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A web based expert system for identification and management of insect pests of tobacco

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Abstract
Insect pests are one of the major constraints in tobacco crop production resulting in substantial losses. An accurate and rapid diagnosis can help to take up appropriate and timely corrective measures to minimize the yield losses. Web based expert system on insect pests of tobacco, identification, damage symptoms and their management was developed using an online tool "Agridaksh". The system was developed using ontology based method for identification and management of insect pests and the database was designed in a tree structure. A knowledge model has been created in such a way that includes knowledge acquisition, problem identification and a knowledge retrieval system for tobacco insect pests. This system can be accessed at any location and point of time by the users through user friendly menus and inference engine using Internet. This will be useful to enhance the capacity of tobacco farmers, extension personnel and crop development agencies for effective pest management leading to increased yield and improved quality of tobacco.

Keywords: Insect pest, knowledge, system, management, tobacco

1. Introduction

Tobacco is one of the important commercial crops grown in India. Tobacco production and quality are adversely affected by insect pests in both nursery and field crop. The yield losses ranging between 21-53% from various insect pests have been documented. The major insect pests infesting the crop are *Spodoptera litura F., Scrobipalpa heliopa* Low., *Bemisia tabaci* Genn*., Mesomorphus villiger* Blan*., Myzus nicotianae Black and Helicoverpa armigera Hub*. Insect pest management involves the correct and timely identification of the insect pests and their control. The identification of tobacco insect pests is a difficult task and often requires consultation with specialists. An accurate and rapid diagnosis can avoid losses by taking appropriate and timely management practices. Scientists have developed several effective management practices for all the insect pests of tobacco, detailed digital photographs of symptoms are made available and precautionary measures are suggested.

However the end users are not been able to utilize the information for lack of knowledge due to ineffective extension mechanism. Manifestation of insect pest damage symptoms on the plant may generally confuse the process of pest identification. Development of information technology created new vistas of scientific information, social interaction, communication and learning leading to the automated systems and information delivery in order to handle the knowledge initiative tasks like identification and management of tobacco insect pests in the present context.

Expert system combines experimental knowledge and experience with intuitive reasoning skills of specialist's to aid farmers in making the best decision for their crop [1-3]. Various expert systems were developed for identification and management of insect pests in different crops *viz.,* rice [4], wheat [5], tomato [6] and mango [7]. At ICAR-Central Tobacco Research Institute, standalone expert systems were developed on various aspects of tobacco cultivation [8-11]. In the present study, a web based expert system with image based tobacco insect pest identification and management was developed using an online tool "Agridaksh" developed by IASRI, New Delhi which enables the extension personnel, researchers and farmers in identification and management of important tobacco insect pests. The web technologies [12] allowed the knowledge engineers and domain experts to build the expert systems that were having dynamic knowledgebase capabilities.

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2. Materials and Methods

As a first step for building the expert system, domain experts from the Division of Crop Protection in tobacco are consulted for the list of attributes for building the knowledge model on tobacco insect pests. After preparing the attribute list, the required knowledge was captured as per the activity chart developed by the domain experts. The information collected for designing the knowledge base was mainly classified into four categories viz., Nursery-Leaf, Nursery-Stem, Field-Leaf, Field-Stem. The attributes included in the system are Crop name with image, Name of the Insect pest with image, Stage of the crop, part effected, initial nature of damage with image, Life cycle and Identification of pest. Utilizing this knowledge base, a web based expert system on tobacco insect pest management was developed with the help of a tool "Agridaksh" [13] in an N-tier architecture. The N-tier architecture composed of two components viz., Client side Architecture which consists of a web browser and Internet connectivity and the server side architecture with application logic level JSP, JESS inference engine, Semantic Web framework JENA and database (Fig. 1). The last layer in this structure is the database layer consisting of tobacco insect pest information. Java Server Pages (JSPs) with HTML documents interleaved with Java are used as a technology to create dynamic content on the Web. The application logic spread over a Web Server and an Application Server. If the request is for an application, it will forward the request onto the Application Server. The Web Server handles request from Web Clients and generate response through static HTML document. To retrieve the list of insect pests from the system, whenever the user click that option using web browser, that request will be received by JSP in web server through internet and generate a response to the client in the form a table as a simple HTML document.

The expert system developed was in the form of ontology based system using a Web Ontology Language (OWL) [14]. Protégé [15], a Web Ontology Language (OWL) is used for ontology based application which is free, open-source platform that provides a growing user community with a suite of tools to construct domain models and knowledge-based applications. Protégé was customized to provide domain friendly support for creating knowledge model on tobacco insect pests and entering data. After developing knowledge model, values of attributes for each insect pest of tobacco has been entered in the system through the knowledge acquisition module and stored in text format as well as in decision tree format. The entered knowledge was validated and the expert system was tested for any possible errors or shortcomings. JESS was used to make inter relations with one query to the other with the stored database until a particular insect pest is identified. The system thus developed has the capability to store and manage extensive information on tobacco insect pests. The system assists the client to use ontology based inference for insect pest identification based on the stored knowledge.

3. Results and Discussion

To identify a particular insect pest through ontology based inference system, the user has to select the 'Problem Identification' option from the tobacco agridaksh home page followed by 'Language (English)' and select module options viz., 'Pest identification, Disease Diagnosis and Variety selection' (Fig. 2). Proceeding further with 'Pest identification', the system will prompt 'select the crop' with Maize, Tobacco and Indian mustard options as expert question. After selecting the tobacco crop, the system will display the expert question as "Select the stage of the crop" i.e., Nursery or Field (Fig. 3). After selecting one of the stage, again the system prompts as "Select the part affected" i.e., leaf or stem. If the user selects any one of that option, the system will display the expert question as "Select the initial nature of damage". In this option, list of symptoms with its photo causing pest attack will get displayed. The user has to select one of the symptom which will match his requirement and followed by 'Proceed further'. A new menu with title page as "Problem identification – Pest identification" gets displayed (Fig. 4) which consists of two sections namely "Question-Answer History" and "Expert solution". The 'question-answer history' displays a table consists of 'Expert question' and 'Your response' that describes, the sequence of questions selected and response given by the system. The 'Expert solution' option displays list of photos by identifying a particular insect pest.

Web based expert systems were developed for disseminating the knowledge on insect pests of various crops viz., Pulses [16], Coffee [17], Soybean [18], Orange [19], Maize [20] etc. Most of the expert systems developed on various crops have used the rule based or object oriented or fuzzy based or machine learning algorithms. The system developed for identification of insect pests of tobacco used ontology based method which is easy for the end user to understand, interact and execute the software in a question – answer mode to identify the insect pests. It has the features of user friendliness, simple user interfaces, use of photographs, use of interactive controls to avoid typing and also has the option for printouts. Web based identification of insect pests in tobacco is the first of its kind and will provide the methods required for management of the identified insect pests.
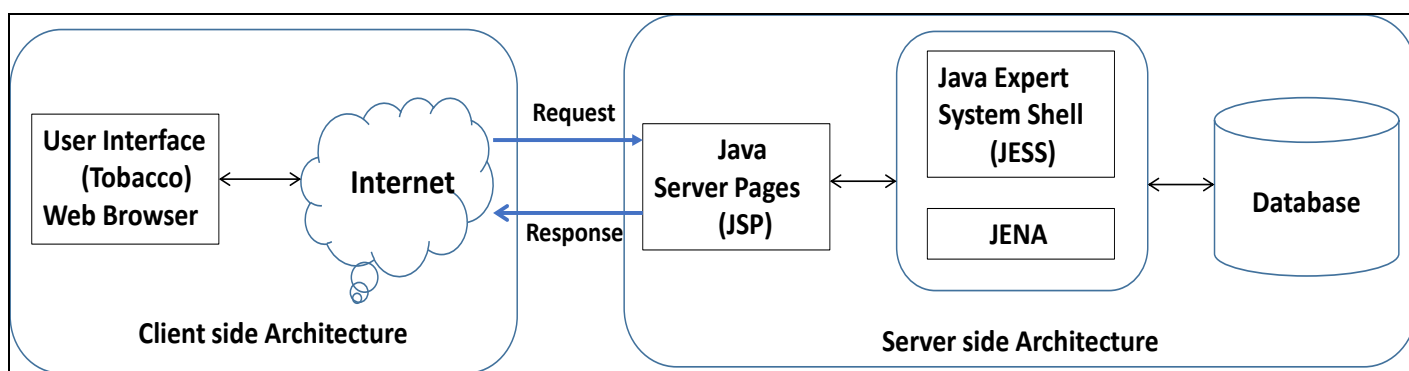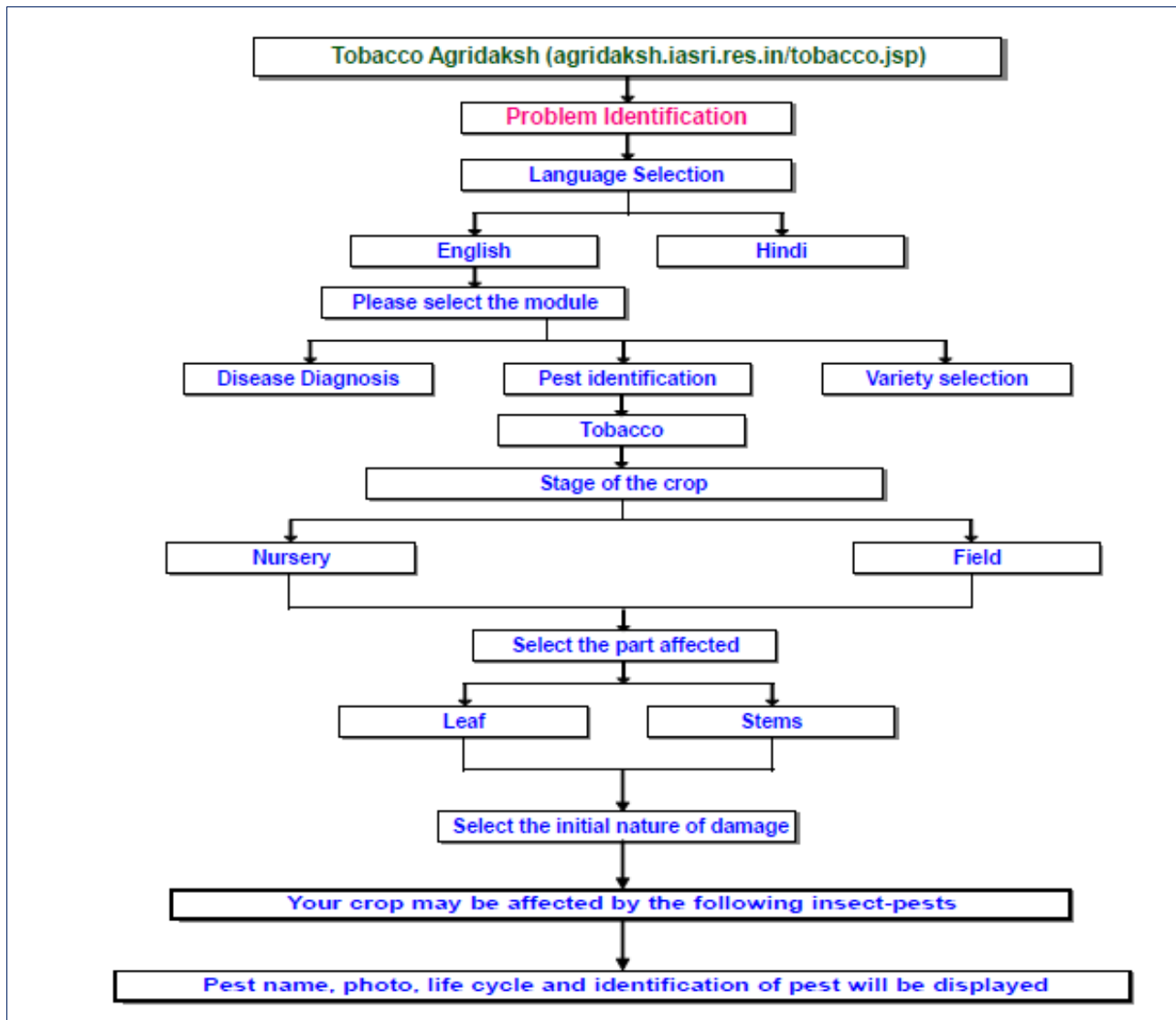

Fig 1: N-Tier Architecture

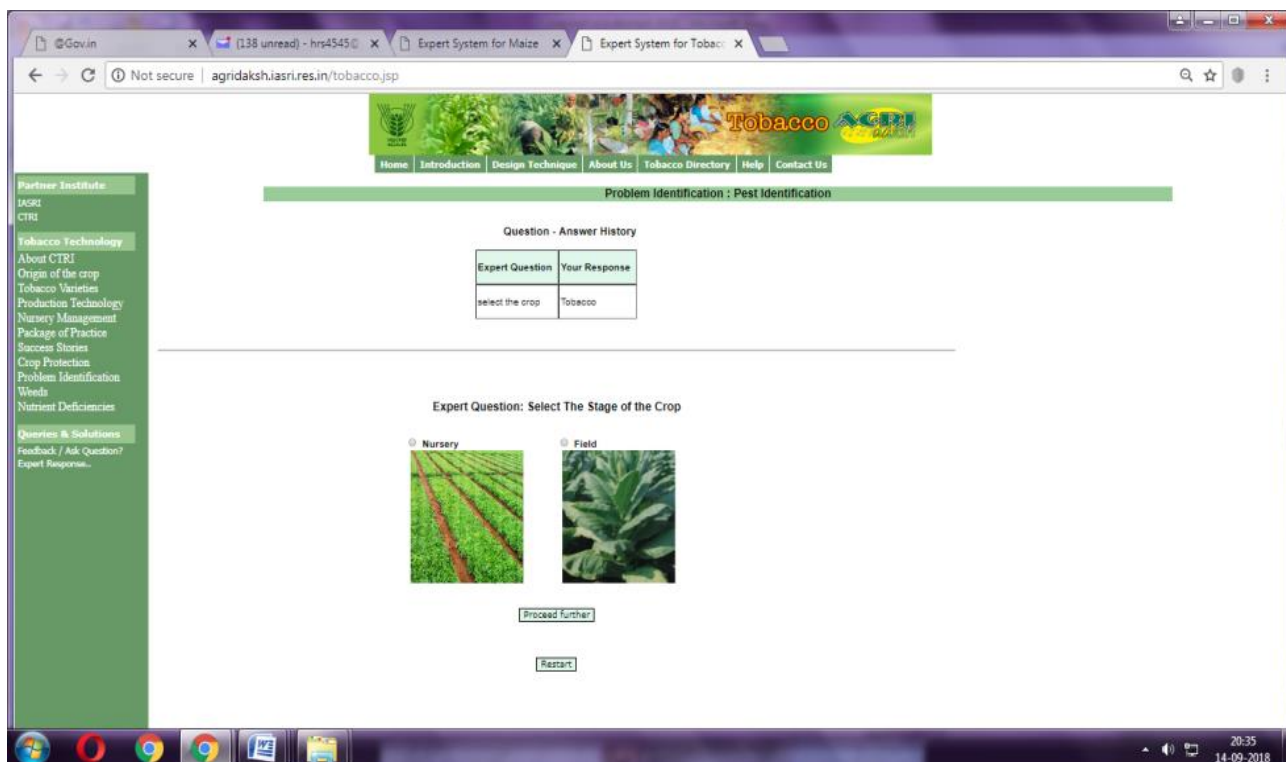**Fig 2:** Flow chart for identification of insect pest

Fig 3: Selecting the Stage of the crop

Fig 4: Ontology based retrieval: Identification of tobacco insect pest

4. Conclusion
The web based expert system for identification and management of tobacco insect pests was developed which is an integration of image and textual data. The system can be used by extension personnel, researchers and farmers to identify and manage the insect pests. User can easily identify the insect pest on the bases of photos of damage symptoms and text description of pest. This expert system developed for tobacco can be used in any location. The system enables the viewer to match his problem with different symptoms displayed and identify the problems as well as remedial measures. The present expert system developed is of great use to all the stake holders of tobacco. With the user-friendly menus, it is easy to execute this system and retrieve the information as per the requirements which will aid in minimizing the losses due to insect pests and help in production of quality of tobacco.

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