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Web based Expert System for Diagnosis of Micro Nutrients' Deficiencies in Crops

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Abstract--After moisture stress, one of the most important limiting factors for crop productivity is nutrient stress. The crop yield losses are estimated to an extent of 10-20% with or without-visual symptoms ("Hidden hunger"). Of the several nutrients, P, Fe, Zn, B & Mg are reported to be in short supply for plant growth and productivity globally. Especially the low level of Fe and Zn has a bearing on human nutrition also. Diagnosis and remedies are critical components of crop productivity. In view of this; we propose a web-based expert system for diagnosis of plant macro and micronutrients disorders in crops. This system aims to provide a guide to identify deficiency of nutrients in crops, i.e., disorders in leaves, stems and roots of a plant. To avoid diseases caused by deficiency, and to solve the problems, expert system is developed using the virtual diagnosis framework. Mineral Information System is a knowledge based information system, which gives detailed information on characteristics of minerals, availability in soil, role and deficiency symptoms in plant growth, prevention and management to correct the nutrition deficiency, and sources and cost of minerals. This system would be of much use to extension workers, scientists and researchers involved in mineral aspects of research. The development methodology adopted and the current status of the system for diagnosis of deficiency in crops is discussed in this paper. The expert system infers the knowledge on diagnosis of nutritional deficiency diseases in crops, which are specific to each nutrient element. The roles, management, symptoms, quantification, critical limits etc. are parameters which will be used to identify the micronutrient deficiencies in the diseased crops. This will help the ultimate user to find remedies to correct the deficient plants by exerting a control on specific parameters. The experience acquired in the development of this expert system as well as its future research potential is also presented.

I. INTRODUCTION

A crisis looms for any crop to grow and remain healthy, unless essential nutrients are made available to the plants from soil and air. This system aims to provide a guide to identify essential and functional plant nutrient disorders. The diagnosis process involves giving support to identify the deficiency of nutrient in the deficient part of plants. Diagnosis identification can be in leaf, stem or root. Identification will focus on artificial intelligence. The expert system for diagnosis in general agricultural domains is already being explored in several works (Huber & Doluschitz, 1990; Durkin, 1994; Yialouris and Sideriadis, 1996; Mahaman et al., 2003; Silvia Maria Fonseca et al., 2006). The Expert systems for diagnosis of deficiency symptoms in plants are limited. Most reasoning frameworks are based on inference of the consequences to the causes in a deductive manner, as the ones employed in the systems. Technology evolution made changes in information systems, as an expert system and the knowledge is inferred by a knowledge engineer through telecommunication and computer science. It is not only supposed to stand alone but also to establish a link between network services as well as inter network service. In such circumstances web based designs boost information dissemination. New technology transfer channels have been proposed (Risdon, 1994; Hill and Swanson, 1996). The potentiality of Internet has attracted the attention of researchers because of its ease of use and its wide reach (Leiner et al., 1997).

Thus a communication resource has become an excellent form to spread technologies, products and services. The necessity for improving the current diagnosis process of deficiency symptoms in plants is linked to the potential of the Internet motivated expert system for diagnosis. However, to develop such applications for a diversified public, it is crucial that information technology and the communication infrastructure be integrated. The first version of this web–based expert system for diagnosis of nutritional deficiency symptoms in plants was developed using virtual diagnosis framework developed by Embrapa (Massruha et. al., 1999). The methodology adopted for the development and the current status of the system is discussed in this paper. The experience acquired in the development of this expert system as well as its future plans is also presented.

II. MATERIALS AND METHODS

The web-based expert system for diagnosis of nutritional a deficiency in plants has been based on deductive inference and its theory base is the order of first logic. The knowledge base of this system contains production rules derived from a decision tree (fig. 2). This tree was generated from literature and interviews with experts in the area (Anderson & Bowen, 1990) and the researchers of International Potash Institute – IPI, revised it. The focus of the project -of a conventional system- is the "data" while the project of an expert system (ES) is the domain "knowledge". This Process is interactive and incremental; that is the programmer creates a prototype of the system, tests it, and then modifies the knowledge of the system to satisfy the user requirements (Durkin, 1994). The development process of this expert system included six phases (fig. 3). The assessment phase involves a preliminary study of the system's requirements. The second phase is *knowledge acquisition*, which represents the

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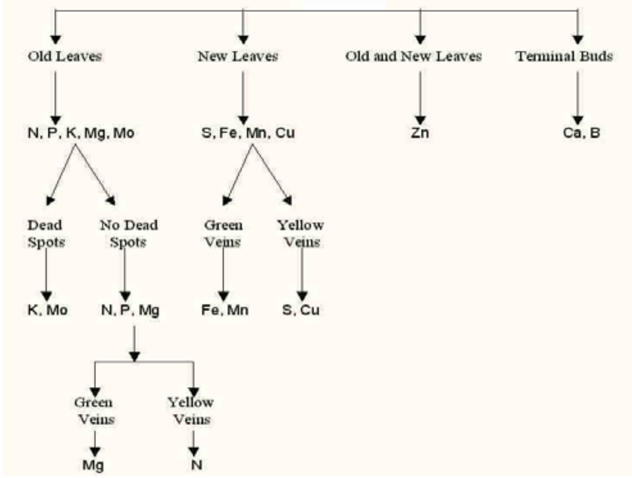

Fig. 1. Flowchart for the identification of deficiency symptoms according to Reddy and Reddi (1997).

bottleneck in the development of an expert system. A classification model of the nutritional deficiency symptoms was generated in this phase. In the *Design* phase, the structure and organization of the knowledge was modified in the form of the decision tree, the methods to process this knowledge were defined along with the software tool to be used in the implementation of the system. The Production rules were generated from the decision tree and the experts system was implemented based on production rules (IF <effects> THEN <causes>). An example of this production rules are shown below

IF part=”new-leaf” THEN question =”q1”
IF part=”old-leaf” THEN question =”q2”
IF part=”root” THEN question =”q3”

q1: IF new-leaf = leaves = “insufficient” THEN “Ca deficiency”**.** The test phase is continuous, the knowledge engineer tests the prototype with domain expert, and the user introduces new knowledge and a new prototype is generated and tested again, and so on In this phase, the test plan and the user evaluation were registered formally. In the documentation phase, a document was elaborated with a “knowledge” dictionary and the resolution procedures of the problem adopted. The *maintenance* phase begins when the system is in production. The expert system is not static, but is dynamic (develops periodically). Therefore, the evolution of the system will be contemplated in this phase. This cycle was adopted in the development of this web-based expert system for diagnosis of nutritional deficiency symptoms in plants. The first version of the expert system was developed using the virtual diagnosis framework developed by the Embrapa (Massruha et al.).

This virtual diagnosis framework was developed using the ServCLIPS tool to support the building and the running of the expert system by web. The ServCLIPS uses the inference engine and the programming language of the CLIPS to develop the expert system (Riley, 2006). Thus a human expert only needs to know the CLIPS language to develop this expert system. More details are described in Moura and Cruz(2001).The main features of the version 1.0 of the web –based expert system in plants are described here. The system is structured in four modules (fig. 3) i.e., the expert system implemented in the ServClips. The session starts with a sequence of question asked such as “which location did the symptoms appear?” and so on. Then the system dynamically adjusts the flow of control between the rules based on the user answers to question and at the end, a diagnosis is provided. The “contact us a opinion” is an optional module that facilitates discussion between experts and producers. The glossary module contains a small dictionary of the area. The help module contains basic information for the use of the system. This first version of the system is not connected to database. Therefore, this system will be able to interface with database in the next version.

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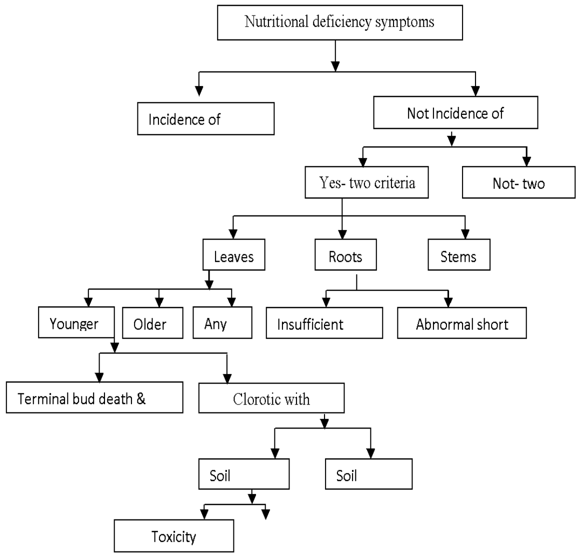

Fig. 2. Symptoms Decision Tree

This tree was generated from literature and interview with an expert in the area and researchers revised it. The focus of the conventional system is the “data”. The expert system is the domain “knowledge”. This process is interactive and incremental; i.e. the programmer creates a prototype of the system, tests it, and then modifies the knowledge of the system to satisfy the user requirements.

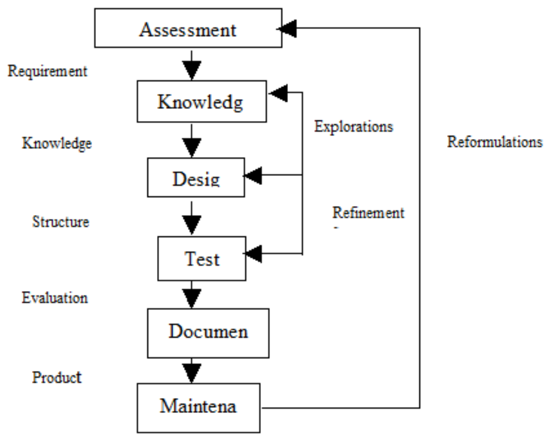

Fig. 3. Life cycle of an expert system

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The *development* process of this expert system includes six phases. The *assessment* phase involves a preliminary study of the system's requirements. *Knowledge acquisition*, in the second phase, represents a bottleneck in the development of an expert system. In the *Design* phase, the structure and organization of the knowledge was modeled in the form of a decision tree, the methods to process this knowledge were defined, as well as the software tool to be used in the implementation of the system. Production rules were generated from decision tree and the expert system was implemented from production rules. The *test* phase, is continuous, that is, the knowledge engineer tests the prototype with the domain expert, the user introduces new knowledge and a new prototype is generated and tested again. In this phase, the test plan and the user evaluations were registered formally. In the *documentation* phase, a document was elaborated with a "knowledge" dictionary and the resolution procedures of the problems adopted. The *maintenance* phase begins when the system is in production. It develops periodically, that is, it is dynamic.

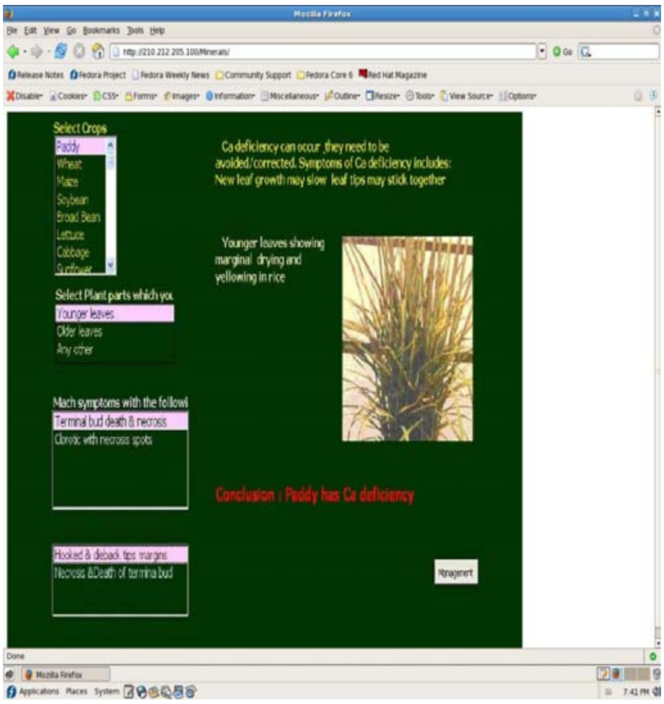

Fig.4. Web designed screen shot

III. DISCUSSION AND CONCLUSION

Although the system is a conceptually simple and powerful tool, it hasn't been disseminated yet. However, an expert system is not static. Hence, evolutions of the systems are being contemplated from some user's observations. It is expected that this system be used on a large scale. This should contribute to, improving the quality and productivity in agricultural sector research. Future work in the context of the Artificial Intelligence will be to evaluate and possibly to develop diagnosis models that are more adaptable to this problem and which improve the efficacy of the development process of ES. The diagnosis is enforced by reasoning of deficiency symptoms and can be seen as a cognitive process that embraces generic knowledge about the flaws and explanations of these flaws (a diagnosis model) as well as knowledge on a private domain and specific heuristics of the domain. We propose to structure the knowledge from the "cause of effects" (abductive inference) as counterpart to the deductive inference model in which the knowledge is structured in the form of "effects cause" (Mussruha et al., 2005). The future work will seek to evaluate several alternatives on possible diagnosis models for nutritional deficiency symptoms in plants, and to develop specific heuristics for the domain of application.

REFERENCE

[1] Durkin J., "Expert Systems: Design and development," Englewood Cliffs, New Jersey, Prentice Hall Inc. 1994. p.800

[2] Hill, K. U. and G.S.Swanson "Utilization of World Wide Web as an Extension Delivery Method. In: International Conference on computers in agriculture," 6 Cancun proceedings. [S.I.]: American Society of Agricultural Engineers. 1996, p. 830-834

[3] Huber, U.G. and R Doluschitz. An overview of expert systems in agriculture Bonn ILB, 1990, p.16

[4] B.M.Leiner, V.G.Cerf, D.D.Clark, R.E.khan, L.Kleinrock, D.C.lynch, J.Postel, L.G.Roberts, S.Wolff, "A brief history of the internet," Disponivel: Internet society 1997, available http://www.isoc.org/internet-history/.

[5] Mahaman, B.D., H.C. Passam, A.B.Sideridis and C.P.Yialouris. "DIARES-IPM:a Diagnostic advisory rule-based expert system for the integrated pest management in the Solanaceous crop system," *Agricultural system* vol. 76, 2003, pp.1119-1135

[6] Massruha, S.M.F.S "Remote diagnosis: An expert system for the diagnosis of the Corn disease by web," The inaugural Australian workshop on the application of the Artificial Intelligence to plant and Animal Production AWAPAP 99, 1999, Sidney.

[7] Mengel and E. A. Kirkby. (International Potash Institute, Berne, Switzerland). *Principles of Plant Nutrition*

[8] Moura, M.F. and Cruz, S.A.B.da, 2006."Estudo de expert system shells Para ambient de diagnosis remota. Campinas: Embrapa Informatica Agropecuaria," 2001. (Embrapa informatica Agropecuaria. Documentos).(in Portuguese)

[9] Riely,G. 2006. "CLIPS: a tool for building expert system," available http://www.ghg.net/clips/CLIPS.html. Accessed on :12 July 2006.

[10] Risdon, P.L. "Internet role in the technology transfer process," Watson D.G.; Zazueta; Harrison, T.S., ed, Computers in agricultural, Proc. 5th Intl. Conf., St Joseph; ASAE, 1994, p.728-730.

[11] Silvia Maria Fonseca Silveria Massruha, Renato S.de Deus, Adrian Delfino dos Santos, Fabio Cesar da Silva and Sergio Aparecido Braga Cruz. "A Web-based Expert system for Diagnosis of Nutritional Deficiencies in Sugarcane," Fifth Intel Conf. Asian Federation for Information Technology in Agriculture. 2006, pp. 545-552.

[12] Yialouris C.P. and Sideridis A.B. " An expert system for the tomato diseases," *Computers and Electronics in Agriculture* vol.14, 1996, pp.61-76.