Application of the Bayes Theorem to the Expert System for Diagnosing Big Red Chili Plants

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Abstract. Big red chili is one of the plants that are easily affected by disease than curly and type of chili pepper, and easily contagious if unknown symptoms initially. The limited knowledge of the farmers or society that cultivate big red chili and lack of power extension officers make slow the process of diagnosis and can be fatal as death, so this is serious because it can be losses for the farmers or society that cultivate large red chili plants. To resolve the above problem researchers will conduct research based on the problem. Bayes theorem is one of the methods used to calculate the uncertainty of data into data that is sure to compare data between Yes and no. In this case, the value used to calculate the probability of outcomes identified in large red chili plant diseases. On the results of the experimental data of the symptoms of the disease generates value accuracy of 100%.

Keywords: Large Red Chilli, Expert System, Bayes Theorem

1 Introduction

In this era of globalization, computers are one of the most important parts of human life, and have even become a necessity that is difficult for people to leave behind. Technological developments are increasingly rapidly making a lot of technology that can change the way human thinking is fixed in artificial intelligence. Artificial intelligence referred to in this discussion is an expert system. An expert system is a computer system that resembles the knowledge or experience of one or many experts who are transformed into certain knowledge to help the community in solving a specific problem in this case regarding the problem of diseases that occur in large red chili plants.

The agronomic characteristics of large red chili are flat or smooth, rather fat, thick fruit skin, early maturity, less resistant and not too spicy. Big red chili is a horticultural commodity that is classified as an annual crop, this plant is estimated to have around 20 species and most of these plants grow in their original place, namely America [1]. Big red chili is a plant that is susceptible to disease attacks, compared to curly or other chili. Big red chili is one of the plants

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that has many types of diseases and is easily transmitted to other plants if the initial symptoms are not known.

In the Lampung region and the responsiveness of the intensity of red pepper plants is 27% -30% [2]. According to the central body of the Lampung statistics (2014) chili production during 2011-2013 tended to decline. One of the causes of decreased production is chili plant disease [3]. According to the horticulture research body In addition to the low agronomic factors, chili production is also caused by the presence of pests and diseases [4]. Some of the disease-causing fungi in chili plants are Gloesporium piperatum and Colletotrichum capsici which cause anthracnose or fruit rot, Cercospora capsici causes leaf spots and Cucumber Mosaic Virus (CMV) disease [5].

Farmers or communities that cultivate large red chili plants to date diagnose diseases still use manual methods, namely by observing the symptoms experienced by large red chili plants directly so that this takes a short time because there are many types of large chilli plants. . limited knowledge of farmers or communities that cultivate large red chilies And the lack of extension workers makes the diagnosis process late and can have fatal consequences such as death, so this becomes serious because it can be a disadvantage for farmers or communities who cultivate large red chili plants.

To solve the above problems researchers will conduct research based on existing problems. The purpose of this study is to design an expert system for diagnosing large red chili plants using the Bayes Theorem method, taking into account the symptoms experienced by large red chili plants. The diseases to be discussed consist of 10 types, namely: late blight (phytophthora), leaf spot (Cercospora), anthracnose rot, powdery mildew (powdery mildew), bacterial wilt (Pseudomonas), sprout drop, complex virus, Gemini yellow virus, Swollen root nematodes.

Bayes theorem is one method used to calculate the uncertainty of data into definite data by comparing data between yes and no [6]. In this case it is used to calculate the probability value of the results identified by the disease of large red chili plants. Based on the explanation above, the problems raised as the theme of the final assignment are entitled "Application of the Bayes Theorem to the Expert System for Diagnosing Large Red Chili Plants".

2 Literature Review

2.1 Artificial Intelligence

Artificial intelligence comes from English "Artificial Intelligence" or short AI, namely intelligence is an adjective that means intelligent, while artificial means artificial. Artificial learning in question refers Cto a machine that is capable of thinking, weighing actions to be taken and being able to make decisions as done by humans[7].

2.1 Expert System

An expert system is a branch of artificial intelligence and a field of science that has emerged along with the development of computer science today. This system is a computer system that can mimic the ability of an expert, this system works to adopt computer knowledge that combines basic computer knowledge (knowladge base) with an inference system to draw conclusions from a set of rules (rules)[8].

2.3 Teorema Bayes

Bayes theorem is one method used to calculate the uncertainty of data into definite data by comparing data between yes and no. Bayes probability is one way to overcome data uncertainty by using the stated Bayes Formula :

Where :

$$P(H \mid E) = \frac{P(E \mid H), P(H)}{P(H)}$$

P (H | E) = probability of hypothesis H based on condition E (posterior probability)
P (E | H) = probability E is based on the condition of the hypothesis H (likelihood)
P (H) = probability of hypothesis H
(prior probability)
P (E) = probability of E (evidence) [6]

2.4 Large Red Chili

The agronomic characteristics of large red chili are flat or smooth, rather fat, thick fruit skin, early maturity, less resistant and not too spicy. Big red chili is a horticultural commodity that is classified as an annual crop, this plant is estimated to have around 20 species and most of these plants grow in their original place, namely America [1] .

2.5 Plant Disease

Some of the disease-causing fungi in chili plants are Gloeosporium piperatum and Colletotrichum capsici which cause anthracnose or rotten fruit, Cercospora capsici which causes leaf spots and cucumber mosaic virus (CMV) [5].

2.6 Codeigniter (CI)

CodeIgniter (CI) is a website development framework using PHP, a framework for working or creating programs using systematic PHP. CI provides a set of libraries needed in developing a website [9].

3 Research Methods

3.1 Data Collection

Data collection techniques by conducting research and direct review of the problems taken. in this case the interviewee was Yusuf Hidayat, SP, MPhil, PhD as a lecturer at the UNPAD faculty of agriculture from the Department of Plant Pest, Dr. Sri Hartati, SP., M.SI as a lecturer at the Faculty of Agriculture UNPAD from the Department of Plant Disease, Ir Tonny Koestoni Moekasan as the principal researcher of the Vegetable Crop Research Institute (BALITSA) Lembang.

3.2 System Development

Making this system is to use a prototype methodology. Stages in the prototyping method are according to the stages below :

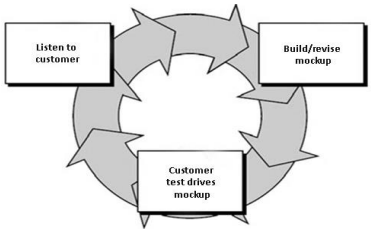

Fig. 1. Metode *Prototype* [10]

Stages in the prototyping method are according to the stages below:

1. *Listen to customer*
   In this step carried out by interviewing several speakers to get the data needed to develop a software to diagnose the disease of large red chili plants. After the data is collected, system design and design are carried out as the initial image for the user visually.
2. *Build mockup/revise mockup*
   in the next step make database design, coding and display design applied in expert system applications that aim to diagnose the disease of large red chili plants by applying the Bayes theorem method. The next step will be an evaluation of the application that will be made to avoid the risk of failure in the application.
3. *Customertest drives mockup*
   In this step, evaluating and testing the expert system application to diagnose the disease by applying the Bayes theorem method, testing the application is done by resource persons and developers to ensure the effectiveness of the application built [10].

4 Result & Discussion

4.1 Flowchart

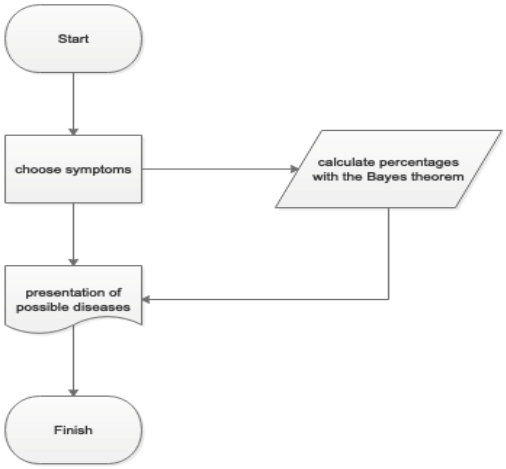

Fig. 2. Flowchart

Generally the application to diagnose the disease by applying the Bayes theorem is explained by the flow cart besides.Figure 2 explains the system to find out the percentage of large red pepper disease, where first the user selects the symptoms experienced after that the system calculates the percentage of the probability of a large red chili plant disease using the Bayes Theorem method based on the selected symptoms. Then after that the user can find out the percentage of possible diseases of a large red chili plant.

4.2 Usecase Diagram

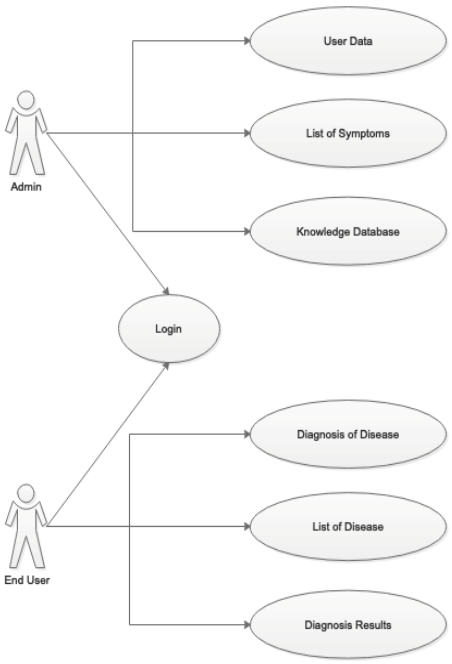

Fig. 3. Usecase Diagram

Figure 3. explain the relationship between the user and the system in the expert system application for diagnosing large red chili plants. Users can diagnose the disease and see a list of diseases that the system has provided. Admin can manage user data, manage disease data, manage symptom data and manage list of symptoms. Relationship between admin and user in expert system application for diagnosing large red chili plants, admin and user can login.

4.3 ACTIVITY DIAGRAM

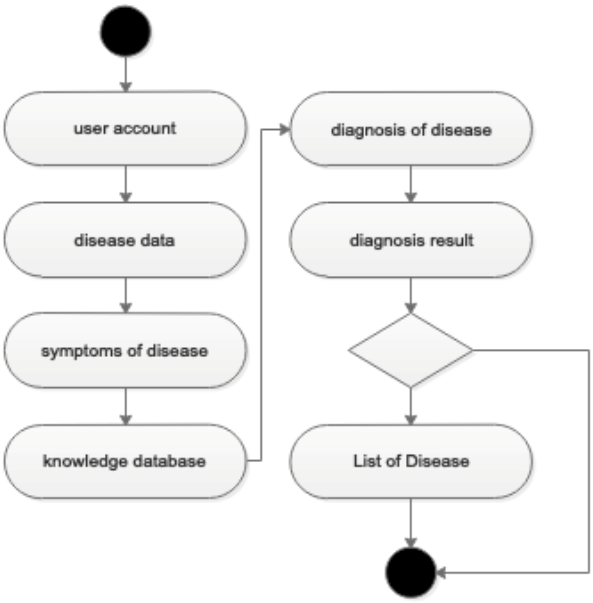

Fig. 4. Activity Diagram

In the picture depicting the activities that occur the admin can add user data, add disease data, add disease symptom data, add knowledge base data. the user diagnoses, then receives the diagnosis if it is correct the system will display the diagnosis.

D Squence Diagram

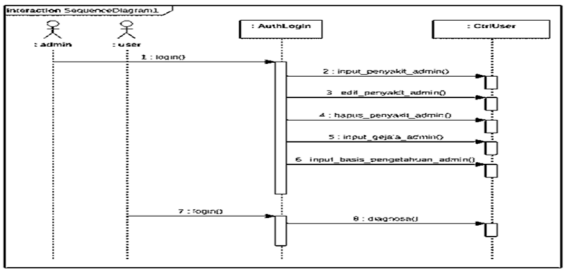

Fig. 5. Activity Diagram

In the description above, the admin and user first log in, then the admin can enter the disease, edit the disease, delete the disease, input symptoms and input the knowledge base. then the user must log in first to diagnose the disease.

A SEQUENCE DIAGRAM ANALYSIS OF BIG RED CHILI DISEASE

Table 1. Disease analysis

Code	Disease
P001	rot leaves *(phytophthora)*
P002	leaf spot *(Cercospora)*
P003	antraknosa fruit rot
P004	powdery mildew *(powdery mildew)*
P005	wilting bacteria (*Pseudomonas*)
P006	fusarium wilt (*Fusarium oxysporum*)
P007	sprout fall down
P008	Complex virus
P009	Gemini yellow virus
P010	Swollen root nematodes

B BIG RED CHILDREN SYMPTOMS ANALYSIS

Table 2. Analysis of symptoms

Kode	The symptoms
G001	The wet spot is spotted on the edge or center of the leaf
G002	The patches are surrounded by white sporangium
G003	leaves look rotten / lonyot like scalded
G004	young stems look rotten like scalded
G005	the whole leaf withers
G006	rot stems become dry and harden
G007	small patches of dark gray
G008	pale to white patches with older edges
G009	The leaves turn yellow and eventually fall
G010	Leaf spot measuring 0.25 cm
G011	Tears often occur at the center of the leaf
G012	blackish brown spots on the surface of the fruit, then the spots become soft
G013	Dried leaves, twigs and branches are dark brown
G014	In the fungus acervuli stems seen in the form of a lump
G015	Shoot off
G016	on the underside of the old leaves there is a layer of white flour
G017	The starched leaves turn yellow to form patches
G018	the leaves turn pale and fall out quickly
G019	plants that suddenly wither
G020	The wilting plant starts from the shoot spread to the bottom of the plant until all the leaves wither and eventually the plant dies
G021	the plants wither, starting from the lower leaves
G022	yellowing leaf bone children
G023	stem and root tissue is brown

Kode	The symptoms
G024	There are yellow spots on the buds
G025	The stems of plants are yellow
G026	a brown wound at the base of the stem, so that the stem is broken and eventually die
G027	the brown color at the base of the roots and rot
G028	Young leaves have mosaic features that have several features
G029	Parts of chlorosis leaves can be light green to yellow, even close to white
G030	Often the leaf surface becomes uneven or appears to have dark green curves
G031	Smaller leaf size
G032	Dappled leaf color green and light green
G033	shoots in the form of yellow spots around the leaf bone
G034	Yellow veins
G035	Concave and contract with light or yellow mosaic
G036	Concave leaves and contracted
G037	Leaf curl up
G038	There are yellow spots on the buds
G039	on the roots of the lumps formed irregularly formed
G040	In the case there are lumps like pimples

D BAYES THEOREM CALCULATION

The following is a weighting table of the probability of disease and symptoms obtained from 3 experts related to the disease of large red chili plants. The value of the probability of the disease and symptoms will be a reference in the calculation of the Bayes Theorem method.

Table 3. Data Analysis of P (H) disease

Disease Weight	
Disease Code	Weight P (H)
P001	0.5
P002	0.4
P003	0.8
P004	0.4
P005	0.3
P006	0.3
P007	0.3
P008	0.3
P009	0.7
P010	0.2

Table 4. Data Analysis of P (E | H) symptoms

Symptom Weight		
Symptom Code	Weight P (E | H)	Disease Code
G001	0.6	P001
G002	0.7	P001
G003	0.7	P001
G004	0.9	P001
G005	0.6	P001
G006	0.7	P001
G007	0.8	P002
G008	0.7	P002
G009	0.7	P002
G010	0.6	P002
G011	0.6	P002
G012	0.7	P003
G013	0.7	P003
G014	0.6	P003
G015	0.9	P003
G016	0.8	P004
G017	0.8	P004
G018	0.7	P004
G019	0.6	P005
G020	0.6	P006
G021	0.7	P006
G022	0.6	P006
G023	0.9	P006
G024	0.7	P006
G025	0.8	P006
G026	0.6	P007
G027	0.8	P007
G028	0.7	P008
G029	0.7	P008
G030	0.7	P008
G031	0.6	P008
G032	0.6	P008
G033	0.6	P009
G034	0.6	P009
G035	0.7	P009
G036	0.9	P009
G037	0.9	P009
G038	0.8	P009
G039	0.7	P010
G040	0.6	P010

In the table above shows a data on disease analysis P (H) and symptoms P (E | H), in the disease analysis table P (H) and the symptoms P (E | H) have a probability value where the value probability is obtained from experts. The usefulness of the probability value is to find out ho w severe / often large red chili plants are affected by the disease. As well as with the probability value we can calculate the percentage value of the probability of the disease.

Calculation step:

If chili plants experience 1 symptom then the calculation uses a formula, namely:, for example chili plants experience G001, G002, G009 the value of these symptoms can be seen in tables 3.3 and 3.4, namely 0.6, 0.7 and 0.7. diseases that have these symptoms are only in C3 and C4. The following statement of symptoms and disease along with the code, namely: (G001) Wet-wet spots on the edge or middle of the leaf, (G002) Leaves look decaying / loyot like scalded, (G009) Leaves turn yellow and eventually fall off and (P001) rot leaf, (P002) leaf spot.

From the statement of symptoms and diseases above, we first do a manual calculation in table 3.5, namely by entering the disease code, the symptom code, the weight value of P (H), the Symptoms of P (E | H) as below, namely:

Table 5. Manual calculation

X	Code the symptoms	Disease code	P (H) disease	P (E | H) symptoms
Enter the symptom code 1	G001	P001	0.5	0.6
Enter the symptom code 2	G003	P001	0.5	0.7
Enter symptom code 3	G009	P002	0.4	0.7

Next after doing manual calculation, first we calculate the probability value by comparing the disease code P001 in the calculation table with the disease code P001 in the table of disease weights. Then if the disease code P001 is the same then to look for probabilities of P001 look at Symptom-1 by multiplying the weight value of P (H) with the Symptom P (E | H) as below: "P (H). P (E | H) "/" P (H). P (E | H) "= (0.5. 0.6) / (0.5. 0.6) = 0.3 / 0.3 = 1, then if the disease code P001 and G002 in the calculation table is manul and the table is in the weight of the disease is not the same then given a value of 0, and the disease code P003 and G009 in the calculation table manul and the table in the weight of the disease is not the same then given a value 0. So on like that until you know the probability value P002 looks at symptoms 2 and the probability of P003 looking at symptom 3.

Table 6. Probability Calculation

X	Probability P001	Probability P002	Probability P003
The symptoms 1	1	0	0
The symptoms 3	1	0	0
The symptoms 9	0	1	0
Total	2	1	0
Probability	0.666666667	0.333333333	0
percentage	67%	33%	0%

Furthermore, after we know the results of the probability of P001 looking at the symptom-1 is 1, the probability of P002 looking at the symptom 2 is 0 and the probability of P003 looking at the Symptom-1 is 0, then we calculate the total by adding the probability value P001 is 2 and many diseases encountered are 3 so 2 divided by 3 is 0.666666667, the probability of P002 is 1 divided by 3 is 0.333333333, P002, the probability of P003 is 0.

Lastly, we calculate the percentage of disease, namely by the results of the overall probability multiplied by 100 which is 0.666666667 multiplied by 100 is 67%, 0.333333333 multiplied by 100 is 33% and 0 multiplied by 3 is 0.

E Interface Implementation

a. Login Page Interface

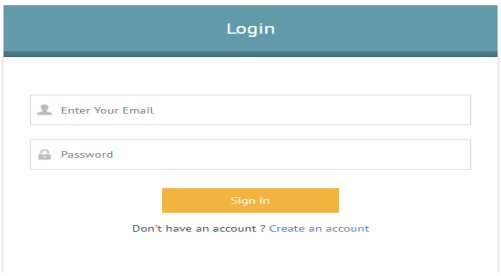

Fig 6. Login Page Interface

Figure illustrates the implementation of the login page login interface where the admin and user can fill in an email and password to enter the admin page on the expert system application to diagnose the disease of large red chili plants.

b. Implementation of Interface Pages Managing Configuring Data

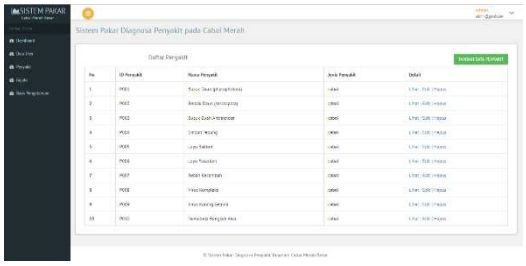

Fig. 7. Interface Pages Managing Disease Data

Figure 7 describes the interface page for managing disease data in the expert system for diagnosing large red pepper plants, this page can only be accessed by the admin.

c. Implementation of Interface Pages Manage Data Symptoms

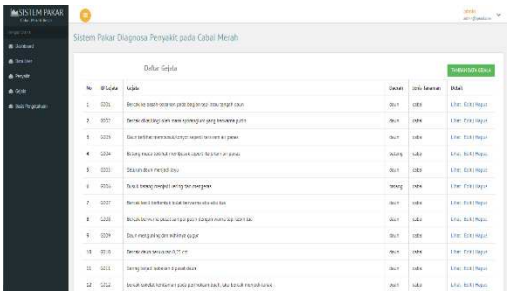

Fig. 8. Implementation of Interface Pages Manage Data Symptoms

Figure 8 describes the interface page managing symptom data in the expert system of diagnosing large red pepper plants, this page can only be accessed by the admin.

d. Implementation of Knowledge Base Interfaces

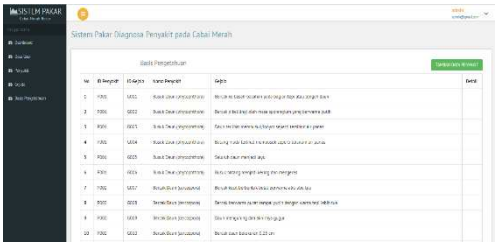

Fig. 9. Knowledge Base Interface

explain the knowledge base page interface in the expert system for diagnosing large red chili plants, this page can only be accessed by the admin.

e. Implementation of Disease Diagnosis Page Interface

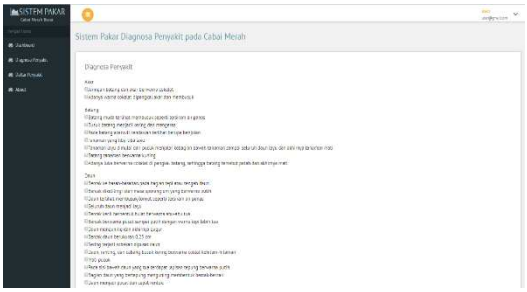

Fig. 10. Disease Diagnosis Page

explain the interface of the disease diagnosis page in the expert system for diagnosing large red pepper plants, this page can only be accessed by the user.

f. Testing

System accuracy testing is done to test how well the diagnosis of the possibility of a large red chili disease is made in the application. The following are the results of the accuracy testing of the expert system for diagnosing large red chili plants:

Table 7. Accuracy Testing

No	**Symptom Code**	**Expert Application of large red chili plants**	**Expert Ir Tonny Koestoni Moekasan**	**Expert Yusuf Hidayat, SP, Mphil**	**Expert Dr. Sri Hartati, SP., M.SI**
1.	G001,G003,G009	rot leaves 66,67%	rot leaves 66,67%	rot leaves 66,67%	rot leaves 66,67%
2.	G012,G013,G014	antraknosa fruit rot 100%	antraknosa fruit rot 100%	antraknosa fruit rot 100%	antraknosa fruit rot 100%
3.	G007,G008,G009, G010	rot leaves 100%	rot leaves 100%	rot leaves 100%	rot leaves 100%
4.	G016,G017,G018	Dew Flour 100%	Dew Flour 100%	Dew Flour 100%	Dew Flour 100%
5.	G019,G020,G021, G022	Fusarium wilt 75%	Fusarium wilt 75%	Fusarium wilt 75%	Fusarium wilt 75%
6.	G026, G025,G040,	Sprout Sprout 33,33%	Sprout Sprout 33,33%	Sprout Sprout 33,33%	Sprout Sprout 33,33%
7.	G033,G034,G040, G012	Gemini Yellow Virus 50%	Gemini Yellow Virus 50%	Gemini Yellow Virus 50%	Gemini Yellow Virus 50%
8.	G007,G010,G005, G013	Leaf spot 50%	Leaf spot 50%	Leaf spot 50%	Leaf spot 50%
9.	G010,G018,G039	Dew Flour 33,335	Dew Flour 33,335	Dew Flour 33,335	Dew Flour 33,335
10.	G027	Sprout sprouts 100%	Sprout sprouts 100%	Sprout sprouts 100%	Sprout sprouts 100%
11	G039,G040	Swollen root nematodes 100%	Swollen root nematodes 100%	Swollen root nematodes 100%	Swollen root nematodes 100%
12.	G013,G015,G020	Anthracnose Fruit Rot 66,67%	Anthracnose Fruit Rot 66,67%	Anthracnose Fruit Rot 66,67%	Anthracnose Fruit Rot 66,67%
13.	G024,G028,G029, G033	Complex Virus 50%	Complex Virus 50%	Complex Virus 50%	Complex Virus 50%
14.	G002,G022,G026, G030	Sprout Sprout 25%	Sprout Sprout 25%	Sprout Sprout 25%	Sprout Sprout 25%
15.	G010,G037	Leaf spot 50%	Leaf spot 25%	Leaf spot 25%	Leaf spot 25%
16.	G028,G029,G030	Complex Virus 100%	Complex Virus 100%	Complex Virus 100%	Complex Virus 100%
17.	G032,G033,G035	Gemini Yellow Virus 66,67%	Gemini Yellow Virus 66,67%	Gemini Yellow Virus 66,67%	Gemini Yellow Virus 66,67%

To find out the results in the case of experimental accuracy of the expert system for diagnosing large red chili plants, it is calculated as follows:

$$\text{Accuracy Value} = \frac{\text{Appropriate amount}}{\text{Number of cases}} \text{x } 100\%$$

$$\text{Accuracy Value of Large Red Chili Plant Disease Diagnosis Results} = \frac{100}{100} \text{x } 100\% = 100\%$$

Based on tests conducted on 100 test data the results of the accuracy of the expert system for diagnosing the disease of large red chili plants is 100%.

5 Conclusion

The expert system for diagnosing large red chili plants is a system that provides information on possible diseases in large red chili plants in expert systems by inputting symptoms experienced by the user. The system can provide a percentage of the probability of illness through calculations in the expert system of large red chili plants after inputting the symptoms experienced by the user. Therefore, this study entitled the application of the Bayes theorem to an expert system for diagnosing large red-based red chili plant diseases. The Bayes theorem is a method used to know the calculation of the probability value of the identification of a large red chili disease.

Based on the results of experimental data on the symptoms of large red chili disease, the accuracy value was 100%. This expert system is declared valid, and can function properly with expert diagnostic processes on Bayes theorem manual calculations.

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