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Fuzzy Verdict Mechanism to Diagnosis the Yield of Rice

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Abstract: This paper expresses the structure of fuzzy expert system by applying the algorithm Fuzzy Verdict Mechanism. The elements of Fuzzy expert system are fuzzification interface, Fuzzy Verdict Mechanism and defuzzification. The knowledge is constructed by using the fuzzification to convert crisp values into fuzzy values. By applying the fuzzy verdict mechanism, diagnosis the yield parameters of rice such as Number of tillers per Hill, Number of grains per panicle and 1000 grain weight, pest and disease incidence, becomes simple for scientist. Fuzzy verdict mechanism uses triangular membership function with mamdani's inference. Defuzzification method is adopted to convert the fuzzy values into crisp values. The effectiveness of the proposed algorithm was implemented using MATLAB Fuzzy Logic tool box to construct fuzzy expert system for rice.

Keywords: Fuzzy Expert System, Fuzzification, Fuzzy Verdict Mechanism, Defuzzification, rice.

I. INTRODUCTION

Agriculture is the backbone of India. Farmers need advice to take decision during their farming activities such as land preparation, sowing, irrigation management, fertilizer management, pest management and storage for higher production of crop. The application of computers in the field of agriculture has highly increased. Expert System and its utility play a very important role in all the fields. Decision making application was developed for crop growth pest and disease population. Fuzzy Logic is an emerging field focusing on the enrichment of agricultural to make decisions. More specifically, to extract the knowledge, Fuzzy Expert System is designed and developed to make innovative decision in agriculture. Combination of Fuzzy Expert System and Agriculture is a relatively new way and used in many areas of agriculture. This combination is used in the area of crop production and crop management. Many Fuzzy Expert Systems has been developed and used for diagnosis. Rice is an important food crop worldwide [1]. The productivity of rice is threatened by a number of insect pests and diseases attacking the crop from nursery to harvest and causing enormous yield loss. Of these, the leaf folder insect (Cnaphalocrocis medinalis Guen.) and sheath blight pathogen (Rhizoctonia solani Kuhn) have gained major importance because of their ability to reduce the yield considerably all over the world. The management of rice leaf folder insect pest and sheath blight disease has been almost exclusively based on the application of chemical pesticides [2]. Many effective pesticides have been recommended against this pest and disease, but not considered as a long-term solution because of concerns about pesticide residue risks, health and environmental hazards, expense, residue persistence, pest resurgence and elimination of natural enemies. The current study was to develop a biological control plant growth-promoting rhizobacteria (PGPR) strategy for pest and disease that is durable and is an alternative to agrochemicals.

Fuzzy Inference System was developed on soil [3]. The inference is framed for soil with If-Then rules. Mamdani Fuzzy Inference System is build by using MATLAB FIS Tool Box. An Expert System to diagnosis diseases [4] was developed for rice using the shell ESTA (Expert System for Text Animation). An Expert System for rice is collection of a knowledge base, inference engine and user-interface. An Expert System for rice was designed using the morphological features and implemented with MATLAB programming. Rice kernels were classified using neural network [5].

Fuzzy Expert System is designed to control and measure disease in Finger Millet known as Ragi [6]. The first section gives the contributions of Expert Systems in agriculture. The second part explains the Integrated Disease Management. The third part deals about knowledge acquisition and knowledge representation. The fourth part gives the application of Fuzzy Logic in Integrated Disease Management. Many researches have been made regarding the Fuzzy Expert System and its application in agriculture. A. V Senthilkumar and M. Kalpana[7] designed fuzzy verdict mechanism which consists of fuzzy inference, implication and aggregation. Fuzzy Expert System helps to diagnosis the yield of rice which is very much used for agricultural scientists and farmers. Fuzzy Expert System has been developed for rice using Fuzzy Verdict Mechanism. This paper is organized as follows: Section II deals with the Design of fuzzy expert system. The experimental results, implemented in MATLAB fuzzy logic toolbox are presented in Section III and in Section IV accuracy of the system is calculated.

II. DESIGN OF FUZZY EXPERT SYSTEM

The fuzzy expert system includes Fuzzification interface, Fuzzy Verdict Mechanism (FVM) and Defuzzification interface for rice represented in Fig. 1.

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A. Rice Data

The Rice Data [8] is used to test the proposed algorithm Fuzzy Verdict Mechanism with the following input parameter Leaf Folder pest incidence(LFI), Sheath Blight disease (SB), Number of Tillers Hill(NH), No. of grains per panicle(GP) and 1000 grain weight(GW).The output parameter is Grain Yield per Plant(YD).

B. Modeling Fuzzy Expert Systems

Fuzzy expert system for rice can be designed using the following steps.

1. Fuzzification interface
2. Fuzzy Verdict Mechanism
3. Defuzzification interface

Fuzzy set and fuzzy numbers are listed in Table I.

C. Fuzzification Interface

The values taken from the rice data are crisp values. These crisp values are transformed into fuzzy values by fuzzification interface. The fuzzy values are taken as the input for the Verdict Mechanism. Membership function adopted is triangular function with the parameter set [a,b,c] as shown in eqn. (1). The parameter is fixed with Minimum, Mean, Standard Deviation, Maximum value for each variable [9]. Then the membership function μ(x) of the triangular fuzzy numbers [10] is given by

$$\mu(x) = \begin{Bmatrix} 0, x \le a \\ (x-a)/(b-a), a < x \le b \\ (c-x)/(c-b), b < x < c \\ 0, x > c \end{Bmatrix} --(1)$$

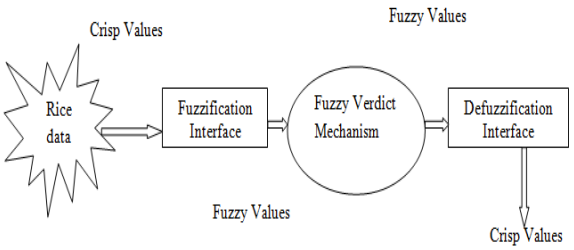

Fig. 1 Diagram of the Fuzzy Expert System for Rice

D. Fuzzy verdict mechanism

In Fuzzy Verdict Mechanism (FVM) three triangular membership functions (MFs) are used for each input variable(D_1,D_2,D_3,D_4,D_5) and three triangular MFs for the output variable (O) using eqn. (1) with parameters D_1 to D_5 {low [Min, Mean-SD, Mean], medium [Mean-SD, Mean, Mean+SD], high[Mean, Mean+SD, Max]} listed in Table I [9].

The fuzzy variable Leaf Folder Incidence has three fuzzy numbers, i.e., LFIlow, LFImedium, and LFIhigh. For the fuzzy variable SB, Shealth Blight is expressed by using the fuzzy numbers SBlow, SBmedium, and SBhigh. The membership functions of NH also have three fuzzy numbers, i.e., NHlow, NHmedium, and NHhigh. The fuzzy numbers GPlow, GPmedium, and GPhigh are defined for the fuzzy variable GP. The membership functions of the fuzzy variable GW are GWlow, GWmedium, and GWhigh. The three fuzzy numbers, i.e., YDlow, YDmedium and YDhigh are adopted to represent the possibility of this instance with rice for output fuzzy variable YD.

TABLE I. REPRESENTATION OF FUZZY VARIABLES AND NUMBERS

Fuzzy Variables	Representation of Fuzzy Variables	Fuzzy Numbers	Representation of fuzzy numbers	Fuzzy triangular numbers
LFI	D_1	low	d_{11}	[2.51,1.72,8.10]
		medium	d_{12}	[1.72,8.10,14.48]
		high	d_{13}	[8.10,14.48,23.29
SB	D_2	low	d_{21}	[3.05,4.9,15.60]
		medium	d_{22}	[4.9,15.60,26.3]
		high	d_{23}	[15.60,26.3,33.77]
NH	D_3	low	d_{31}	[13.73,15.33,17.74
		medium	d_{32}	[15.33,17.74,20.15]
		high	d_{33}	[17.74,20.15,21.2]
GP	D_4	low	d_{41}	[137.37,165.15,196.70]
		medium	d_{42}	[165.15,196.69,228.23]
		high	d_{43}	[196.70,228.23,228.32]
GW	D_5	young	d_{51}	[18.26,20.15,22.44]
		medium	d_{52}	[20.15,22.44,24.73]
		old	d_{53}	[22.44,24.73,26.36]
YD	O	low	O_1	[6.51,6.71,7.32]
		medium	O_2,	[6.71,7.32,7.93]
		high	O_3	[7.32,7.93,8.18]

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The proposed fuzzy rule-based inference system for the fuzzy verdict mechanism consists of four steps, i.e., fuzzy matching, fuzzy inference, combination, and defuzzification. The membership degrees for all instances of the fuzzification are calculated using the membership functions and then using the OR fuzzy disjunction, the operator combines the matching degree of each rule with multiple conditions. Secondly, fuzzy interface is invoked by using Mamdani's approach[11]. Thirdly, inference results of the rules fired the same consequences are integrated by performing MIN fuzzy operations. The final combined fuzzy conclusion is converted into a crisp value by using the centroid method. Fig. 2 represents the membership graph for fuzzy variables NH. Fig. 3 represents the rule for Fuzzy Expert System.

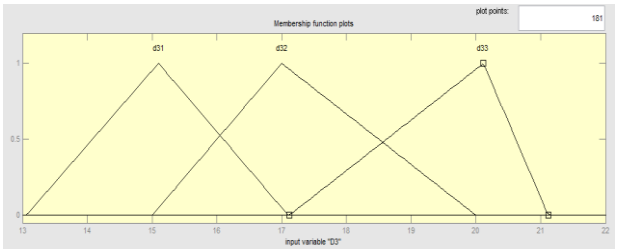

Fig. 2 Membership graph for the fuzzy variable NH

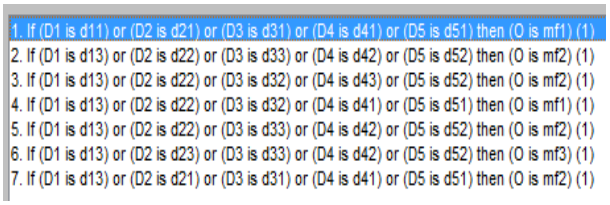

Fig. 3 Rule for Fuzzy Expert System

Fuzzy Verdict Mechanism analyzes the personal physical data, converts the inferred results into knowledge, and then presents the decision results through descriptions [12], [13]. Algorithm for the fuzzy verdict mechanism is displayed in Table II.

TABLE II ALGORITHM OF FUZZY VERDICT MECHANISM

INPUT
Input the fuzzy set for LFI, SB, NH,GP and GW
OUTPUT
Output the fuzzy set for YD

METHOD
Begin
Step1:Input the crisp values for Leaf Folder Incidence(LFI), Shealth Blight(SB), Number of Tillers Hill(NH), No. of grains per panicle(GP) and 1000 grain weight(GW).
Step 2: Set the triangular membership function for the fuzzy number with equation (1).
Step 3: Built the fuzzy numbers for Leaf Folder Incidence(LFI), Shealth Blight(SB), Number of Tillers Hill(NH), No. of grains per panicle(GP) and 1000 grain weight(GW) for input set
Step 3.1: Built the fuzzy number for Grain Yield per Plant(YD) for the output set.
Step4: Fuzzy inference are executed by Mamdani method.
Step 4.1: Input the rule as {Rule 1,2…..k}
Step 4.2: Matching degree of rule with OR fuzzy disjunction are calculated for fuzzy input set (LFIlow, LFImedium, LFIhigh, SBlow, SBmedium, SBhigh, NHlow, NHmedium, NHhigh, GPlow, GPmedium, GPhigh, GWlow, GPmedium, GPhigh)
Step 4.3 Calculate the aggregation of the fired rules having same consequences for fuzzy output set DM (YDlow, YDmedium, YDhigh).
Step5: Defuzzify into the crisp values by

$$DM_i \leftarrow \frac{\sum_{i=1}^{n} Z_i \mu(Z_i)}{\sum_{i=n}^{i=1} \mu(Z_i)}$$

Where Z_i means the weight for $\mu(Z_i)$ and $\mu(Z_i)$ means the number of fuzzy numbers of the output fuzzy variable YD
Step6: Present the knowledge in the form of human nature language.
End.

III. EXPERIMENTAL RESULTS

MATLAB Fuzzy Logic toolbox was used to evaluate the performance of the proposed fuzzy expert system with the algorithm Fuzzy Verdict Mechanism, using rice dataset. Table III indicates the result obtained from FVM about the Efficacy of microbial bioagents agaist leaf folder pest and sheath blight and yield of rice. The acquired result from Table III transferred into knowledge and presented in the human understandable form.

IV. EVALUATION OF SYSTEM PERFORMANCE

Performance Assessment Statement can be assessed based on the accuracy level. The True Positive (TP) and the True Negative (TN) denote the correct classification. False Positive (FP) is the outcome when the predicted class is yes (or positive) and actual class is no (or negative). Still, a False Negative (FN) is the outcome when the predicted class is no (or negative) and actual class is yes (or positive). Table IV lists the various outcomes of a two-class prediction [14]. Accuracy is the proportion of the total number of predictions that were correct. The eqn. (2) show the formula for accuracy.

The proposed method achieves the accuracy value 77.78% for rice data with the input parameters Leaf Folder Incidence (LFI), Shealth Blight(SB), Number of Tillers Hill(NH), No. of Grains Panicle(GP) and 1000 Grain Weight(GW) and output parameter is Grain Yield per Plant(YD). The Fuzzy Expert System helps to know the Grain yield of rice with the parameters Leaf Folder Incidence, Shealth Blight, Number of Tillers Hill, No. of

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Grains Panicle and 1000 Grain Weight. This helps the scientist to analysis the yield of rice.

$$Accuracy = \frac{TN + TP}{TN + FP + FN + TP} X\ 100\ \% \quad (2)$$

TABLE III EFFICACY OF MICROBIAL BIOAGENTS AGAIST LEAFFOLDER PEST AND SHEATH BLIGHT AND YIELD OF RICE

Data	LFI	SB	NH	GP	GW
	8.68	17.54	18.23	213.58	21.97
Statement study	If(LFI is LFIl) or(SB is SBm) or (NH is NHh) or (GP is GPh) or(GW is GWh) then (YD is YDh)				
Assessment Statement	The Assessment Statement justifies that the yield of rice is high(possibility:7.16)				
Justification by Scientist	Scientist justifies that yield is high				

Table IV

DIFFERENT OUTCOMES OF A TWO-CLASS PREDICTION

Actual class	Predicted class	
	Yes	No
Yes	True positive (*TP*)	False Negative (*FN*)
No	False positive (*FP*)	True Negative (*TN*)

V. CONCLUSIONS AND FUTURE RESEARCH

This research presents application of fuzzy expert system for diagnosis of yield of rice using Fuzzy Verdict Mechanism. The rice data set is initially processed and the crisp values are converted into fuzzy values in the stage of fuzzification. The fuzzy verdict mechanism then executes rules to make a decision on yield of rice. Finally defuzzification is adopted to convert the fuzzy output set to a crisp output and to present the knowledge with descriptions.

The results are consistent with the findings of several research workers who demonstrated the use of P. fluorescens strains against various pest and fungal pathogens. In addition to disease management, P. fluorescens strains were found to increase plant growth and yield in the potato, radish, from the earlier findings, it is assumed in the present study that antagonism, plant growth promotion and induced defence responses by the application of P. fluorescens strains might account for the reduction in leaf folder pest and sheath rot disease on rice plants. In conclusion, these results demonstrated the increased efficacy of fluorescent pseudomonad when they are applied to rice plant. Accuracy achieved through this method is 77.78% which can also improved through future works. Further investigations have to be carried out to find out the specific interactions that can influence the disease reduction by application of biocontrol strains. Future works also includes to modify rules and to add rules to fuzzy expert system to perform similar accuracy.

REFERENCES

[1] Brar DS and Khush GS, "Transferring genes from wild species into rice, in Quantitative Genetics," Genomics and Plant Breeding, ed. by Kang MS. CABI, Oxford, UK, pp. 1–41, 2002.
[2] Singh S, Kushwaha KS and Sharma PD, "Resurgence of rice leaffolder Cnaphalocrocis medinalis Guenee due to application of carbofuran granules," Indian J Entomol 57:366–372 (1995).
[3] Maria Wenisch S., Uma G.V. and Ramachandran A.," Fuzzy Inference System for an Integrated Knowledge Management System," International Journal of Computer Applications, vol.10, no.1, pp.6-10, 2010.
[4] Shikhar Kr. Sarma, Robindro Singh Kh.and Abhijeet Singh, "An Expert System for diagnosis of diseases in Rice Plant," International Journal of Artificial Intelligence, vol.1, no.1, pp.26-31, 2010.
[5] MousaviRad S.J., Akhlaghian Tab F. and Mollazade K., "Design of an Expert System for Rice Kernel Identification using Optimal Morphological Features and Back Propagation Neural Network," International Journal of Applied Information Systems, vol.3, no.2, pp.33-37, 2012.
[6] Philomine Roseline, Clarence J. M Tauro and Ganesan N., "Design and Development of Fuzzy Expert System for Integrated Disease Management in Finger Millets," International Journal of Computer Applications, vol.56, no.1, pp.31-36, 2012.
[7] M.Kalpana and A.V Senthilkumar, "Fuzzy Expert System for Diabetes using Fuzzy Verdict Mechanism," Internationl Journal of Advanced Networking and Applications, vol. 03, issue:02, pp.1128-1134, 2011.
[8] Karthiba L, Saveetha K, Suresh S, RaguchanderT, Saravanakumar D and Samiyappan R, "PGPR and entomopathogenic fungus bioformulation for the synchronous management of leaffolder pest and sheath blight disease of rice," Pest Manag Sci, vol.66, pp. 555–564, 2010.
[9] A.V Senthilkumar and M.Kalpana ,"Diagnosis of Diabetes using Intensified Fuzzy Verdict Verlag Mechanism," A. Abd Manaf et al. (Eds.): ICIEIS 2011, (Part III, CCIS 253)(Springer-Berlin Heidelberg,), pp. 123–135, 2011.
[10] William Siler and James Buckley ,"Fuzzy Expert System and Fuzzy Reasoning," Wiley & Sons, Inc,pp,40,49-50,60-62, 2005.
[11] Arazi Idrus, Muhd fadhil Nuruddin, M. arif Rohman, "Development of project cost contingency estimation model using risk analysis and fuzzy expert system," Expert System with applications, vol. 38,pp.1501-1508, 2011
[12] L. A. Zadeh, "Toward human level machine intelligence—Is it achievable? The need for a paradigm shift,," IEEE Comput. Intell. Mag., vol. 3, no. 3, pp. 11–22, Aug. 2008.
[13] M. Margaliot, "Biomimicry and fuzzy modeling: A match made in heaven," IEEE Comput. Intell. Mag., vol. 3, no. 3, pp. 38–48, Aug. 2008.
[14] C. S. Lee and M. H. Wang, "Ontology-based intelligent healthcare agent and its application to respiratory waveform recognition," Expert Syst.Appl., vol. 33, no. 3, pp. 606–619, Oct. 2007.

BIOGRAPHIES

Dr. M. Kalpana obtained her B.Sc Degree (Statistics) in 2001. She is a rank holder in under graduate degree. She obtained her M.C.A degree from Maharaja College for women in 2004 and M.Phil in Computer Science at Madurai Kamaraj University and her Ph.D in Computer Science in Bharathiar University during 2014. She has to her credit three books, 4 papers in National Conference and 2 paper in International Conference, 10 papers in International Journals and two book chapters in IGI Global, U.S.A. She has also coordinated for the training offered by National Horticultural Mission (NHM) to the State Agricultural and

Horticultural officers and prepared manuals. She is a Life member of International Association of Engineers (IAENG), International Association of Computer Science and Information Technology (IACSIT) and member of Internet Society (ISOC). She has been awarded Bharat Jyothi Award from India International Friendship Society.

Dr. L. Karthiba, completed her B.Sc (Agriculture) degree in 2006, and obtained her M.Sc (Plant pathology) in 2008 and completed her Ph.D in 2012 from Tamil Nadu Agricultural University, Coimbatore with 93.5 percentage marks and she is also a recipient of Jawaharlal Nehru Memorial Fund (JNMF) Fellowship for pursuing Ph.D degree in plant pathology. She has participated in several seminars and symposia and published research papers of four international, five national papers and three book chapters. She had received best poster and oral presentation award in a national symposium and awarded PR Verma, Ph.D, student award, Smt Guman Devi Verma Memorial best scientist award 2013 and Brig.Anil Adlakha award for best Ph.D thesis in rice. She has attended DAAD supported summer school training on "Teaching and Research for sustainability" at Leibniz university Hannover, Germany. She has been awarded post doctoral fellowship for women for the year 2014 from university grants commission.

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