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ARTIFICIAL INTELLIGENCE BASED EXPERT SYSTEMS: APPLICATIONS TO HORTICULTURE.

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ABSTRACT

Decreasing supporting resources and increasing complexity of horticultural crop production necessitate the new technologies be developed to transfer information to farmers as well as commercial producers. Expert systems, a sub area of artificial intelligence of computer science offer the possibility to implement horticultural knowledge into field practice in the form of computer programme in order to support the farmers in decision making at farm level. This paper provides an overview of the concept of expert system and examples of areas of horticultural applications of these systems are in use at present are also outlined. This paper further examines how expert system techniques are being used at present in problem solving and why someone in the field of horticulture might want to use them.

KEY WORDS : Artificial Intelligence, Expert System, Horticulture, Applications.

Increasing complexity of horticultural crop production necessitates the new technologies be developed to transfer information to farmer, extension agents as well as to commercial producers. Besides many horticultural tasks involve complex interaction as well as experience and judgement in making a decision. For instance, horticultural variables namely orchard size, cultivar composition, fruit growth rate and labour costs etc., often require human judgement and expertise of the field of horticulture. This information is also useful where some quick decisions are needed to be taken during preliminary investigation stage.

The modern area of computer science namely Export System (ES), a sub area of Artificial Intelligence (AI) provide an opportunity to develop such a hybrid system so as to help farmers and extension service personnels for making decision in day to day management of horticultural crops. In recent years ES has been recognized as a new type of software technology for use in many research areas of farm science (in agriculture for diagnosing crop diseases, in animal husbandry, reproductive problems in cattle and in agricultural engineering, irrigation system management etc.). They are just beginning to emerge as an area of research and development within horticulture. Before going into the details of practical aspects of bringing ESs in the field of horticulture. An overview of the concept of ES technique is briefly described in this paper.

BASIC CONCEPT OF AN EXPERT SYSTEM

The ES employs human knowledge to solve a problem that ordinarily requires human intelligence. The name comes from the idea that the computer system is programmed to simulate an expert in communication with a client who has a problem to be solved. The knowledge necessary to perform at such a level, plus inference procedure used can be thought of as a model of the expertise of the best practitioners of the field. ES is also called knowledge based system since it relies upon the reservoir of knowledge of a particular domain.

An ES consists of (Fig.1):

(i) A knowledge base of domain facts, rules, procedures and heuristics (rules of thumb,

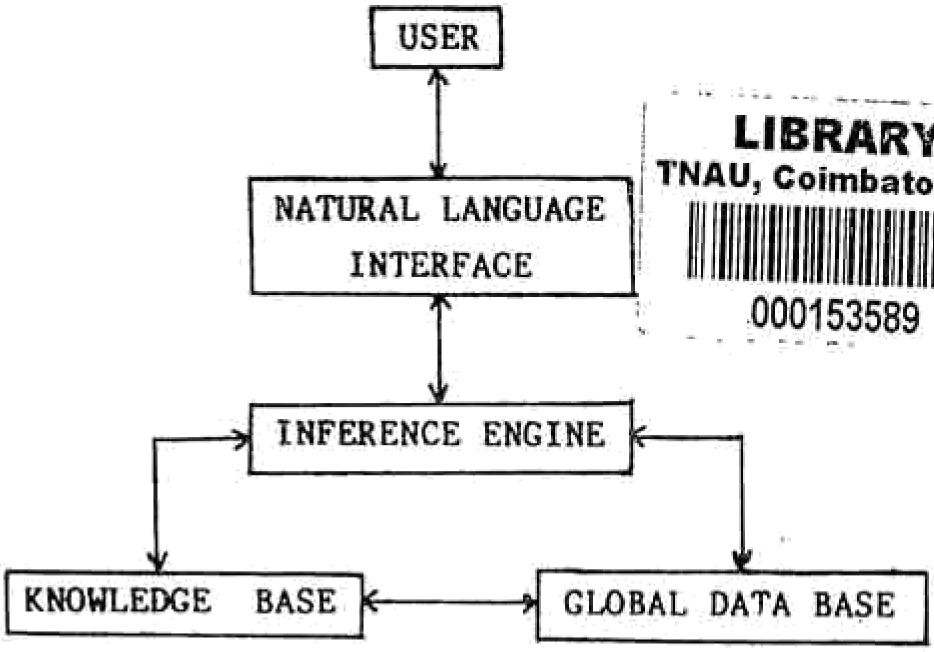

Fig.1. Components of an Expert System

basis of judgement, common sense information) associated with the problem.

(ii) An inference engine with procedures of utilizing the knowledge base for the solution of the problem.

(iii) A working memory or global data base for keeping track of the problem status and the user supplied input for the problem.

(iv) A natural language interface. This component of ES allows two-way communication between the system and the user. It has two main functions; it gives advice and explanations to the user and managers the knowledge acquisition.

Thus, the user friendly natural language interface facilitates both development and use of the ESs. The heart of an ES is the inference engine. It is a programme which utilizes the knowledge and the heuristics contained in the knowledge base to solve the problem specified by the user. The inference engine carries on the reasoning process from the information received through the user interface in the course of the execution and the data available in the fact base.

The knowledge base can be updated independent of the inference procedures. The most common method of representing this knowledge is the production rule system, which encodes expertise in premise- action rules that execute the actions when the conditions in their premises are satisfied. The knowledge base always is an unfinished portion, constantly undergoing updating and expansion as weaknesses and possible areas of improvement are revealed. Changes or additions can be made by the user through a knowledge acquisition system.

HORTICULTURAL APPLICATION OF EXPERT SYSTEMS

Since the application of ESs in horticulture is in relatively early stage, it is difficult to provide a complete overview of ES development and research. Many ESs in highly different domains are now under development. Based on published information, a listing of existing applications of ESs in the field of horticulture is presented in Table 1.

Building An Expert System

ESs may be developed from scratch for each domain using the AI programming languages such as PROLOG, LISP and CLIPS. In recent years, several general purpose ES shells (programming language for coding domain knowledge) are becoming commercially available which may be

Table 1. Existing Horticultural Expert Systems

Specification	Field of application	Reference
GRAPES	Viticulture	Saunders *et al.* (1987)
ES	Citrus harvest management	Khuri *et al.* (1988)
COPOL	Orchard management	Schuricht (1988)
ES	Greenhouse environmental control monitoring	Kano *et al.* (1988)
ES	Apple tree spacing determination	Crassweller *et al.* (1989)
ES	Cucumber cultivation	Gohler (1989)
MISTING	Greenhouse monitoring	Jacobson (1989)
ES	Pest management in apple orchards	Kemp *et al.* (1989)
ES	Peach nectarine cultivars selection	Crassweller *et al.* (1990)
ES	Herbicide choice in orchard management	Tilley (1990)
HARVMARK	Harvesting and marketing stategies of apples	Embree *et al.* (1991)
GABY	Integrated pest control in apple orchard	Moles *et al.* (1992)
ES	Fire blight management in apple orchard	Travis *et al.* (1993)
ES	Nutriecnt selection for cucumber growth	Fynn *et al.* (1994)

used for a particular domain. An expert system shell contains an inference engine which controls how rules are fired and decides the order of the inference. Developing an ES is a time consuming team work. Knowledge engineers (a person who implements an ES) and domain experts work together to design ES. The knowledge engineer develops ES, and the domain expert provides the information for the knowledge base development. The details of various steps involved during the process of development can be found from the literature (Waterman. 1986).

CONCLUSION

The technology for representing and transferring human expertise is now available for solving today's horticultural problems. It is especially suited for applications that call on experience, knowledge, judgement and complex interactions to make decisions. Since problems in horticultural management presently become routinely highly complex, the possibility of fusing knowledge from different domains might be the most promising advantage for horticultural ESs. The logical, almost human like 'reasoning' process has many potential applications in horticulture.

For example, ES programmes in horticulture might be developed for areas of pest management, site selection for orchard, weather related advisories, garden and lawn diseases, spraying scheduling, fertilizer applications and marketing analysis etc. Similar list can be generated for other disciplines by fusing the knowledge sources.

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EFFICACY OF CALCIUM HYDROXIDE AGAINST NUCLEAR POLYHEDROSIS VIRUS OF SILKWORM, *Bombyx mori*

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ABSTRACT

Laboratory experiments were conducted to study the efficacy of calcium hydroxide against nuclear polyphedrosis virus (NPV) disease of silkworm, *Bombyx mori* L. Feeding the larvae with calcium hydroxide at 100 ppm treated mulberry leaves once during the third instar of *B.mori* was effective against NPV. Calcium hydroxide treatment did not produce any deleterious effect on the larval and cocoon parameters of *B.mori*.

KEY WORDS : *Bombyx mori*, Calcium hydroxide, NPV, Mulberry

Silkworm, *Bombyx mori* L. is more prone to different types of infectious disease. Among them, grasserie caused by nuclear polyhedrosis virus (NPV) accounts for more than 15 per cent loss in cocoon yield (Vaidya, 1960). To control the disease, formalin (2%) disinfection is widely recommended. (Nango, 1972; Krishnaswami *et al.*, 1973; Samson, 1985; Seki, 1986). But use of formalin is likely to phased out slowly because of its carcinogenic nature to vertebrates

Therefore, identification of selective chemicals for managing NPV without adversely affecting silkworm is necessary. The present paper reports the laboratory investigations on the efficacy of calcium hydroxide against NPV of silkworm.

MATERIALS AND METHODS

The NPV was isolated from the fifth instar *B.mori* larvae showing the gross pathological symptoms. The virus was collected before the death of larvae in order to minimise the contamination and enhance purity of virus. The prolegs of diseased worms were excised to collect the haemolymph. The haemolymph from the same diseased larvae was passed through a double layer of muslin cloth to remove the debris. The suspension was then centrifuged at 500 rpm for about one min to remove the crude tissue debris and the supernatant was collected.

The supernatant was centrifuged at 3000 rpm for three min and a sediment containing the polyhedral occlusion bodies (POB) was obtained. The pellet was washed thrice in distilled water and finally suspended in distilled water. The POB suspension was stored at - 10^0C in freezer. The strength of POB was assessed using a Naubaeur haemocytometer (FEINOPTIK blanken burg). Calcium hydroxide (Sarabhai Chemicals Ltd). at different concentrations *viz.*, 0, 12.5, 25.0, 50.0, 75.0 and 100 ppm was prepared in distilled water containing 0.1 per cent teepol. Mulberry leaves were dipped in these suspensions and shade dried. Third instar larvae of *B.mori* ($PMXNB_4D_2$) were orally inoculated with active virus @ 100 POB/larva by using a microsyringe applicator (0.2µ l). The leaves treated with different concentrations were fed once during third instar, third, fourth instar, third, fourth and fifth instar. An absolute control fed with untreated leaves and without vir- inoculation was also maintained. After Ab- correction (Abbott, 1925), the actual mo- ...al to grasserie was computed by ...ke consideration the mortality due ...r the hydroxide in larvae not inoculated ... top a