Expert system for diagnosing cucumber diseases and physiological disorders

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ABSTRACT

An expert system for cucumber diseases and nutritional disorders(ESCD) was developed using HCLIPS in which several interaface programs were added to CLIPS developed in NASA. The knowledges for constructing knowledge base was obtained from interviews with farmers, agrochemical vendors and employees of agrochemical company. The ESCD is able to diagnose eleven diseases and twelve nutritional disorders which could be frequently found in fields and greenhouses. Validation of ESCD by twenty-four experts proved a possibility of its practical use for diagnosing cucumber diseases and nutritional disorders in the future.

Keywords : expert system, cucumber, diagnosis, diseases, nutritional disorders

INTRODUCTION

Cucumbers are crops which give farmers high profit and its cultivation area are being extended continuously in Korea. However, a loss of production by diseases increases too. Because various diseases that occurred on cucumbers cultivated in greenhouses or fields are due to interaction among crops, environment and pathogens, farmers who don't have many experience of cultivating cannot diagnose diseases timely and accurately, thus, need expert's advices. However, as the number of the expert is small and their function of advising is limited to spaces and times, it is not easy to obtain expert's advice for accurate diagnosis of the diseases. As such a difficulty of appropriate protection, agrochemicals are abused.

On the other hand, farmers who have cultivated cucumbers for long period have many heuristic knowledges. If such heuristic informations are systematized and integrated with a knowledge base, farmers that have a little experiences or non-experts on cucumber cultivation can get a great help from the knowledge

base. And various diseases will be greatly decreased.

The object of this study is to develope an expert system which supports decision of diagnosis and protection of diseases and nutritional disorders of cucumber.

MATERIALS AND METHODS

Construction of The Knowledge Base

The heuristic knowledges which were needed for construction of the expert system were obtained through examining literatures and interviews with farmers, agrochemical vendors and technical employees of agrochemical company. About seven hundred photographs for help-picture were obtained.

Knowledges and photographs obtained were systematized as following :

① From the knowledge obtained, the symptoms by which each disease and disorder was distinguished were extracted. Preliminary working sheet which represented the relation between each disease or nutritional disorder and the symptoms were written as Tables 1 and 2. In the tables, the horizontal axis represents each disease and disorder, the vertical axis represents symptoms. Degree of the relation between the disease or disorder and symptoms was displayed into 4 lebels.

② Based on the preliminary working sheets, the rules which were used to diagnose each disease and disorder were constructed as IF-THEN form(Giarratano and Riley (1994)).

③ Out of photographs obtained, forty photographs which explicitly showed symptoms which were used in the rules for the diagnosis were chosen, and stored as PCX format.

Building of Expert System

To build expert system, HCLIPS was used. HCLIPS was developed by adding several interface programs to the CLIPS developed by NASA(Cho and Kim (1993)). The expert system for cucumber diseases and nutritional disorders(ESCD) was constructed as Fig. 1.

The querys for acquiring facts were written out to have a serial structure to avoid unnecessary questions excluded by answers of preceding questions. Important questions are asked forehead, and according to its answers, the needed questions are asked. Questions to acquire facts were divided into 4 groups.

Fig. 2. shows such a structure of four level querys. More than one answer can be selected for each question regarding on types of symptom and plant parts which the symptom were found. Therefore, multi-part infections caused by a

pathogen and complex infections caused by multiple pathogens can be easily diagnosed.

The method of inference for diagnosis is the forward chaining rule which is generally used in expert systems. A result of inference with rules and facts showed multiple answers for diagnosis with different certainty factors. Calculation of the certainty factors was done by the certainty factor calculation used in the MYCIN expert system(Giarratano and Riley (1994)).

The ESCD can diagnose eleven diseases and twelve nutritional disorders.

RESULTS AND DISCUSSION

Eight farmers, five agrochemical venders, and eleven employees of agrochemical companies, tested the ESCD with respect to convenience of use and accuracy of diagnosis.

In all test, the results of diagnosis with the ESCD coincided well with the predicted diseases. 87.5% of users responded that the ESCD was convenient to use. Especially, more than 70 % of experts such as farmers and employees of agrochemical companies recognized convenience of the ESCD. About 60 % of all users and 80 % of agrochemical venders commented that they would use the ESCD on the case of distribution of ESCD in the future.

CONCLUSION

A expert system for diagnosing cucumber diseases and nutritional disorders(ESCD) was developed using HCLIPS in which user-interfaces for Korean were added to CLIPS. The ESCD has the forward-chaining as method of inference and infers using approximate 100 rules. Text informations and photograph informations were added so as to help users answer and to be convenient to use.

The ESCD was tested by farmers and employees of agrochemical companies. The result of test was that more than 87% of users recognized performance credit of expert system.

REFERENCE

Cho, S. I. and S. C. Kim. 1993. Development of user-interfaces for expert system using CLIPS. Joural of the Korean Society for Agricultural machinery 18(2): 133-143.

Giarratano, J. and G. Riley. 1994. Expert systems principles and programming. PWS Publishing Company, Boston.

Table 1. Preliminary working sheet for diagnosing cucumber diseases

certainty factors : No sign: 0-40% ○: 40-55% ◎: 55-70% ◉: 70-85% ●: 85-100%

		damping off	downy mildew	fusarium wilt	powdery mildew	grey mold	gummy stem blight	scab	anthrac-nose	phyto-phthora blight	sclero-tinia rot	angular leaf spot
plant part	leaf		○		○	○	○	○	○			○
	stem	○		○			○	○	○	○	○	
	root			○						○		
	fruit					○		○	○	○	○	○
environ-ment	high temp., high moist.			○			○	○	○	○	○	○
	high temp., low moist.	○	○		○		○		○			○
	low temp., high moist.	○	○	○		○	○	○	○	○	○	○
	low temp., low moist.	○			○	○						○
location	house		○	○	○	○				○	○	○
	field		○	○	○	○	○	○	○	○		○
growth stage	seedling stage	◉	○		○							○
	flowering stage		◎	○	◎	◎	○	◎	○	◎		◎
	fruit development stage		◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
	harvesting stage		◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
root stock	pumpkin			○						- ○		
symptom	white powder				●							
	leaf wilt			◉			◎			◉		
	dark fungi under leaf surface		●									
	root decay			◉						◉		
	sclerotinia										●	
	hyphae on the fruit: grey					●						
	hyphae on the fruit: black in white										●	
	hyphae on the fruit: white									◉	○	
	ooze secretion							◎				◉
	lesion: part	stem near soil	leaf			leaf, fruit, flower	stem, leaf	leaf, fruit, stem	leaf, fruit stem,	stem near soil	fruit, stem	leaf, fruit
	lesion: color	brown to dark brown	yellow			brown, dark grey	white brown, dark brown	dark green to brown	yellow to brown	brown, white	grey to dark	dark green, dark brown
	lesion: shape	narrowing	restricted with vascular			amor-phous, conc-entric	amorph-ous, triangular	hollow, water soaked amorp-hous	hollowed, circular	water soaked, amorp-hous	amorp-hous, lump	restricted with vascular, oil-soaked
	lesion:	●	◉			●	◉	◉	◉	●	◎	◉
	browning of stem inside			◉								
	browning oneside of stem			●								
	browning of fruit inside						●					
	hole in the leaf							○	○			◎
	stem split			◉								
	black spots in dead stem						◉					
	growth shriveling						◎	◉				
	abnormal branches at top							◉				

Table 2. Prelimnary working sheet for dianosing nutritional disorder of cucumber

Certainty factors : No sign: 0-40 % ○: 40-55% ◎: 55-70% ◉: 70-85% ●: 85-100%

			N-	P-	K-	Mg-	Ca-	B-	Mn-	Zn-	N+	B+	Mn+	Zn+
pland part	leaf		○	○	○	○	○	○	○	○	○	○	○	
	stem				○		○			○			○	
	fruit		○					○			○			
	flower						○							
	bud						○							
location	greenhouse			○	○			○						○
	field									○				
substrate	sandy soil		○		○			○			○			
	peat soil			○			○		○					
	rock-wool				○	○	○							
	nutrient soln.				○	○	○							
	loam soil								○					
	leaf	colorr	yellowish green	dark green	yellowish green	yellow			yellowish		dark green	yellowish green	reddish brown	
		chlorosis			●	●	●	◎						◉
		necrosis			●	◎			●	○		◉	●	
		small		○	○		○		○			○		
		stiff		○										
		watery spots		◉				◎						
		spots		◉							◉	◉	◉	
		white dot					●							
		fade		◎								◉		
		shrivel		◉		●	◎							
		mottle							●	◉				
		curl					◉	◉			◉	◉		
		disicate		◉	●									
	fruit	colors	grayish green											
		spiny	◎											
		short	◉				◎				◎			
		shape	abormal											
		furrowed					◉							
		tasted					○							
	stunted	stunted	●	●	●		◉				●	◉	◉	●
	short	short			◉		◉			◎				

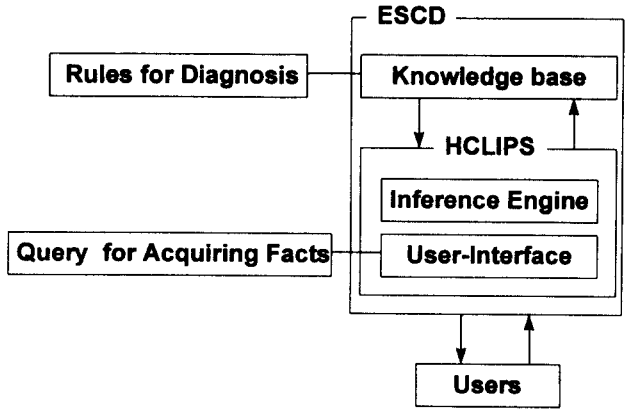

Fig. 1. Construction of ESCD

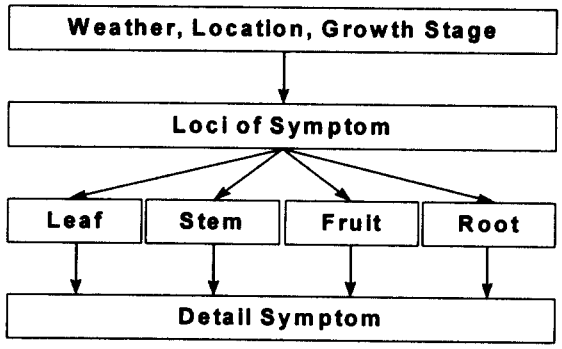

Fig. 2. Question structure of the ESCD