



## Expert system for identification of weed seedlings

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### ABSTRACT

Weeds can be controlled effectively only when the management practices are employed at an early growth stage. Therefore, identifying weeds at seedlings stage is very essential for designing an efficient strategy for their management. However, it is a difficult task unless one has enough knowledge and experience. To help in identifying weeds at seedling stage, an expert system has been developed at the Directorate. The expert system uses scientific name-based classification and a mix of the text description and images. The system is supported by a database containing information on 138 weed species with colour images of weed seedling at five growth stages. The expert system was evaluated following the conventional expert system evaluation methodologies. Results indicated that non-expert users were able to make weed seedling identification using the expert system more efficiently.

**Key words:** Agriculture, Identification, Information, Knowledge, Expert system, Weed seedling

Weeds can be managed efficiently when they are small and in their early vegetative stage. Therefore identifying weeds at seedling stage is very much important for planning right management strategy. Also identification of weed seedlings is technically important because it would be helpful to identify the seed bank of the expected competitor weeds so that management can be planned in advance. Identifying weeds at the seedling stage is important because they are most susceptible to chemical or mechanical control at this stage. Also, accurate identification of these seedling weeds often is necessary to select the best herbicide or other method of weed control. Weed seedling identification is important for timely implementation of the appropriate weed control practice. Controlling the weeds in the early stages of growth not only increase the effectiveness of the control measures, but also reduces the crop losses.

Identifying a weed at seedling stage is very difficult compared to identifying a grown-up weed. Assistance in the form of a manual or software is very much needed for effective identification of weed seedlings. In order to overcome this type of problem, expert systems have been developed. The primary goal of expert systems is to enable decision makers and technicians to do the job more efficiently. The expert system technology is a new approach for weed identification.

An expert system is a computer program that contains formally encoded knowledge of experts in a given

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problem area or domain, and is able to use this knowledge to provide help to a non-specialist in problem solving in that domain (Donald 2004, Patterson 2004). In agriculture, expert systems were developed in various disciplines (Gonzalez *et al.* 1990, Lonchamp *et al.* 1991, Olmo and Recasens 1995, Schulthess *et al.* 1996, Chakrabarti and Chakraborty 2007, Ravisankar *et al.* 2009, 2010, Ahmed Rafea 2010) that combine the experimental knowledge and experience with intuitive reasoning skills of specialists to aid in making the best decisions.

The information system on weed seedlings allows their identification by performing the search with scientific name or with cotyledon shapes. Images of each shape with its name are displayed for performing the search easily. Under each shape, list of scientific names gets displayed. With the selection of scientific name, its description and seedling stages of the plant get displayed. With each choice you make, the list of possible plants shrinks. It is easy to confirm the identity of weed seedlings by comparing the sample specimen to the many coloured photos. This application is as useful to the amateur enthusiast as it is for professionals in the field of weed science. An attempt has been made to develop an expert system for identifying seedlings of 138 commonly found weed species of cropped and non-cropped areas in the country.

### MATERIALS AND METHODS

An expert system on weed seedling identification was developed with the combined efforts of specialists from the concerned subject, software professionals and other technical experts. The first step in building an expert system requires knowledge acquisition (Spangler *et al.* 2003).

For this expert system, the domain expert is the “Agricultural Scientists in the field of Weed Science”. The knowledge engineer codes the information in the form of rules or some other representation scheme. System editor (Software expert) serves as intermediary between the domain expert and the computer that will emulate their expertise. The software expert acquires the information about the weeds in the form of facts and rules through consultation and document analysis and then prepares a knowledge base for the system. The process is repeated until a sufficient body of knowledge has been collected to build the expert system.

A study was carried at the Directorate of Weed Science Research, Jabalpur (M.P) during the period from 2002 to 2012. Category-wise listing of weed seedlings, their characteristics and other related information was generated through pot culture studies and also gathered partly from literature. Weed seeds were sown in pots and after germination the images were captured at five different stages in the early vegetative growth. The information about scientific names, morphological features of cotyledons, true leaves, petioles, along with weed seedling images at five stages was documented and catalogued.

The expert system was developed using Visual Basic .NET (Gaddis *et al.* 2003, Balena 2005) as front-end application and MS Access (Teresa *et al.* 2010) as back-end application with user-friendly menus. A prototype of the expert system was built and validated. All the images were stored in digitized form. The knowledge base contained information about 138 weeds consisting of 5 parameters which were stored as rules of inference for use during the reasoning process. These rules were of ‘if...then...else’ nature or any other valid form. Reports were designed using ‘Crystal reports’ by providing flexibility to the user to view selected parameters and take the hard copy. Interface was provided to the back-end to access the database from ‘MS Access’ and to store the new information into it.

To use the system easily, the user-friendly interface was developed with GUI which allows the user to communicate with the system in a more natural way by permitting the use of simple selection drop down option menus or the use of a restricted language which is close to a natural language. Through user-interface, the user is allowed to view and search query for the weed seedling information, view the complete data for a particular seedling by selecting the scientific name which is considered as a primary key. One powerful tool included in this system is that by using search query, the users can shortlist

the weed seedlings based on Cotyledon shape and can get the identity of a particular weed seedling by selecting the scientific name within that shape.

## RESULTS AND DISCUSSION

The main menu of this software consists of 4 modules, *viz.* Weed Seedling Information, Search Query, (Fig. 1), About software and Exit. The scientific names of plants are considered as primary key for identifying the characteristics of weed seedling.

*Weed seedling information:* It is a simple search mechanism which allows the user to search for a particular weed seedling by its scientific name. For easy searching, all the names are arranged alphabetically, *viz.* A ..... Z (Fig. 2). For example if the user is searching for a par-



Fig. 1. Main menu

ticular weed seedling and its name starts with ‘M’ like ‘*Mimosa pudica* L.’, the user has to select ‘M’, then a list of scientific names gets displayed. By selecting ‘*Mimosa pudica* L.’ from the list, the information, *viz.* seedling description, image of the weed (grown-up) and images of weed seedling at 5 different stages get displayed. The user can also view the full image of the plant by selecting the option ‘Full View’.

*Search /query:* It is a powerful tool through which the user can make a query for a particular weed seedling by selecting cotyledon shapes. nineteen cotyledon shapes are defined and designed in such a way, with its image followed by the name and all the plants scientific names,

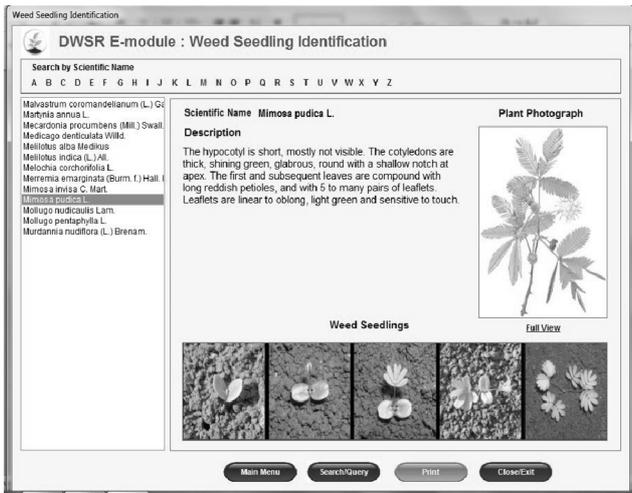


Fig. 2. Weed seedling information menu

are classified into these nineteen shapes. Once any one of the above shape is selected, a list of scientific names of weed seedlings that have the opted characteristics gets displayed and selecting one among the list displays the information of a particular weed seedling having the characteristics opted. For example, if the user selects the 'oblong' in cotyledon shape option, a list of scientific names of weed seedlings having oblong cotyledons gets displayed (Fig. 3). The user can select one of the scientific names from that list to display the characteristics of that particular weed seedling, viz. description, plant photo and five different stages of weed seedlings (Fig. 4). Hard

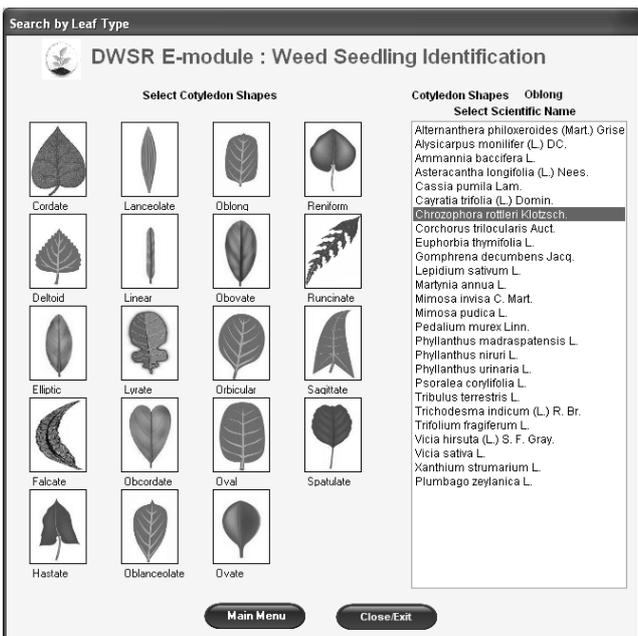


Fig. 3. Search by leaf type

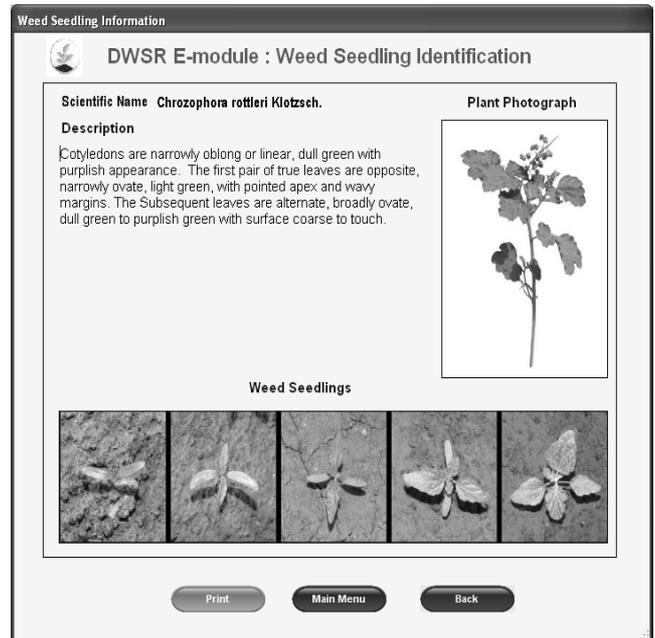


Fig. 4. Weed seedling identification

copy of the report can be taken by selecting the 'Print' option. Navigating tools allow the user to move back and forth between the screens easily.

*About Software:* This is portable software, which makes possible to execute this software in any system. For this, a 'SETUP' program is created (executable file) including all the files and data. Any user can install this software by running this 'SETUP' program and the execution of the software is self-explanatory.

The idea of an expert system is shifting the focus of the research community to knowledge dissemination in contrast to knowledge accumulation. The expert system in combination with powerful personal computers and devices like CD-ROM has the potential to open whole warehouses of accumulated knowledge for agricultural development. The main purpose of the expert system is to serve as delivery systems for extension information and management for decision makers. It also plays an important instrument in agricultural education. It helps in dissemination of up-to-date scientific information in a readily accessible and easily understood form to agricultural researchers, advisers and farmers.

With the help of the expert system for weed seedling identification, one can arrive at accurate identification of the weeds at their seedling stage. The correct identification of weeds at early stages will help in planning appropriate management practices at right time. Further modification and additions to current system will be a

continuous process based on the information and impressions received from various stakeholders.

Results of validation indicated that identification of weeds at seedling stage was an easy task with the use of this expert system even for an ill-skilled person. Those who tried this expert system opined that the system had educational and management importance. Use of images of five different stages of weed seedlings would be helpful to narrow down the identity correctly. This expert system available on the website of the Directorate. The suggestions for refinement, if any, will be considered to make the system accessible to every one.

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