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A Computer-Based Advisory System for Diagnosing Crops Diseases in Korea

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컴퓨터를 이용한 식물병 임상진단 시스템 개발

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ABSTRACT : A computer-based diagnosing system for diseases of grasses, ornamental plants and fruit trees was developed using a 16 bit personal computer (Model Acer 900) and BASIC was used as a programing language. The developed advisory system was named as Korean Plant Disease Advisory System (KOPDAS). The diagraming system files were composed of a system operation file and several database files. Data base files are composed of text files, code files and implement program files. The knowledge-base of text files are comoposed of 79 files of grasses diseases, 122 files of ornamental plant diseases and 67 files of fruit tree diseases. The information of each text file include disease names, causal agents, diseased parts, symptoms, morphological characteristics of causal organisms and control methods for the diagnosing of crop diseases.

Key words **: Computer-based advisory system, disease diagnosis, crop diseases.**

A lot of agroproducts from foreign countries have been imported into Korea due to the opening of the agroproduct market. Beside this in order to increase the ability of international trade competition of Korean agroproducts in the world market, farmers have to improve the quality and standardization of agroproducts to fit to the requirement of foreign consumers. In relation to these the rapid and accurate diagnostic methods for plant diseases are very important pending problems. Moreover, a lot of agrochemicals are misused and over used due to lower qualification of plant protection extension workers and agrochemical-store owners. Such phenomena resulted in the increase of environmental pollution and reduction of agroproductivities.

To cope with such limiting factors, we need more accurate and rapid disease diagnosis systems. A computer diagnosis system has been employed for the development of the diagnosis of plant diseases. In 1983, PLANT/ds (5) was first developed for diagnosing soybean diseases in the U.S.A. Since that time several advisory systems has been developed; MICCS (3) for strawberry and tomato diseases in Japan in 1985; SIRATA (6) for cotton management in Australia; BLOCK (1) for grapevine and sunflower diseases in France in 1987; PLADIDAS (2) for plant diseases diagnosis by relational database in Japan in 1989, and an expert system for diagnosing muskmelon disorders by a Latin group in the U.S.A in 1990 (4). However, such programs have not been used practically by extension workers and farmers because of limited information on the control of plant diseases.

The object of this study is to develop a computer advisory system for the diagnosis of diseases of grsses, ornamental plants and fruit trees.

MATERIALS AND METHODS

Program development process

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System of hardware and software. Hardware is a 16 bit PC (Acer900) which consists of the MS-DOS 3.30 operating system, five logical disk drives, one serial port, 1 MB memory, and the 14″ mono monitor. Printer is a 24 pin dot matrix one (Epson LQ-1550H). BASIC was used as a programing language.

File construction. For the diagnosis of gramineae, ornamental plants and fruit tree diseases, the program are composed of text file, code file and implement program file. The text file is a knowledge base which includes the disease name, pathogen name, diseased part of plant, symptom and sign, mophological characteristics of spores and control measures for the disease etc.

The diagnostic code file is composed of many parameters such as the part of diseased plant, lesion type, color of symptom, sign, sort of spore, conidial type, conidial color, No. of septa per conidia, conidiogenous cell, and hyphal type based on the alphabetical letter for individual disease for respective host as shown in Table 1. In order to draft the diagnostic code file, eleven different parameters with subparameters were illustrated as follows.

1. Name of the host
   A. Apple B. Pear C. Peach
   D. Grape E. Citrus
   F. Persimmon G. Chestnut
2. Diseased part of the plant
   A. Leaf B. Twig(branch) C. Fruit
   D. Scion E. Root F. Flower
   G. Petiole H. Grafted part
   I. Soil level J. Whole plant
   K. Tendril L. Unknown
3. Symptom
   A. Canker B. Oval or ellipsoid
   C. Irregular D. Sooty E. Globose
   F. Double ring spot G. Mosaic
   H. Star shape I. Dwarf
   J. Malformation K. Gall L. Wilt
   M. Necrosis N. Rot
   O. Yellowing P. Black spot
   Q. Shot hole R. Gummosis
   S. Blight T. Fruit split
   U. Powdery V. Early leaf fall
   W. Bark split X. Rust
   Y. Blue mold Z. Unknown
4. Colour of the lesion
   A. Black to brown B. Red to purple
   C. Gray to white
   D. Yellow to copper color
   E. Green to blue F. Unknown

Table 1. The diagnostic code file for pear diseases

Disease name	Diseased part of plant	Symptom	Lesion color	Sign	Sort of spore	Color of spore	Morphology of spore	No of cell/ spore	Sporulation type	Hyphal type
Black canker	ABC	EF	A	E	FG	A	BC	A	A	C
Scab	ABCH	CHIJST	A	BE	EG	C	ABC	A	A	C
Rust	ACGH	EHJ	BD	G	H	AC	ACD	AB	A	C
Black spot	ABCD	BCEST	A	B	E	C	F	CDE	B	C
Anthracnose	BC	EF	A	BE	EG	A	B	A	A	C
Mycosphaerella leaf spot	A	EF	AC	E	FG	A	HK	CD	A	C
Leaf spot	A	E	AC	B	E	AC	C	CD	A	C
Die back	BC	CS	A	E	FG	A	BEH	A	A	C
Powdery mildew	ACDGH	UC	C	B	EG	A	BF	A	AB	C
Gray mold	AC	CF	AC	B	E	A	AB	A	C	C
Crown gall	BE	K	AC							
White root rot	EJ	LV	F	A	EG	A	C	A	A	C
Nectria canker	B	KS	B	E	EG	A	B	AB	C	C
Sooty mold	AC	D	A	E	FG	ABC	AB	AC	A	C
Leptosphaeria										C
Leaf spot	A	EC	C	E	FG	A	BC	AC	A	C
Blue mold	C	Y	AE	B	E	A	A	A	B	C
Necrotic spot	A	CEP	A	A						C

5. Sign
   A. Sporodochium B. Sporulation
   C. Sclerotium D. Toad stool
   E. Pycnidium or ascocarp F. Gland
   G. Unknown
6. Sort of the spore
   A. Nonsporulation B. Zoospore
   C. Oospore D. Basidiospore
   E. Conidia F. Pycnidiospore
   G. Ascospore H. Asciospore, Uredospore, Teliospore
   I. Unknown
7. Color of spore
   A. Hyaline B. Yellow to copper
   C. Brown to black D. Green to blue
   E. Red F. Unknown
8. Shape of spore
   A. Globose B. Oval C. Spindle
   D. Fusiform E. Sickle type
   F. Clavate G. Spiral H. Filiform
   I. Cylindrical J. Sickle moon shape
   K. Banana shape L. Peanut shape
   M. Unknown
9. No. of septa per spore
   A. None B. One transverse septum
   C. 2-4 transverse septa
   D. More than 5 transverse septa
   E. Longitudinal septa F. Unknown
10. Conidiogenous cell formation
    A. Solitary B. Chain
    C. Cluster D. Unknown
11. Hyphal structure
    A. No mycelial formation B. No septation
    C. Septation D. Unknown

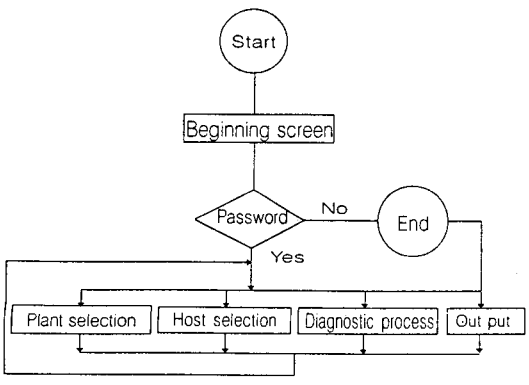

Fig. 1. System flow-chart.

Feature of implement file. In order to operate a computer advisory system for diagnosing crop diseases a code file and a prepared text file were programed using a BASIC language. This developed system was very simply constructed and easy to operate by beginners as shown in Fig. 1.

THE SYSTEM IN OPERATION

The first step is to choose one crop (Fruit trees) from three crops such as grasses, ornamental plants and fruit trees related with the clinic target host.

Program for plant disease clinic				
Crop-selection	Host-selection	Diagonostic process	Print out	End

Selection of crop

Grasses
Ornamental plants
[Fruit trees]

The second step is to choose the pear as a host (pear) among seven fruit trees.

Program for plant disease clinic				
Selection of crop	[Host-selection]	Diagnostic process	Print out	End

Host selection

Apple	Peach
Grape	Chestnut
[Pear]	Persimmon
Citrus	Clear

The third step is to select one of different diagnostic parameters from top to bottom one by one to diagnose the diseased host. Firstly the chosen parameter is part of diseased plant as shown in the following flow chart and select subparameters relevant diseased host. The diagnostic results show the name of suspected disease in right column.

Program for plant disease clinic

Diagnosing disease (Host : pear)

Diagnostic parameters	Diagnosed disease name
[Part of diseased plant] A C G Symptom Lesion-colour Sign Sort of spore Spore-colour Spore-shape No of cell/spore Conidiogenous cell formation Hyphal structure Return to origin	Canker Scab Rust Black rot Anthracnose Leaf spot Die-back Powdery mildew Brown rot

A) Leaf	B) Twig(branch)	C) Fruit	D) Scion
E) Root	F) Flower	G) Petiole	F) Part of grafted stem
I) Soil level	J) Whole plant	K) Tendril	L) Unknown

Direction key : Position movement	Alphabet : Selection of subparameter
Esc : Clear or correction	Enter : End

Secondly, when subparameters in symptom parameter were chosen, the total number of suspected pear diseases were reduced from nine to seven.

Diagnosing disease (Host : pear)

Diagnostic parameters	Diagnosed disease name
Part of diseased plant A C G [Symptom] E H J Lesion-color Sign Sort of spore Spore-color Spore-shape No of cell/spore Conidiogenous cell formation Hyphal structure Return to origin	Canker Scab Rust Black rot Anthracnose Anthracnose Leaf spot Brown rot

Canker	B) Oval	C) Irregular spot	D) Sooty
E) Globose	F) Double ring	G) Mosaic	H) Star shape
I) Dwarf	J) Malformation	K) Gall	L) Wilt
M) Necrosis	N) Rot	O) Yellowing	P) Blight
Q) Short hole	R) Gummosis	S) Blight	T) Fruit split
U) Powdery	V) Early leaf fall	W) Bark split	X) Rust
Y) Blue mold	Z) Unknown		

Direction key : Position movement	Alphabet : Selection of subparameter
Esc : Clear or correction	Enter : End

Thirdly when the subparameters in lesion color parameter were chosen, only one pear disease name (Rust) appeared as a final diagnostic disease name on the screen.

Diagnosing disease (Host : pear)

Diagnostic parameters		Diagnosed disease name
Part of diseased plant	A C G J	Rust
Symptom	E H J	
Lesion-color	B D	
Sign		
Sort of spore		
Spore-color		
Spore-shape		
No of cell/spore		
Conidiogenous cell formation		
Hyphal structure		
Return to origin		

A) Black to brown B) Red to purple C) Gray to white
D) Yellow to copper color E) Green to blue F) Unknown

Direction key : Position movement Alphabet : Selection of subparameter
Esc : Clear or correction Enter : End

If the diagnostic result will come out through the plant disease clinic program, the control measure related with designated pear rust will be printed out for farmers.

Program for plant disease clinic				
Selection of crop	Host selection	Diagonostic process	Print out	End
Selection of designated disease Pear Rust				

The plant disease control prescription sheet will have the following information. Name of host, name of disease, scientific name of pathogen, part of diseased plant, symptom and sign, characteristic of causal organism, factors related disease development, and control measures.

RESULTS AND DISCUSSION

Through the three years MST's (Ministry of Sciences and Technology) project on computer-based advisory system for dianosing crop diseases in Korean "Korean Plant Advisory System" was developed. The advisory system was grogrammed using BASIC language and covered 79 grasses diseases, 122 ornamental plant diseases and 67 fruit tree diseases.

Most of the developed advisory systems are concerned with one or two specific host's diseases rather than many crop's diseases. PLANT/ds (5) was developed for diagnosing soybean diseases in the USA. MICCS (3) for strawberry and tomato diseases was develeped in Japan. BLOCK was also developed for grape and sunflower dseases (1). Recently a expert system was developed for musk melon disorders in USA (4). The KOPDAS is more similar to the Japanese advisory system which includes most of the important crop diseases. However, the system didn't cover bacterial and viral diseases.

The developed KOPDAS makes it relatively easy for the begining computer users to disagnose plant diseases. According to a screen indication order, the diagnostic process will be followed step by step; 1) host name, 2) diseased position, 3) symptom, 4) lesion, 5) sign, 6) colour, morphology, cell number and sporulating structure of conidia, and 7) mycelial structure. Based on the above function of the developed diagnosing system, the five features of this program are described as follows.

The first, this system was developed on a basis of combination of plant hosts and causal agents. Thus when the system is started, the plant name will come out first as a priority on the screen, followed by host name, and then the coded systems operate within the host plant file. Therefore, the possibility of successful diagnostic process will be very high.

The second, after the name of the host plant is selected by the operator, unless any other inputs follow, all names of the host diseases will appear on the screen. Therefore, the informations itself should be very helpful for us to continuously operate the computer diagnosing system.

The third, since this system is relatively simple, the diagnostic capacity could be increased by adding items of diagnostic conditions, and increasing the textfile contents etc.

The fourth, most of the informations in this system was obtained from "A List of Plant Diseases, Insect Pest and Weeds in Korea, Rice Diseases and a few other books." Therefore, this information is not enough to diagnose the as-of-yet host-unrecorded crop diseases in Korea. The fifth, the construction of textfilles and code files mainly relied on the information of references. Thus, the decision of morphological characteristics of a causal organism will not be synchronized objectively because of the possibility of misjudgement of syndrom. Even though the KOPDAS has many merits than those programs developed from foreign countries, this system need to be improved in terms of efficiency of accuracy for the diagnosing of plant diseases through preliminary tests in several extension units. Because the developed program (KOPDAS) will be used by non professiond experts such as extension workers and farmers.

요 약

16Bit PC와 BASIC언어를 이용하여 화본과 작물병, 화훼병 및 과수병을 대상으로 식물병 전산화 progarm을 개발하였다. 개발한 식물병 전산프로그램을 KOPDAS(Korean Plant Disease Advisory System) 즉, 한국식물병진단 프로그램으로 이름 붙였다. 본 프로그램 작동화일과 여러개의 데이타베이스 화일로 구성되었으며, 데이타베이스 화일은 기본 설명화일, 코드화일 및 실행화일로 구성되어 있다. 그리고 기본 설명화일의 구성은 79종의 화본과병, 122종의 화훼병 및 67개 과수병을 포함하였고, 각 병별 기본화일의 구성은 병명, 병원, 발병부위, 병징, 병원균의 형태적인 특징 및 방제법 등의 정보가 수록되어 있다.

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