35 yes)
(potato-symptom 36 yes)
(potato-symptom 37 yes)
(potato-symptom 38 yes)
(not (potato disease identified))
=>
(assert (potato disease identified))
(printout fdatao "8" crlf )
)
(defrule disease9
(potato-symptom 39 yes)
(potato-symptom 40 yes)
(potato-symptom 41 yes)
(potato-symptom 42 yes)
(not (potato disease identified))
=>
(assert (potato disease identified))
(printout fdatao "9" crlf )
)
(defrule disease10
(potato-symptom 43 yes)
(potato-symptom 44 yes)
(potato-symptom 45 yes)
(potato-symptom 46 yes)
(not (potato disease identified))
=>
(assert (potato disease identified))
(printout fdatao "10" crlf )
)
(defrule disease11
(potato-symptom 47 yes)
(potato-symptom 48 yes)
(potato-symptom 49 yes)
(potato-symptom 50 yes)
(not (potato disease identified))
=>
(assert (potato disease identified))
(printout fdatao "11" crlf )
)
(defrule endline
(potato disease identified)
=>
(close fdatao)
)
(defrule readdata
(declare (salience 1000))
(initial-fact)
?fx <- (initial-fact)
=>
(retract ?fx)
(open "data.txt" fdata "r")
(open "result.txt" fdatao "w")
(bind ?symptom1 (read fdata))
(bind ?symptom2 (read fdata))
(bind ?symptom3 (read fdata))
(bind ?symptom4 (read fdata))
(bind ?symptom5 (read fdata))
(bind ?symptom6 (read fdata))
(bind ?symptom7 (read fdata))
(bind ?symptom8 (read fdata))
(assert
(potato-symptom ?symptom1 yes)
(potato-symptom ?symptom2 yes)
(potato-symptom ?symptom3 yes)
(potato-symptom ?symptom4 yes)
(potato-symptom ?symptom5 yes)
(potato-symptom ?symptom6 yes)
(potato-symptom ?symptom7 yes)
)
(close fdata)
)

```

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