



AGRICULTURAL SITUATION IN INDIA

MARCH, 2016

FARM SECTOR NEWS

GENERAL SURVEY OF AGRICULTURE

ARTICLES

Economics Analysis of
Rejuvenation Technology of
Mandarin-Orange Orchard

Gender Issues in Indian Agriculture:
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Agriculture Labor Force Participation

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A Case of Rayalaseema Region

A Study of Prototype Knowledge Based
Expert System for the Management of
Downy Mildew Disease in the Crop

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CONTENTS

	PAGES
FARM SECTOR NEWS	1
GENERAL SURVEY OF AGRICULTURE	9
ARTICLES	
Economic Analysis of Rejuvenation Technology of Mandarin Orange Orchard - <i>Dr. Nishant V. Shende</i>	14
Gender Issues in Indian Agriculture: The Structural Changes in Agriculture Labour Force Participation - <i>Pushpa, Punit Kumar Agarwal and B.S. Chandel</i>	27
Regional Disparities in United Andhra Pradesh: A Case of Rayalascema Region - <i>M. Srinivasa Reddy, Sanjit Kumar Rout and T. Sudarsana Reddy</i>	34
A Study of Prototype in the Rule Based Expert System for the Management of Downy Mildew Disease in Grape Crop - <i>Mr. S. K. Jadhav and Dr. R.D. Kumbhar</i>	42
AGRO-ECONOMIC RESEARCH	
Impact Study of the National Horticulture Mission (NMH) Scheme in Kerala - <i>K. Jothi Sivagnanam, Agro-Economic Research Centre, University of Madras, Chennai-600 005.</i>	49
COMMODITY REVIEWS	
Foodgrains	58
COMMERCIAL CROPS :	
Oilseeds and Edible oils	60
Fruits and Vegetables	60
Potato	60
Onion	60
Condiments and Spices	60
Raw Cotton	60
Raw Jute	60

A Study of Prototype in the Rule Based Expert System for the Management of Downy Mildew Disease in Grape Crop

Mr. S.K. Jadhav* and Dr. R.D. Kumbhar**

Abstract:—In recent years, expert system technology is used by professionals in different fields. Development of an expert system on agricultural crops will guide the farmers to take decisions into different aspects of crop management. Downy mildew disease caused by fungus *Plasmopara Viticola*. During monsoon, this disease noticed on leaves of grape crop. If the fruit pruning taken before 15th October, then there is a greater risk of downy mildew because there are more chances of rains and also temperature is warmer. On the basis of information like crop period, whether pruning is foundation or forward pruning and appearance of infection of downy mildew etc, this system suggests various preventive measures and different pesticide treatments. This paper presents the development of a prototype of a rule based expert system for the management of Downy Mildew disease in grape crop.

Keywords:—Expert System, Downy Mildew, Pesticide Treatment, Forward Chaining.

1. Introduction

An Expert System is computer program that emulates the behavior of human expert to solve problems which are real word problems associated with a particular domain of knowledge [3]. The most commonly known type of knowledge based system is the rule based expert system in which the experience and knowledge of human experts is captured in the form of IF-THEN rules and facts which are used to solve the problems. It contains the knowledge and analytical skills of one or more human experts.

Downy mildew of grapes is caused by the obligate parasitic fungus, *Plasmopara viticola*. All varieties of grapes in the species *Vitis vinifera* are highly susceptible, *V. aestivalis* and *V. labrusca* are less susceptible, while *V. Cordifolia*, *V. rupestris* and *V. rotundifolia* are relatively resistant [4]. Infection of downy mildew takes place when leaf, cane or bunch remains wet during day time at least for 2.5 to 3.00 hours. These conditions are observed when it rains and dew or fog remains for long time in the morning. Heavy losses due to downy mildew are observed when it rains during November and December.

Grape cultivation in one of the most remunerative farming enterprises in India. It faces serious threat from

several insect pests and diseases. Diseases like downy mildew, powdery mildew, anthracnose etc. causes enormous economic losses to grape sector every year. Downy mildew is a highly destructive disease of grapevines in all grape-growing areas causing up to 100% losses if the disease is not controlled during favorable weather. To avoid such losses, it is necessary to make use of appropriate pesticides in right does (i.e. proper combination and ratio) at right time. It is also important to note that, indiscriminate use of pesticides not only adds to the cost of production significantly, but also results in pesticide (chemical substance) residues in the final produce (i.e. grape) and also in soil.

Author has developed a prototype of expert system for the use of various pesticides at different stages of grape crop to control the attack of downy mildew. The paper includes

2. Grape Crop in Maharashtra (India)

Grape (*Vitis vinifera*) is growth under a variety of soil and climatic conditions in three distinct zone namely, sub-tropical, hot tropical and mild tropical climatic regions in India. Nashik, Sangali, Solapur, Pune, Satara, Lature and Osmanabad districts of Maharashtra state comes under hot tropical climatic region. Vines do not undergo dormancy and double pruning and single harvesting is the general practice in this region. Maximum and minimum temperature is 42°C and 8°C respectively, The major problems in this region are soil and water salinity and drought. Berry growth is impaired and in certain locations pink bluish sometimes develops on green berries due to temperature that drop to a low of 8°C. Thompson seedless & its clones (i.e. Tas-A-Ganesh, Sonaka), Anab-E shahi, Sharad seedless and Flame seedless are the varieties grown in this region.

In India, Maharashtra is a leading state in production of grapes. With regard to agricultural land under grape cultivation and production, Nashik and Sangali districts are at forefront in the state. Area under grapes in Maharashtra is 86.0 thousand ha and production is around 774.0 thousand MT annually. (source: National Horticulture Board, Govt. of India).

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3. Information About Various Disease Observed In Grape

The major diseases observed in the grapes are

- a) Powdery Mildew: Powdery mildew is observed in all the grape growing regions. It is devastating disease like downy mildew. Diseases are characterized by the presence of white powdery (ash like) coating in patches on both sides of the leaves, young shoots and immature berries. The disease develops under warm and dry conditions. Shade or diffused light also helps in the development of this disease. Affected shoots remain weak and immature. The buds affected during growing season, fail to sprout after October pruning. Thus the productivity of the cane and the number of productive canes are reduced. If blossoms are affected they fail to set fruit.
- (b) Downy Mildew: Downy mildew is the most devastating disease of grapes in the tropical region of the country. The disease mainly appears on the leaves, but also attacks the flower clusters and young fruits. Diseases are characterized by the presence of oil spots. The losses are very high when it attacks the clusters before fruit set. Entire clusters decay, dry and drop down. [5] It comes naturally in the rainy season when humidity of environment is high. After the cutting or plants for grape production, in the first 40 to 65 days, the leaves of grapes are delicate & immature. At that time this disease comes. [6]
- (c) Rust: This disease is caused by fungal pathogen *Phakopsora euvesicis*. Symptoms of the disease initially are brown spots on the upper side of leaves. Corresponding to the spots on the underside of leaves, yellowish-orange mass of powdery spores are formed profusely. Infection spreads rapidly on the leaves causing them to dry and wither. It can infect the vines all year round but becomes noticeable during the dry season. The disease is spread through air. Heavy infection during harvest time, which often occurs in warm temperature, causes considerable reduction in yield.
- (d) Anthracnose: The disease is characterized by small light brown or grayish black lesions on tender shoots, young leaves, flowers and young berries. It is found in warm, humid and rainy regions.

- (e) Bacterial Leaf Spot or Stem Canker (*Xanthomonas campestris*):

The disease is more prevalent during June-August and again in February-March. Temperature range of 25-30°C and relative humidity of 80-90% is favorable for the development of the disease. The young growing shoots are affected first. Disease infects leaves, shoots and berries. The symptoms appear as minute water soaked spots on the lower surface of the leaves along the main and lateral veins. Later on these spots coalesce and form larger patches. Brownish black lesions are formed on the berries, which later became small and shriveled. (Source: National Horticulture Board, Govt. of India).

4. Effect or Damage due to Attack of Downy Mildew in Grape:—

Downy mildew has become an increasing threat to grapevine causing heavy loss in the field.

- (1) Downy mildew primarily attacks grape leaves.
- (2) It may also attack and cause severe malformation of shoots, tendrils or berries early.
- (3) The attacked leaves eventually turn brown, become dry and fall.
- (4) Once it is affected it will diminish the quantity & quality of grapes, it reduces the photosynthesis process.
- (5) Downy mildew causes deformed shoot, cluster growth reduction, premature defoliation causes delayed ripening of fruit, young berries will turn light brown, become soft then fall off the cluster easily. [6]

5. Control or Management of Downy Mildew Attack in Grape Crop:—

Management of downy mildew can be planned well in advance especially immediately after both April and October pruning.

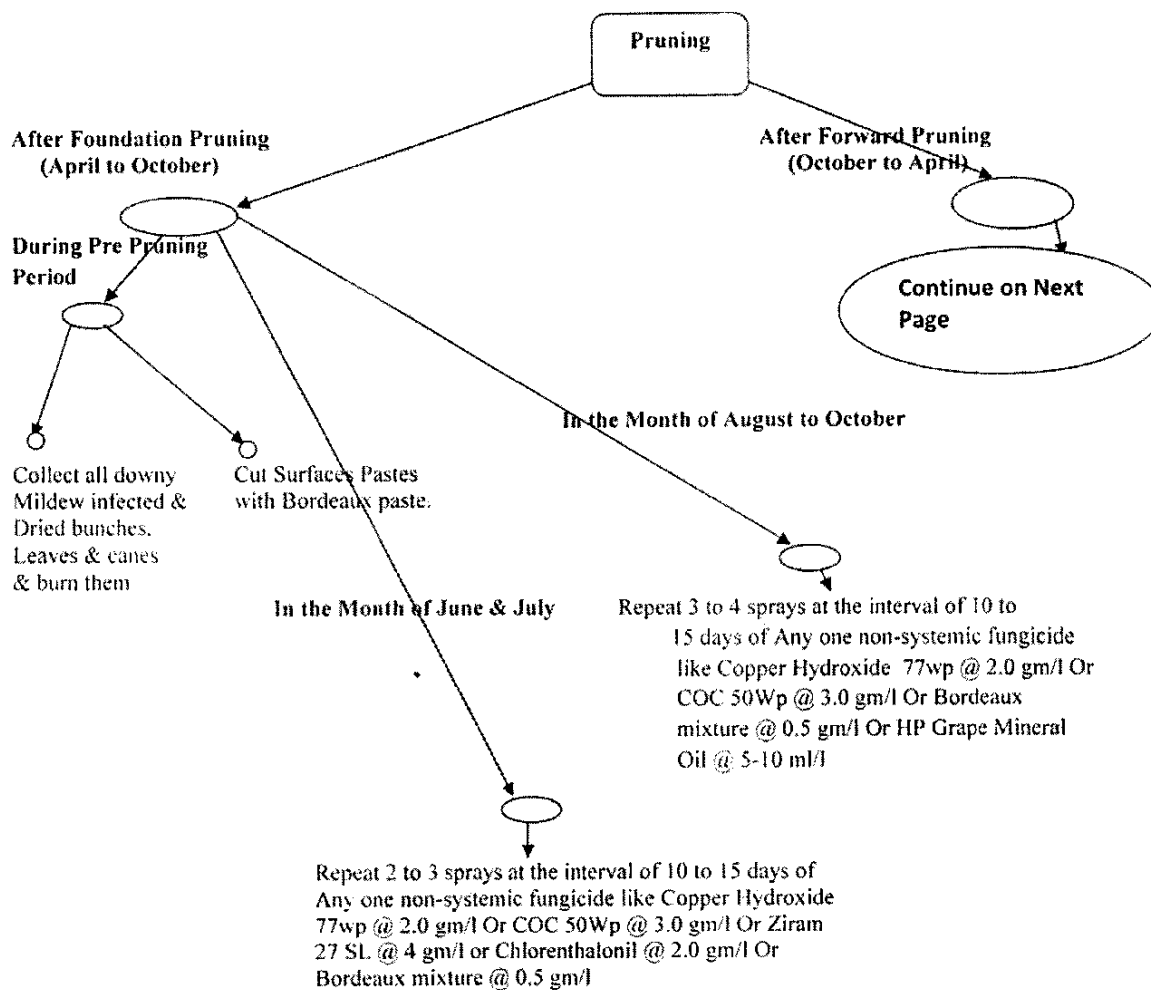
Pruning: In Maharashtra, the vines are forced to undergo for about a month immediately after harvesting. This helps in storing the food material in the mature parts of the vine. The canes are cut back in April by keeping 1-2 buds which develop into canes in 4-5 months. The dried canes are also removed. Here it is called "Back pruning" or "

Foundation" or "Growth Pruning".

In the month of September-October, these canes are pruned for fruiting. This pruning is called "Forward pruning" or "Winter Pruning". Vines, which have attained

the age of one year, can be subjected to this pruning. The level of forward pruning depends upon the region, variety and vine vigour. Normally the vines start yielding in about 5 months from forward pruning.

Here after foundation as well as forward pruning,



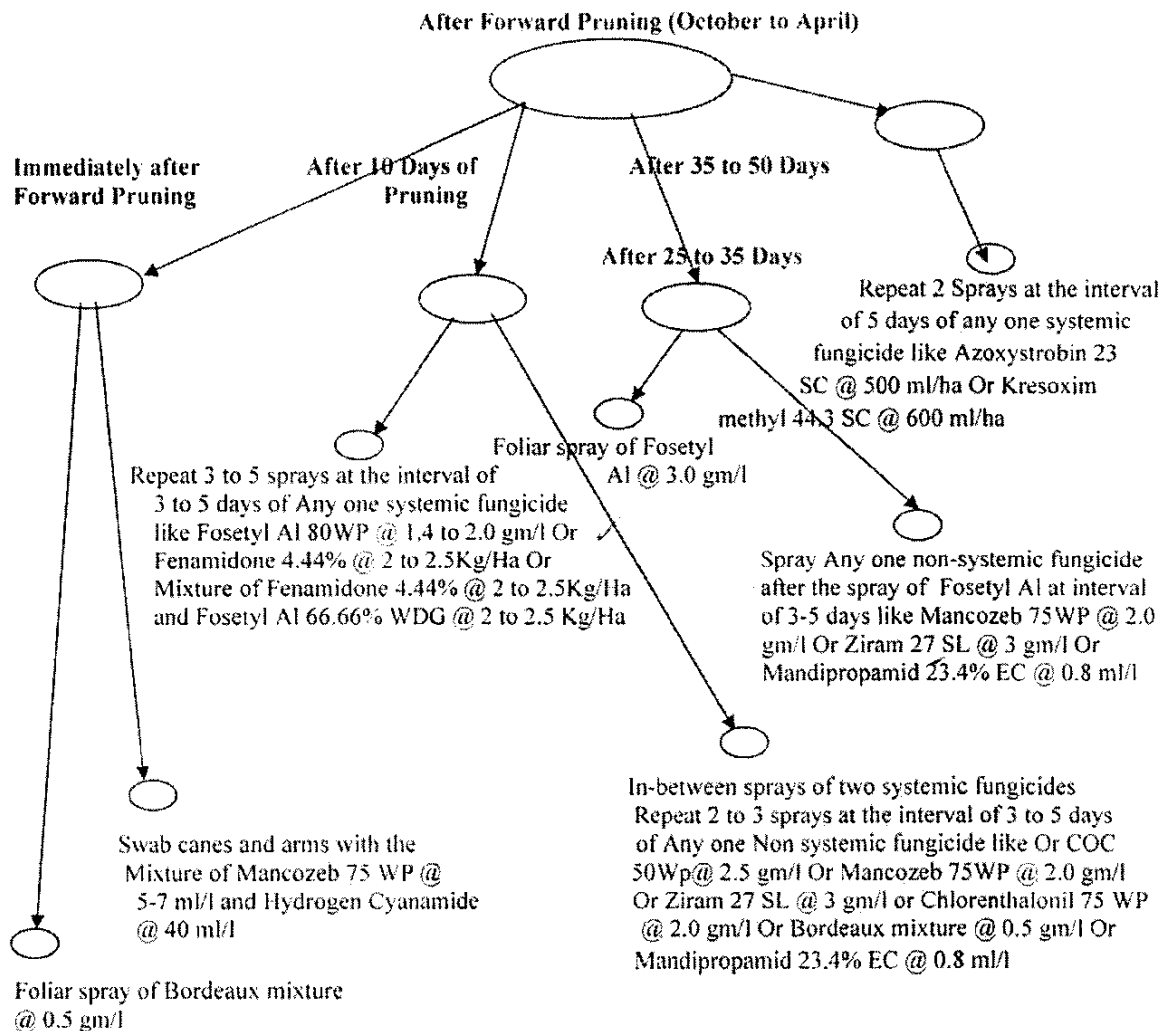


Figure-1: Tree Structure of Representation of the Primary, Secondary and Tertiary Nodes.

several downy mildew controlling steps are suggested and shown in following figure as below.

6. Rule Base Development:

The human mental process is internal and it is too complex. However most experts are capable of expressing their knowledge in the form of rules for problem solving.

For ex. IF the 'traffic light' is Green
THEN the action is 'GO'
IF the 'traffic light' is Red
THEN the action is 'STOP'

The term rule is AI is the most commonly used type of knowledge representation can be defined as an IF-THEN structure. A rule provides some description of how to solve

a problem. They are relatively easy to create and understood. A rule can have multiple antecedents joined by keyword AND (conjunction), OR (disjunction or combination of both.

IF <antecedent>
AND <antecedent>
.....
AND <antecedent>
THEN <consequent>

The rule based system uses rules in the form of IF-THEN. The IF part needs to be satisfied by the facts for the goal i.e. to fire the THEN part. The knowledge base is a collection of knowledge in the domain area. Here domain is to study the pest named downy mildew and to suggest

various pest control treatments against it. In this paper, expert knowledge is acquired in the form of If-Then rules to suggest disease control treatment on the basis of input given by the user. End user enters information like type of pruning, number of days after pruning etc. The prototype model will accept this information and suggest different disease control treatments.

There are two inference techniques, forward chaining and backward chaining. Forward chaining is the data-driven reasoning. It starts with the available data and uses inference rules to extract more data (from an end user) until a goal is reached. An inference engine using forward chaining searches the inference rules until it finds one where the antecedent (IF clause) is known to be true. When such a rule is found, the engine can conclude, or infer, the consequent (THEN clause), resulting in the addition of new information to its data. [3] The reasoning starts from the known data and proceeds forward with that data. Each time only topmost rule is executed. Any rule can be executed only once. However, in forward chaining, many rules may be executed that have nothing to do with the established goals. Therefore, if our goal is to infer only one particular fact, the forward chaining inference technique would not be efficient.

Backward chaining is the goal-driven reasoning. In this technique, an expert system has the goal (*i.e.* a hypothetical solution) and the inference engine attempts to find the evidence to prove it. First the knowledge base is searched to find rules that might have the desired solution. Such rules must have the goals in their THEN (action) parts. If such rule is found and its IF (condition) part matches data in the database, then the rule is fired and the goal is proved. Thus the inference engine puts aside the rule it is working with and sets up new goal or sub-goal, to prove the IF part of this rule. Then the knowledge base is searched again for rules that can prove the sub-goal. [18]

Rule based systems differ from standard procedural or object-oriented programs in that there is no clear order in which code executes. Instead, the knowledge of the expert is captured in a set of rules, each of which encodes a small piece of the expert's knowledge. Each rule has a left hand side and a right hand side. The left hand contains information about certain facts and objects which must be true in order for the rule to potentially fire *i.e.* execute. Any rules whose left hand sides match in this manner at a given time are placed on an agenda. Then right hand side is executed and family it is removed from the agenda. The agenda is then updated and new rule is picked to execute. This continues until there are no more rules on the agenda.

Following rules illustrates how the knowledge base has been represented in the form of 'IF-THEN' rules.

7. Rule Base System for the Management of Downy Mildew

For the data driven forward chaining expert system, it starts with the available data and uses inference rules to extract more data. Here the available data is stage of crop life cycle (*i.e.* forward or foundation pruning), age of crop (*i.e.* days after pruning) etc. and the final aim is: suggesting proper ratio of Pesticides and other preventing actions. Anyone can have 9 resulting combinations (If-then rules in Rule base), based on which he/she decide which Pesticide should be used against attacked pest at which stage. The system ultimately has to reach one of these goals after processing all the parameters under each rule to complete the evaluation process and provide the final decision about the management of downy mildew. On which system suggest appropriate ratio of pesticides.

Following rules represents the expert's knowledge in the form of IF-THEN rules.

Rule #1

If Pruning is Foundation Pruning and Crop Period is Pre-pruning Period and Vine is Infested by Downy Mildew Then Collect all Downy Mildew Infected & Dried Bunches, Leaves & Canes and Burn them. Also Cut Surfaces Pastes with Bordeaux Paste.

Rule #2

If Pruning is Foundation Pruning and Crop Period is the Month of June and July and Vine is Infested by Downy Mildew Then Repeat 2 to 3 Sprays at the Interval of 10 to 15 days of Any One Non-Systemic Fungicide like Copper Hydroxide 77WP @ 2.0 GM/L

Or COC 50WP @ 3.0 GM/L

Or Ziram 27 SL @ 4 GM/L

Or Chlorentalonil @ 2.0 GM/L

Or Bordeaux Mixture @ 0.5 GM/L

Rule #3

If Pruning is Foundation Pruning and Crop Period is the Month between August to October and Vine is Infested by Downy Mildew Then Repeat 3 to 4 Sprays at the Interval of 10 to 15 days of Any One Non-Systemic Fungicide like Copper Hydroxide 77WP @ 2.0 GM/L

Or COC 50WP @ 3.0 GM/L

Or Bordeaux Mixture @ 0.5 GM/L

Or HP Grape Mineral Oil @ 5-10 ML/L

Rule #4

If Pruning is Forward/Fruit Pruning and Crop Period is the Immediately after Fruit Pruning and Vine is Infested by Downy Mildew Then Foliar Spray of Bordeaux Mixture @ 0.5 GM/L Also, Swab Canes and Arms with the Mixture of Mancozeb 75WP @ 5-7 ML/L and Hydrogen Cyanamide @ 40 ML/L

Rule #5

If Pruning is Forward/Fruit Pruning and Crop Period is 10 days of Fruit Pruning and Vine is Infested by Downy Mildew Then Repeat 3 to 5 Sprays at the Interval of 3 to 5 days of Any One Systemic Fungicide like Fosetyl AL 80WP @ 1.4 to 2.0 GM/L Or Fenamidone 4.44% @ 2 to 2.5 Kg/Ha Or Mixture of Fenamidone 4.44% @ 2 to 2.5 Kg/Ha and Fosetyl AL 66.66% WDG @ 2 to 2.5 Kg/Ha

Rule #6

If Pruning is Forward/Fruit Pruning and Crop Period is 10 days to Fruit Pruning and Vine is Infested by Downy Mildew And Spray of Systemic Fungicide has taken Then In-between Sprays of Two Systemic Fungicides Repeat 2 to 3 Sprays at the Interval of 3 to 5 days of Any One Non-Systemic Fungicide like COC 50WP @ 2.5 GM/L

Or Mancozeb 75WP @ 2.0 GM/L

Or Ziram 27 SL @ 3 GM/L

Or Chlorenthalonil 75WP @ 2.0 GM/L

Or Bordeaux Mixture @ 0.5 GM/L

Rule #7

If Pruning is Forward/Fruit Pruning and Crop Period is 25 to 35 days of Fruit Pruning and Vine is Infested by Downy Mildew Then Foliar Spray of Fosetyl AL @ 3.0 GM/L

Rule #8

If Pruning is for Ward/Fruit Pruning And Crop period is 25 to 35 days of fruit pruning And vine is infested by downy mildew And foliar spray of fosetyl Al has taken Then Spray any one non-systemic fungicide at the interval of 3-5 days like mancozeb 75WP @ 2.0gm/l or ziram 27 SL @ 3 gm/l or mandipropamid 23.4% EC @ 0.8 ml/l

Rule #9

If Pruning is for ward/fruit pruning And crop period is 35 to 50 days of fruit pruning And vine is infested by downy Mildew Then Repeat 2 Sprays at the interval of 5 days of any one Systemic Fungicide like Azoxystrobin 23 SC @ 500 ML/HA

Or Kersoxim Methyl 44.3 SC @ 600 ML/HA

Or Fenamidone 4.44% @ 2.0 to 2.5 KG/HA

Or Fosetyl Al 80WP @ 1.4 to 2.0 GM

Sample Rule

Consider following rule from above rule base.

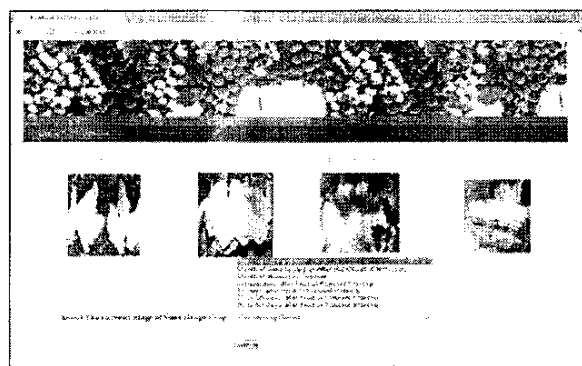
Rule #8

If Pruning is forward/Fruit Pruning And Crop period is 25 to 35 days of fruit pruning And vine is infested by downy mildew And foliar spray of fosetyl Al has taken Then Spray any one non-systemic fungicide at the interval of 3-5 days like mancozeb 75WP @ 2.0gm/l or ziram 27 SL @ 3 gm/l or mandipropamid 23.4% EC @ 0.8 ml/l

Here forward chaining method is used to reach to the result. The available data is stage of crop life cycle (i.e. forward pruning), age of crop (i.e. 25-35 days after pruning), and application of systemic fungicide like Fosetyl Al has taken before 3-5 days. Hence Rule # 8 is selected, because its antecedent matches the available data. Now the consequent is added to data. Nothing more can be inferred from this information, but we have now accomplished our goal of suggesting pesticide treatment for "Downy mildew" disease. Thus forward chaining is implemented here. In this way remaining rules are prepared.

8. Implementation

Many expert systems are built with products called expert system shells. The shell is software which contains the user interface, knowledge base and inference engine. The knowledge engineer uses the shell to build a system for a particular problem domain. For the proposed study,



author developed a prototype using ASP .net and Ms-Access.

9. Conclusion

This Knowledge Based System is helpful to grape growers, agricultural professional, research scholars and academicians to take decision related to the management of Downy mildew disease in grape crop. i.e. the system suggests a preventive action with use of pesticides to control disease which attack on grapes. As a pesticide treatment, this system suggests different pesticide to control single disease. So here grape growers get choice of selecting pesticide by considering different companies and their prices. This expert system is checked by grape growers as well as agricultural expert and initial feedback collected which is positive. With further work, the scope of the expert system can be widened. Also the author is quite interested to develop an expert system in grape crop management, which will be useful as a virtual expert for grape growers.

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