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Application of Artificial Intelligence In The Detection Of Plant Diseases (Clubroot)

Moch. Iswan Perangin-angin[1)], Mhd. Gilang Suryanata[2)], Deski Helsa Pane[3)], Khairi Ibnutama[4)], Rian Farta Wijaya[5)]

[1]Management Informatica, STMIK Triguna Dharma, Jl. A. H NasutionNo. 73 Medan Johor, Kota Medan
[2,3,4]Information Systems, STMIK Triguna Dharma, Jl. A. H NasutionNo. 73 Medan Johor, Kota Medan
[5]Computer Science, Universitas Pembangunan Pancabudi, Jl. Gatot Subroto No.Km.4, RW.5, Simpang Tj., Kec. Medan Sunggal –Kota Medan

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ABSTRACT

Indonesia is a tropical country with diverse flora and fauna stretching from west to east. One of the cabbage plants grown in Indonesia has many benefits for human health. Cabbage plants are susceptible to diseases such as pests and pathogens. One of them is clubroot disease, which causes the plant not to grow and develop. Based on the above problems, it is necessary to have a system to support farmers in the scientific field of expert systems that uses the Certainty Factor method to diagnose the nature of clubroot disease. It is hoped that this system can provide information more quickly on whether or not cabbage plants have clubroot disease. The results of this study represent an integrated system capable of solving problems in cabbage plants, especially in the diagnosis of clubroot disease. It is hoped that the applied system can be further developed together with technological developments.

Corresponding Author:

Moch. Iswan Perangin-angin
Information Management, STMIK Triguna Dharma
Jln. A. H NasutionNo. 73 Medan Johor, Medan, Indonesia
Email: mochammadiswan@gmail.com

1. Introduction

Cabbage is a vegetable plant belonging to the Brasccae Oleracae var. capitat L family, often called cabbage or cabbage. Cabbage vegetables contain valuable ingredients such as vitamin A, vitamin B, vitamin C and vitamin E, as well as many minerals, namely potassium, calcium and phosphorus, and contain anti-cancer compounds [1]. However, efforts to grow cabbage plants are often attacked by various pests and pathogens that cause plant and crop diseases. One of these is clubroot disease, which occurs in cabbage plants [2]. Clubroot disease or clubroot is a disease caused by the soil-borne pathogen Plasmodiophora brassicae Wor. This pathogen causes swelling of the root tissue, which can impair root function such as the transfer of nutrients and water from the soil to the leaves [3].

To overcome this, one needs an expert or a cabbage plant disease expert. Meanwhile, not all cabbage disease experts can help in overcoming these problems every time. a system that can help an expert or professional to find out the disease that has occurred more easily. One of these is the use of expert system knowledge. A universal expert system is a scientific field that can be used in diagnosing a disease and is implemented on a computer. According to the understanding expressed by Ignizo, the expert system is a procedure related to a specific container whose level of knowledge can be compared with that of an expert [4]. In another study, an expert system was used to diagnose onion plant diseases, with the result that the

expert system was able to search for symptoms, diseases and solutions by looking for answers to questions posed by the system [5].

In the expert system, there is a method, namely Certainty Factor (CF), which is used in this study. The Certainty Factor method is used to deal with uncertainty in the creation of MYCIN. The certainty factor (CF) is a clinical parameter value given by MYCIN to indicate the level of confidence. The certainty factor method is used to track the input of damage symptoms and then determine the density value (confidence) for each damage according to the symptoms. After the identity value is determined, the combination of rules can be determined. In MYCIN, there are rules for combining symptoms in a certainty factor rule defined as equation [6].

2. Research Methodology

In the concept of writing, the system design method is one of the most important elements in research. In the system design method, especially in software, various methods can be applied, including the waterfall algorithm or the waterfall algorithm used in this study [7].

In the structure of the expert system, there are two main components, namely the development environment and the consulting environment. The development environment is used for the process of developing an expert system both in terms of producing the components and the knowledge base. consult an expert (expert) [8][12].

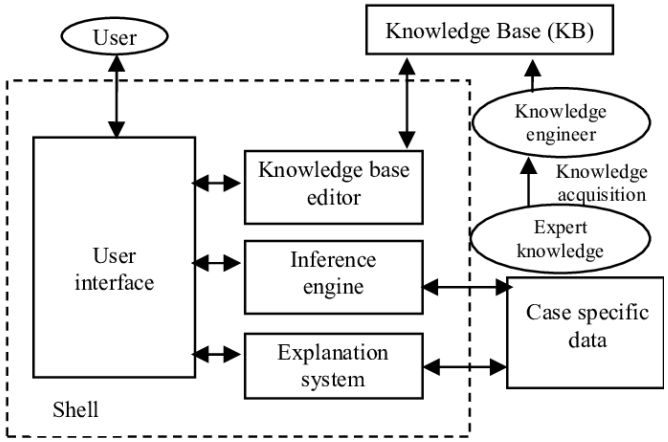

Figure 1. Components in an expert system

Expert systems have the ability to recommend a set of actions or user behaviour to run a correct and accurate correction system. In doing so, this system also uses reasoning skills to draw conclusions based on available data and facts. [11]

An expert system aims to produce a conclusion or description from a set of raw data (raw data). Decision-making is based on observations, starting with image analysis, word recognition through speech, signal interpretation and the ability to project the consequences of certain situations and conditions [13].

3. Result and Discussion

3.1. System Algorithm

In solving problems encountered in diagnosing clubroot disease in cabbage, knowledge representation is the method used for encoding expert system knowledge. The following is a system algorithm for completing an expert system for diagnosing clubroot disease in cabbage plants, including [14]:

1. The determination of disease and symptom data.
2. Inputting disease and symptom data
3. Determining the rule of disease and symptom data.
4. Calculating the values of MB and MD
5. Performing Certainty Factor calculations.

Flowchart is a flowchart that contains an algorithm for diagnosing a disease with symptoms or steps present using the Certainty Factor method and the detailed process sequence. The design of a flowchart consists of three parts, namely input, process and output [1]. The basic purpose of flowcharts is to describe a phase of problem solving in a simple and sequential manner using predetermined symbols or standards. Here is a picture of the flowchart [15]:

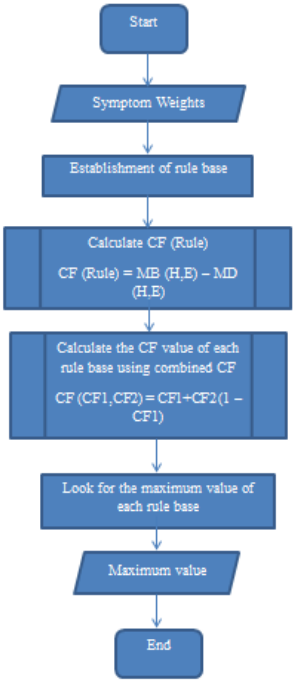

Figure 2. Flowchart of Certainty Factor Method

The first step in the method of certainty factors is:

1. Assign a value to each symptom in the knowledge base
2. Calculate the certainty factor value of each user response given
3. Calculate the certainty factor value of the results of each user response multiplied by the symptom value using the certainty factor combination.

The results of the user responses from the expert system process are then processed to calculate the certainty value using the certainty factor method. The certainty factor is a method for proving the untrustworthiness of an expert. Certainty is determined by giving a weight to each symptom selected by the user. The certainty factor method thus provides a confidence value [13].

3.2. Symptoms and Disease Data

The success of an expert system results from the knowledge of experts with assumed experts, and how to manage the knowledge gained from the results of the survey and then create it as a disease table to help diagnose clubroot disease in cabbage plants can be seen in the table below:

Table 1. Symptoms Of Clubroot Penyakit Disease

No	Symptom Code	Symptom Name	Disease Rate
1	X005	Leaves dry	Clubroot Plasmodiophora brassicae Wor. (High)
2	X006	Yellow leaves	
3	X008	Plants become stunted	
4	X009	Black nodules on the roots	
5	X010	Roots swell elongated resembling stems	
6	X003	Pale green leaves	Secondary Zoospore Clubroot Disease (Currently)
7	X004	The underside of the plant turns yellow	
8	X006	Yellow leaves	
9	X007	Leaves cannot form a crop optimally	
10	X009	Black nodules on the roots	
11	X001	Withered during the day	Plasmodium Clubroot Disease

12	X002	Come back fresh at night	(Low)
13	X003	Pale green leaves	
14	X004	The underside of the plant turns yellow	

The process of collecting from experts, it was found that for the high category of cabbage plant diseases had symptom characteristics given the initials X005, X006, X008, X009 and X010. For the medium category, the symptoms are X003, X004, X006, X007 and X009, while the low category is X001, X002, X003 and X004.

3.3. Measure of Belief (MB) and Measure of Disbelief (MD) Weight Value

Each symptom of the disease has a weight value or value that contains certainty and uncertainty as follows:

Table 2. Value Measure of Belief and Measure of Disbelief

No	Disease Code	Disease Rate	Symptom Code	MB	MD
1	P1	Clubroot Plasmodiophora brassicae Wor. (High)	X005	0.7	0.2
			X006	0.7	0
			X008	0.7	0
			X009	0.8	0
			X010	0.9	0
2	P2	Secondary Zoospore Clubroot Disease (Currently)	X003	0.6	0.1
			X004	0.7	0.1
			X006	0.7	0
			X007	0.7	0
			X009	0.9	0
3	P3	Plasmodium Clubroot Disease (Low)	X001	0.7	0.1
			X002	0.5	0
			X003	0.6	0.1
			X004	0.7	0.1

Based on the grouping of symptoms and the determination of the cabbage disease category, the value of Measure of Belief and Measure of Disbelief was obtained from each category (High, Medium, and Low). This data was obtained from various journals and previous research. The value of cabbage disease in the high category has a Measure of Belief value of 0.7, 0.7, 0.7, 0.8, 0.9 in the high category, 0.6, 0.7, 0.7, 0.7, 0.9 in the medium category, and 0.7, 0.5, 0.6, 0.7 in the low category.

3.3.1. Rules

Rules are usually written in the if-then form (If....Then....). The following rules can be taken from the above disease table:

Rules 1 : IF Dry leaves AND
Yellow leaves AND
Plants become stunted AND
Black nodules on the roots AND
Roots swell up like stems THEN
Disease Clubroot Plasmodiophora brassicae Wor (High).

Rules 2 : IF Pale green leaves AND
The underside of the plant turns yellow AND
Yellow leaves AND
Leaves cannot form an optimal stand AND
Black nodules on the roots THEN
Secondary (moderate) zoospore clubroot disease (at present).

Ruls 3 : Withered during the day AND
Come back fresh at night AND
Pale green leaves AND
The lower part of the plant turns yellow THEN
Plasmodium clubroot disease (low).

3.3.2. Manual Calculation of Certainty Factor Method

The following is an example of a case study of the manual calculation of the certainty factor method:

Table .3 User Choice Symptom Data

No	Symptom Code	Symptom Name	Choose
1	X001	Withered during the day	✓
2	X002	Come back fresh at night	
3	X003	Pale green leaves	✓
4	X004	The underside of the plant turns yellow	✓
5	X005	Leaves dry	
6	X006	Yellow leaves	
7	X007	Leaves cannot form a crop optimally	✓
8	X008	Plants become stunted	✓
9	X009	Black nodules on the roots	✓
10	X010	Roots swell elongated resembling stems	✓

Based on the case study above, the following is a manual calculation of the certainty factor method by determining the CF value of each symptom using the formula:

CF(h,e) = MB(h,e) – MD (h,e)

1. Clubroot Plasmodiophora brassicae Wor (High)
   Symptoms experienced in Clubroot Plasmodiophora brassicae Wor disease (High) are: X008, X009, X010
   X008 = Plants become stunted
   = 0.7 – 0
   = 0.7
   X009 = Black nodules on the roots
   = 0.8 – 0
   = 0.8
   X010 = Roots swell elongated resembling stems
   = 0.9 – 0
   = 0,9

2. Clubroot Zoospora Sekunder (Currently)
   Symptoms experienced in secondary (moderate) clubroot zoospore disease are: X003, X004, X007
   X003 = Pale Green Leaves
   = 0.6 – 0.1
   = 0.6
   X004 = The underside of the plant turns yellow
   = 0.7 – 0.1
   = 0.6
   X007 = Leaves cannot form an optimal stand
   = 0.7 – 0
   = 0.7

3. Clubroot Plasmodium (Low)
   Symptoms experienced in Clubroot Plasmodium (Low) Low are:: X001, X003, X004.
   X001 = Withered during the day
   = 0.7 – 0.1
   = 0.6
   X003 = Pale Green Leaves
   = 0.6 – 0.1
   = 0.5
   X004 = The underside of the plant turns yellow
   = 0.7 – 0,1
   = 0.7

The next step is to combine the values from CF to measure the degree of certainty in diagnosing the symptoms of Clubroot disease. Below is the formula for combining the CF values:

CF Combine (CF,CF2) = CF1 +CF2*(1-CF1)

1. Plasmodiophora brassicae Wor (High)

$CF_{Combine}\, CF[H,E]_{1,2}$ $= CF[H,E]_1 + CF[H,E]_2 * (1- CF[H,E]_1)$
$= 0.7 + 0.8 * (1-0.7)$
$= 0.7 + 0.24$
$= 0.94$ old1

$CF_{Combine}\, CF[H,E]_{old1,3}$ $= CF[H,E]_{old1} + CF[H,E]_3 * (1- CF[H,E]_{old1})$
$= 0.94 + 0.9 * (1-0.94)$
$= 0.94 + 0.054$
$= 0.994$

CF * 100% $= 0.994 * 100\%$
$= 99.4\%$

2. Clubroot Zoospora Sekunder (Currently). lubroot Currently

$CF_{Combine}\, CF[H,E]_{1,2}$ $= CF[H,E]_1 + CF[H,E]_2 * (1- CF[H,E]_1)$
$= 0.6 + 0.7 * (1-0.6)$
$= 0.6 + 0.28$
$= 0,88$ old1

$CF_{Combine}\, CF[H,E]_{old1,3}$ $= CF[H,E]_{old1} + CF[H,E]_3 * (1- CF[H,E]_{old1})$
$= 0.88 + 0.7 * (1-0.88)$
$= 0.88 + 0.084$
$= 0.964$

CF * 100% $= 0,964 * 100\%$
$= 96,4\ \%$

3. Clubroot Plasmodium (Low)

$CF_{Combine}\, CF[H,E]_{1,2}$ $= CF[H,E]_1 + CF[H,E]_2 * (1- CF[H,E]_1)$
$= 0,7 + 0.6 * (1-0.6)$
$= 0.7 - 0,24$
$= 0,94$ old1

$CF_{Combine}\, CF[H,E]_{old1,3}$ $= CF[H,E]_{old1} + CF[H,E]_3 * (1- CF[H,E]_{old1})$
$= 0.94 + 0.7 * (1-0.94)$
$= 0.94 + 0,042$
$= 0,982$

CF * 100% $= 0,982 * 100\%$
$= 0,98,2\ \%$

The results of the calculations and diagnoses are explained on the basis of experts who have an assessment of the certainty factor in this case, the cabbage plant has clubroot Plasmodiophora brassicae wor disease (High) with a CF value of 99.4%, which means that the degree of confidence in the disease is 99% affected. clubroot disease.

3.4. Application and Implementation

Implementation is the phase in which the created system is executed or operated. This phase explains how you can operate the created system.

1. User Main Page

The following is a display of the main user page, namely:

Figure 3. User Main Page.

The user's main menu display is the start display or the user's first display in the cabbage disease diagnosis expert system. On the user's main menu display, there is also a menu with options for the disease diagnosis pages, expert profiles and admin logins.

2. Diagnosis Page
   The following is a display of the user diagnosis page, namely:

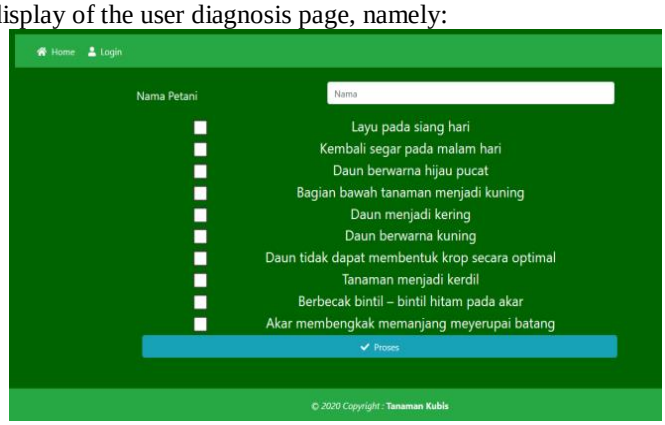

Figure 4. User Diagnosis Page.

The menu display on the diagnosis page where the user diagnoses cabbage plant diseases by selecting which symptoms occur in cabbage plants. The user confidence menu display shows the questions for each symptom that occurs in cabbage plants. In this view, the user has to fill in each question and select one of the beliefs. There are 10 choices, namely: probably, very probably, almost certainly and definitely.

3. Diagnostic Results Page
   The following is a display of the user diagnostic results page, namely:

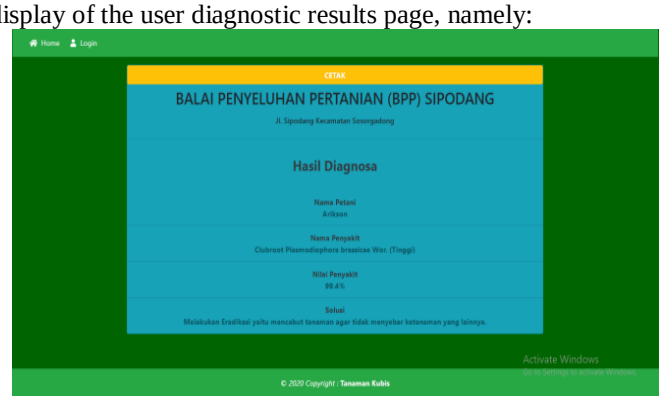

Figure 5. Diagnostic Results Page.

The Diagnostic Information menu display is the display of the diagnostic results created by the user. In this display, the cabbage plant disease expert system shows the results of the diagnosis based on the individual symptoms and the level of confidence in the questions answered. The results are displayed in the form of the percentage of possible diseases on the cabbage plants.

4. Conclusion

The following conclusions can be drawn from the results of the investigation of clubroot disease using the Certainty Factor method: An expert system for plant diseases using the Certainty method has been successfully built and displays the symptoms, the results of calculations also using the Certainty factor, the results of the diagnosis and the solution of the disease. The system created is able to provide information about diseases in cabbage plants in a simple way, using the symptoms selected in the system according to the conditions to which the cabbage plants are exposed.

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