Fuzzy Rules in Knowledge Based Diagnosis of Anthracnose Disease in Grape Crop

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Abstract:

This paper presents the knowledge based diagnosis of Anthracnose disease found in grape crop using fuzzy rules. Fuzzy logic is a form of many-valued logic. To produce quality grape, grape growers have to protect their crop from the attack of different diseases. Anthracnose is major diseases observed in vineyard. This study assists or guides the grape growers, experts, counselors in agricultural field to find symptoms appeared on the leaves due to change in weather conditions, also use of fungicides to control the attack of Anthracnose disease using fuzzyrules.

Keywords: Fuzzy rules, Knowledge Based Diagnosis, Anthracnose disease and Fungicides.

1. Introduction:

Prolog (PROgramming in LOGic) is AI language. It is simple, powerful, declarative symbolic language based on predicate logic. Prolog is particularly suitable when a problem is expressed in form of logic (for e.g. if x and y then z), or a problem is goal-oriented (for e.g. to satisfy x, satisfy y and z). Fuzzy logic rules provide a basis for both capturing imprecise knowledge and performing approximate reasoning.(See Turunen 1999; Jang & Sun 1997) [1].

In grape farming, grape growers face difficulties in diagnosis the attack of Anthracnose disease. Diagnosis may be done by observing symptoms appeared on the leaves of grape crop and change in weather conditions [4].

Downy mildew, Powdery Mildew and Anthracnose are three major diseases observed in vineyard. They caused by fungal pathogens. The occurrence of all diseases is dependent on weather conditions. Some factors like high or low Temperature, relative humidity, wetness of leaves etc influence disease development [5].

During monsoon, attack of anthracnose is found on leaves.The powdery mildew disease appears during cloudy conditions. Another disease like Bacterial leaf spot or stem canker and rust also occurs in vine yards [5].

This study deals with the diagnosis of Anthracnose disease by observing symptoms appeared on the leaves of grape crop and change in weather conditions. The main aim of the study is to offer the decision support system to identify and control the attack of Anthracnose disease. However, the decision support should be knowledge-oriented to improve effectiveness of the decision made. Knowledge-oriented decision making helps in identifying most plausible diagnosis. This type of knowledge based system will be an efficient means to store and to pass experts knowledge in documental form for long time and it can

provide advice to grape growers at every stage of crop. The research paper includes Knowledge-oriented approach, structure of the system and an illustrative case.

2. Knowledge-Oriented Approach:

A **knowledge base** is a database for knowledge management. It provides the means for the computerized collection, organization and retrieval of knowledge [2].

A fuzzy rule format has a basic form i. e.

IF antecedents THEN consequent

3. Structure of the System:

The following figure-1 represents the overall process structure of knowledge base system for diagnosis of Anthracnose disease in grape crop. The various components of the system are Case specific database, knowledge base, inference engine and knowledge acquisition system. The domain knowledge is stored in Knowledge base Case specific database exist data about the Pruning type, Crop Period, Weather Conditions, and in detail information of symptoms. Inference engine is a set of program, which represent as a problem solving model. It uses the rules in the knowledge base and situation specific knowledge in the working memory, to solve problems.
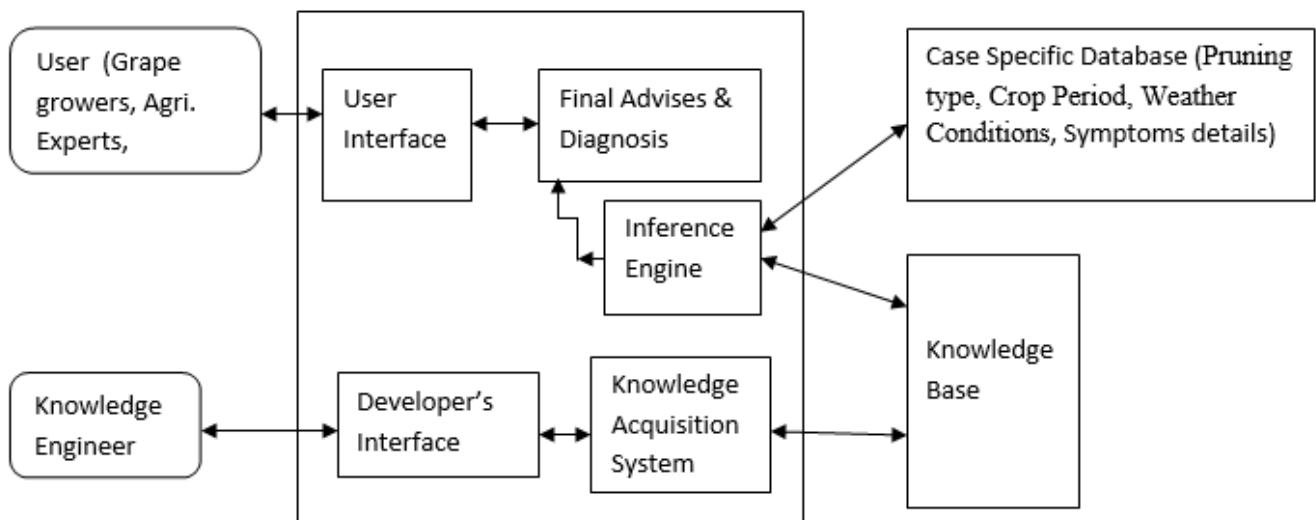
Fig. 1   Structure of the system

It is program part of expert system. It accepts facts from user, searches these facts through rule base and finds the final results.

If certain antecedents are evaluated as true, then it logically follows the consequent. As denoted above, the modified Prolog rule format is

Hypothesis (Pruning type, Crop Period, Disease, Probability);

Weather Condition (Indication, Probability);

Weather Condition (Indication, Probability);

Symptom (Indication, Probability);

Symptom (Indication, Probability);

Symptom (Indication, Probability);

Here hypothesis, weather conditions and symptoms are user defined predicates in prolog. These predicates use symbols (variables) like Pruning type, Crop Period and probability (Chances in percentage). Probability factors given along with the rules for the concerned advices are considered as the degrees of uncertainty related with the decision taken. These values are considered by taking samples fromexperts. The hypothesis proved true if grape crop has all indications (symptoms) given in symptom lists and found all weather conditions given. So such multiple fuzzy rules are exists in system knowledge base, which represents the domain knowledge in the form of prolog code [3].

4. An Illustrative Case of diagnosing attack of Anthracnose disease.

In this system, interactive sample rules are proposed, that can directly guide to grape growers in finding the probability of attack of diseases in grape crop. The system prepares data by asking several questions and predicts the probability of having attack of Anthracnose disease.

4.1 Sample Rules for the Above Case

Sample rules in modified prolog for the prototype implementation of the system are given as follows:

R1 Hypothesis (Pruning type is foundation or back pruning, Crop period is during 15 to 50 days of back pruning i.e. month of April to may, Disease,1.0):-

Weather Condition (presence of continuous or intermittent rain and high humidity, 1.0

Or presence of heavy rain and storms,0.8

Or presence of temperature between 20 o c & 26 o c, 1.0

Or more than 12 hours, leaves & stems remain wet, 1.0)

Symptom (small black spot on leaves, which later give way to shot-hole appearance, 1.0

Or in severe infection symptoms like leaves shrivel up and drop, 1.0)

THEN infection of Anthracnose observes.

> Rule #1.1
>
> IF vine is infested by anthracnose
>
> THEN spray systemic fungicide like
>
> carbendazim 50 wp @ 1.0 gm/l
>
> Rule #1.2
>
> IF vine is infested by anthracnose
>
> and spray of systemic fungicide has
>
> taken
>
> THEN spray any one non-systemic
>
> fungicide like
>
> ziram 27 sl @ 4.0 ml/l
>
> Or chloronthalonil @ 2.0 gm/l
>
> Or propineb 70 wp @ 3.0 gm/l
>
> Or copper hydoxide 77wp @ 2.0 gm/l
>
> Or coc 50 wp@ 3.0 gm/l
>
> Rule # 1.3
>
> IF pruning is foundation or back pruning

And crop period is during 15 to 50 days

of back pruning (month of

April to may)

And rain is stopped

THEN immediately after rain spray

systemic fungicide like carbendazim 50 wp @ 1.0 gm/l

R2 Hypothesis (Pruning type is foundation or back pruning, Crop period is during the month of June to July, Disease,1.0) :-

Weather Condition (Presence of continuous or intermittent rain and high humidity, 0.7

Or presence of heavy rain and storms, 0.7

Or presence of temperature between 20 o c & 26 o c, 1.0

Or more than 12 hours, leaves & stems remain wet, 0.8)

Symptom (like small black spot on leaves, which later, giveway to shot-hole appearance, 0.8

Or in severe infection symptoms like leaves shrivel up and drop, 1.0

Or symptoms appears on stem, like brown to black spots developinto sunken canckers, 1.0)

THEN infection of Anthracnose observes.

> Rule #2.1
>
> IF Vine Is Infested By Anthracnose
>
> AND Period is During Breaks in Rain
>
> THEN Repeat 2 To 3 Sprays at the
>
> Interval of 10 To 15 Days of any One
>
> Non-Systemic Fungicide Like
>
> Ziram 27 Sl @ 4.0 Ml/L
>
> Or Chloronthalonil @ 2.0 Gm/L
>
> Or Propineb 70 Wp @ 3.0 Gm/L
>
> Or Copper Hydoxide 77wp @ 2.0 Gm/L
>
> Or Coc 50 Wp @ 3.0 Gm/L
>
> Or One Spray of Systemic Fungicide
>
> Like Carbendazim 50 Wp @ 1.0 Gm/L
>
> Or Carbendazim 50 Wp + Coc 50wp @
>
> 1.0 Gm/L + 2.5 To 3.0 Gm/L

R3 Hypothesis (Pruning type is foundation or back pruning, Crop period is during the month of August to October, Disease, 1.0) :-

Weather Condition (Presence of continuous or intermittent rain and high humidity, 0.8

Or presence of heavy rain and storms, 1.0

Or presence of temperature between 20 o c & 26 o c, 1.0

Or more than 12 hours, leaves & stems remain wet, 0.8)

Symptom (like small black spot on leaves, which later give way to shot-hole appearance, 1.0

Or in severe infection symptoms like leaves shrivel up and drop, 1.0

Or symptoms appears on stem, like brown to black spots develop into sunken canckers, 1.0)

THEN infection of Anthracnose observes On old Leaves.

> Rule #3.1
>
> IF Old Leaves Infested by Anthracnose

THEN Spray any One Non-Systemic
Fungicide Like Copper Hydoxide 77wp
@ 2.0 Gm/L
Or Coc 50wp @ 3.0 Gm/L
Or Ziram 27 Sl @ 4.0 Ml/L
Or Chloronthalonil @ 2.0 Gm/L
Or Propineb 70 Wp @ 3.0 Gm/L

R4 Hypothesis (Pruning type is Forward or Fruit Pruning, Crop period is during Period of 8 Days After Fruit Pruning, Disease,1.0) :-

Weather Condition (Presence of Continuous or Intermittent Rain and High Humidity, 1.0
Or Presence Of Heavy Rain And Storms, 1.0
Or Presence Of Temperature Between 20 O C & 26 O C, 1.0
Or More Than 12 Hours, Leaves & Stems Remain Wet, 1.0)

Symptom (like Small Black Spot On Leaves, Which later give way to Shot-Hole Appearance, 1.0
Or In Severe Infection Symptoms Like Leaves Shrivel Up and Drop, 1.0
Or Symptoms Appears On Stem, Like Brown to Black Spots Develop into Sunken Canckers, 1.0)
THEN Infection of Anthracnose Observes.

Rule #4.1
IF Vine is infested by Anthracnose
THEN Spray Any One Systemic
Fungicide like Carbendazim 50 Wp @
1.0 Gm/L
Or Difenconazole 25 Ec @ 0.5 Gm/L
Rule #4.2
IF Vine is infested by Anthracnose
AND Spray of Systemic Fungicide has
Taken
THEN After 2 To 3 Days Of Systemic
Fungicide Application, Use Any One
Non-Systemic Fungicide Like
Copper Hydoxide 77wp @ 2.0 Gm/L
Or Coc 50wp @ 3.0 Gm/L

R5 Hypothesis (Pruning type is Forward or Fruit Pruning, Crop period is during Period of 25 to 35 Days After Fruit Pruning, Disease,1.0):-

Weather Condition (Presence of Continuous or Intermittent Rain and High Humidity, 1.0
Or Presence of Heavy Rain And Storms, 1.0
Or Presence of Temperature Between 20 O C & 26 O C, 1.0
Or More than 12 Hours, Leaves & Stems Remain Wet, 1.0)

Symptom (like Small Black Spot On Leaves, Which later give way to Shot-Hole Appearance, 1.0
Or In Severe Infection Symptoms Like Leaves Shrivel Up and Drop, 1.0
Or Symptoms Appears On Stem, Like Brown to Black Spots Develop into Sunken Canckers, 1.0
Or Symptoms Appears as Dark Red Spots or Violet to Grayish in the Center of the Berry, 1.0)
THEN Infection of Anthracnose Observes.

Rule #5.1
IF Vine is infested by Anthracnose
The Spray of Systemic Fungicide like
Fosetyl Al @ 3.0 Gm/L
Rule #5.2
IF Vine is infested by Anthracnose
AND Spray of Systemic Fungicide has
taken
THEN after 2 To 3 Days of Systemic
Fungicide Application, Use Any One
Non-Systemic Fungicide Like
Mancozeb 75 Wp @ 2.0 Gm/L
Or Mandipropamid 23.4% Ec @ 0.8
Ml/L
Or Ziram 27 Sl @ 3.0

As stated above, a rule base for the application is developed.The knowledge collected from the field expert and grape growers is codified in the Prolog language. These rules are sequentially executed to come to a conclusion or diagnosis. If the above mentioned symptoms and weather conditions match, the hypothesis of having Anthracnose disease at a particular grape crop stage is true to some extent. For example, in Rule 1 (R1) i.e. During Crop period 15 to 50 days of back pruning i.e. month of April to May and Pruning type is foundation or back pruning, if one or more Conditions like

1. presence of continuous or intermittent rain and high humidity
2. presence of heavy rain and storms
3. presence of temperature between 20 o c & 26 o c
4. more than 12 hours, leaves & stems remain wet are observed in vineyard.

And symptoms like

1. small black spot on leaves, which later give way to shot-hole appearance
2. in severe infection symptoms like leaves shrivel up and drop

etc are observed then 100% probability of Attack of Anthracnose disease in vineyard is observed [4]. In this way all rules will be checked sequentially and test results in the condition as well as symptom and conclude the probability of having attack of Anthracnose disease.

Once attack of Anthracnose disease confirmed, this system also suggest rule base to provide Fungicide treatment to control the Anthracnose disease.

Conclusion

This research paper is purely based on the observation of appearance of grape crop due to change in weather conditions. No specific tests have been conducted to confirm any symptom.

Using the proposed design one may go for the diagnosing and advisory systems in different domain. This type of system can be proved an efficient means to store and pass experts knowledge in documental form for long time. Hence it can be used as a training and documentation too also.

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