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Expert System for the Diagnosis of Wheat Diseases

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Abstract*: *Background: *Wheat is a wild grass belongs to Poaceae (Gramineae), an enormously multipurpose grain. The proteins of the wheat, gliadins and glutenins together referred to as storage prolamines are responsible for viscoelasticity of the dough. Wheat proteins belonging to both the soluble and insoluble fractions can act as allergens and cause allergic symptoms in susceptible individuals. Celiac disease is an auto immune disease characterized by immune mediated enteropathy of proximal small intestine triggered by the ingestion of gluten containing cereals (wheat, barley and rye) in genetically susceptible individuals. The average worldwide prevalence of celiac disease is 1-6%. India confirmed the prevalence rate of 0.3% in adults and 6% in children. The mainstay of the treatment is a strict lifelong adherence to gluten free diet .**Objectives**: The main objective of this expert system is to assist farmers in detecting wheat diseases and solutions. **Methods**: In this paper the design of the proposed Expert System which was produced to help farmers in diagnosing many of the wheat The proposed expert system presents an overview about wheat diseases are given, the cause of diseases are outlined and the treatment of disease whenever possible is given out .E-clips Expert System language was used for designing and implementing the proposed expert system. **Results:** The proposed wheat diseases diagnosis expert system was evaluated by group of farmers and they were satisfied with its performance. **Conclusions:** The Proposed expert system is very useful for farmers in diagnosing wheat diseases and treatment it whenever possible is given.*

Keywords: Expert System, CLIPS, Delphi, wheat, Diseases

1. INTRODUCTION

Wheat (Triticum aestivum L.) is the most important cereal crop for the majority of world's populations. It is the most important staple food of about two billion people (36% of the world population). Worldwide, wheat provides nearly 55% of the carbohydrates and 20% of the food calories consumed globally. Wheat is cultivated over a wide range of climatic conditions and therefore understanding of genetics is of great value for genetics and plant breeding purposes. Wheat belongs to family Poaceae (Gramineae) which includes major crop plants such as wheat (Triticum spp. L.), barley (Hordeum vulgare L.), oat (Avena sativa L.), rye (Secale cereale L.), maize (Zea mays L.) and rice (Oryza sativa L.). Triticeae is one of the tribes containing more than 15 genera and 300 species including wheat and barley. Linnaeus in 1753 first classified wheat. In 1918, Sakamura reported the chromosome number sets (genomes) for each commonly recognized type. He separated wheat into three groups viz. diploids (2n=14), tetraploids (2n=28) and hexaploids (2n=42) chromosomes. Wheat is grown in all the states in India except Southern and North Eastern states. Uttar Pradesh, Haryana, Punjab, Rajasthan are the major wheat producing states and accounts for almost 80% of total production in India. Only 13% area is rainfed. Major Rainfed wheat areas are in Madhya Pradesh, Gujarat, Maharashtra, West Bengal and Karnataka. Central and Peninsular Zone accounts for total 1/3rd of wheat area in India. All India basis only 1/3 irrigated wheat receives desired irrigations and remaining is limited irrigation only. Breeding programmers are generally aimed for rainfed and irrigated environments and there is need to develop varieties which are responsive to limited irrigation conditions. Thus to increase the productivity of this region different physiological techniques need to be adopted, for improving water use efficiency and breeding wheat genotypes tolerant to water stress and heat[2].

2. BENEFITS OF WHEAT AND ITS SIDE EFFECTS:

It has a ton of health benefits such as controlling obesity, improving the metabolism in your body, preventing type 2 diabetes, reducing chronic inflammation, preventing gallstones, preventing breast cancer, promoting gastrointestinal health in women, preventing childhood asthma, protecting the body from coronary diseases, relieving postmenopausal symptoms and preventing heart attacks. By including wheat in your diet regularly, you can benefit from all the nutrients it has to offer and prevent the occurrence of a multitude of ailments[3].

3. EXPERT SYSTEMS IN AGRICULTURE:

Expert systems have applications in many domains. They are mostly suited in situations where the expert is not readily available. In order to develop an expert system the knowledge has to be extracted from domain expert. This knowledge is then converted into a computer program. Knowledge Engineer performs the task of extracting the knowledge from the domain expert. Rule based expert systems are the most commonly known type of knowledge based systems. The knowledge is represented in the form of IF-THEN rules. Figure 2 shows different modules for a rule-based expert system[11-17].

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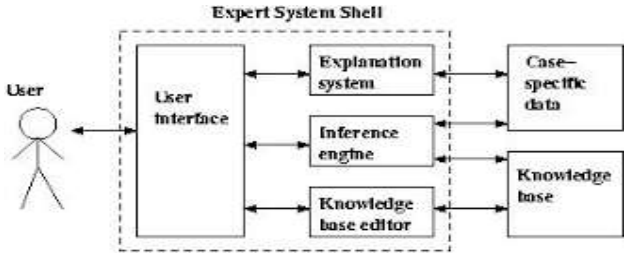


Figure 1: Expert System Architecture [1]

Expert systems have been developed and applied to many fields. In agriculture, expert systems are developed to diagnose the diseases and pests of various crops. Farmers across the world face problems like soil erosion, increasing cost of chemical pesticides, weather damage recovery, the need to spray, mixing and application, yield loses and pest resistance. On the other hand researchers in the field of agriculture are constantly working on new management strategies to promote farm success. In many countries today, farming has become technologically advanced and expert systems are widely used in the field of agriculture. In this way farmers can get expert opinion on their specific problems like selection of most suitable crop variety, diagnosis or identification of livestock disorder, suggestion tactical decisions throughout production cycle etc. from the expert system. Symptoms of diseases, disorders and pests have due geographical variations. So there is always a need to develop a new expert system for a different geographical region. Using expert system technology in agriculture is not new. (POMI), an expert system for integrated pest management of apple orchards has been developed in Italy. CUPTEX) is an expert system for handling management of cucumber disorders. The NEPER wheat expert system is used for handling the production management aspects of wheat crops. Authors in [14] developed an expert system for tomato. It handles the tomato disease identification problem. The US Department of Agriculture has developed an expert system for cotton crop management to provide appropriate management recommendations to cotton growers [4]. Center for Informatics Research and Advancement Kerala has prepared an Expert System called AGREX. It helps the Agricultural field personnel give timely and correct advice to the farmers [4]. An expert system for integrated production of muskmelon can be found in Ref. [8]. TOMATEX is an expert system for tomatoes [9].

4. MATERIALS AND METHODS:

The proposed expert system performs diagnosis for wheat diseases by asking select number of options. The proposed expert system will ask the user to choose the correct options in screen. At the end of the dialogue session, the proposed expert system provides the diagnosis and recommendation of the disease to the user. Figure 1 shows a sample dialogue between the expert system and the user Figure 2 shows how the users get the diagnosis and recommendation

Figure 1: The figure presents shows when the system asks the user

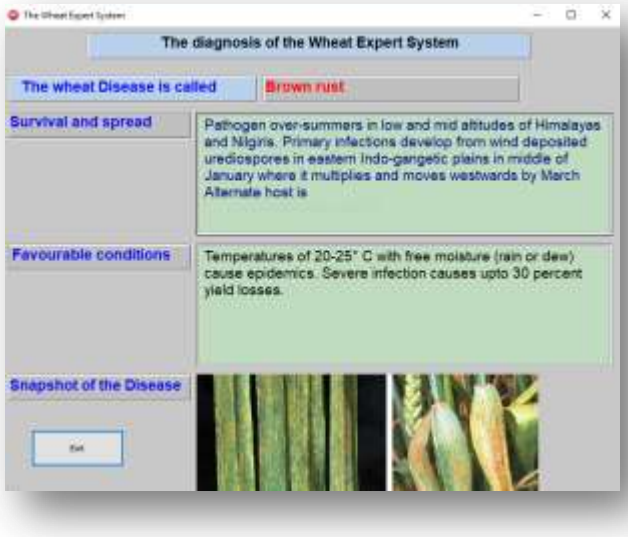


Figure 2: The figure shows diagnosis and recommendation of the expert system

5. LITERATURE REVIEW:

There are many expert systems that are designed to diagnose plant[18-40], and other kinds of diseases[41-60]. But there is no expert system for diagnosing wheat diseases available for free. Although many plant diseases have common symptoms. The proposed expert system was developed specifically to help farmers diagnose wheat diseases

6. KNOWLEDGE REPRESENTATION:

The main sources of knowledge for expert systems either from an expert in the field of agriculture or a website specialized in wheat diseases, these sources are transferred to CLIPS There are currently in the expert system a number of rules that help to treat 13 diseases of wheat

a) Powdery mildew

Disease symptoms

Powdery mildew can easily be diagnosed by the white, powdery patches that form on the upper surface of leaves and stem.
Greyish white powdery growth appears on the leaf, sheath, stem and floral parts.
Powdery growth later become black lesion and cause drying of leaves and other parts

Survival and spread
Fungus remains in high hills during summers in infected plant debris as dormant mycelium and asci. Primary spread is by the asciospores and secondary spread through airborne conidia.

Favorable conditions
The disease infects plants during periods of high humidity (not necessarily rain) and cool to moderate temperatures (20-21°C)

b) Loose smut
Disease symptoms
It is a seed borne disease; infection occurs during Loose Smut flowering through wind-borne spores.
The infection remains dormant inside the otherwise healthy looking seed but the plants grown from such seeds bear infected inflorescence.
At this time, infected heads emerge earlier than normal heads. The entire inflorescence is commonly affected and appears as a mass of olive-black spores, initially covered by a thin gray membrane.
Once the membrane ruptures, the head appears powdery

Survival and spread
The disease is internally seed borne, where pathogen infects the embryo in the seed.
Primary infection occurs by sowing infected seeds.

Favorable conditions
Infection is favored by cool, humid conditions during flowering period of the host plant

c) Brown rust
Disease symptoms
The most common site for symptoms is on upper leaf blades, however, sheaths, glumes and awns may occasionally become infected and exhibit symptoms.
The pustules are circular or slightly elliptical, smaller than those of stem rust, usually do not coalesce, and contain masses of orange to orange-brown Urediospores.

Pathogen over-summers in low and mid altitudes of Himalayas and Nilgiris. Primary infections develop from wind deposited urediospores in eastern Indo-gangetic plains in middle of January where it multiplies and moves westwards by March
Alternate host is Thalictrum sp.

Favorable conditions
Temperatures of 20-25° C with free moisture (rain or dew) cause epidemics. Severe infection causes up to 30 percent yield losses

d) Stripe rust /Yellow rust
Disease symptoms
Mainly occur on leaves than the leaf sheaths and stem. Bright yellow pustules (Uredia) appear on leaves at early stage of crop and pustules are arranged in linear rows as stripes.
The stripes are yellow to orange yellow. The teliospores are also arranged in long stripes and are dull black in colour.
The pustules of stripe rust, which, contain yellow to orange-yellow urediospores, usually form narrow stripes on the leaves.
Pustules also can be found on leaf sheaths, necks, and glumes.

Survival and spread
The inoculum survives in the form of uredospores /teliospores in the northern hills during off season on self sown crop or volunteer hosts, which provide an excellent source of inoculums and primary spread occur through uredospores from hills

Favorable conditions
Disease is prominent when temperature is 10-20°C and high humidity.

e) Black rust

Disease symptoms

Symptoms are produced on almost all aerial parts of the wheat plant but are most common on stem, leaf sheaths and upper and lower leaf surfaces.

Pustules (containing masses of urediospores) are dark reddish brown - occur on both sides of the leaves, on the stems, and on the spikes.

Pustules are usually separate and scattered, heavy infections -coalesce.

Prior to pustule formation, "**flecks**" may appear. Before the spore masses break through the epidermis, the infection sites feel rough to the touch.

As the spore masses break through, the surface tissues take on a ragged and torn appearance.

Survival and spread

The disease is seed and soil borne. Smut spores are viable for more than 10 years.

Primary infection occurs by sowing infected seeds or by resting spores present in the soil.

Favorable conditions

Temperature of 18-24°C.

Relative humidity 65% and above

f) Flag smut

Disease symptoms

Symptoms can be seen on stem, clum and leaves from late seedling stage to maturity.

The seedling infection leads to twisting and drooping of leaves followed by withering.

Grey to grayish black sori occurs on leaf blade and sheath. The sorus contains black powdery mass of spores.

Survival and spread

The disease is seed and soil borne. Smut spores are viable for more than 10 years.

Primary infection occurs by sowing infected seeds or by resting spores present in the soil.

Favorable conditions

Temperature of 18-24°C.

g) Hill bunt or Stinking smut

Disease symptoms

The fungus attacks seedling of 8-10 days old and become systemic and grows along the tip of shoot.

At the time of flowering hyphae concentrate in the inflorescence and spikelets and transforming the ovary into smut sorus of dark green color with masses of chlamydospores.

The diseased plants mature earlier and all the spikelets are affected.

Survival and spread

The pathogen survives in seeds and sowing such seeds are source of primary infection.

Favorable conditions

Temperature of 18-20°C.

High soil moisture.

h) Karnal bunt

Disease symptoms

Symptoms of Karnal bunt are often difficult to distinguish in the field due to the fact that incidence of infected kernels on a given head is low.

There may be some spreading of the glumes due to sorus production but it is not as extensive as that observed with common bunt.

Symptoms are most readily detected on seed after harvest.

Survival and spread

The disease is seeds borne and sowing of infected seeds is the source of primary infection.

Fabourable conditions

Temperature of 18-20°C.

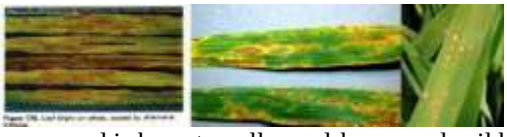
High soil moisture.

i) Leaf blight

Disease symptoms

Reddish brown oval spots appear on young seedlings with bright yellow margin. In severe cases, several spots coalesce to cause drying of leaves.

It is a complex disease, having association of A. triticina, B. sorokiniana and A. alternate.



Primary spread is by externally seed-borne and soil borne conidia. Secondary spread by air-borne conidia.

Favourable conditions
Temperature of 25°C and high relative humidity.

j) Foot rot
Disease symptoms
The disease mainly occurs in seedlings and roots and rootlets become brown in colour.
Seedlings become pale green and have stunted growth.

The disease is soil borne, pathogens survives in soil.
Primary spread occurs through soil and irrigation water.

Favorable conditions
Wet weather and high rainfall.

k) Head scab/ Fusarium leaf blotch (Snow Mold)
Leaf blotch
Disease symptoms
The blotching caused by this organism becomes evident on leaves at about late-joint to early-boot growth stage.
Young lesions occur as oval to elliptical, greyish green mottled areas, usually located where the leaf bends. The lesions enlarge rapidly, developing into large, "eyespot" blotches with bleached or light grey centers; the leaves tend to split or shred, beginning at the centers of the lesions.

Head Scab
The fungus also can cause head scab.
Symptoms of Fusarium head blight include tan or light brown lesions encompassing one or more spikelets. Some diseased spikelets may have a dark brown discoloration at the base and an orange fungal mass along the lower portion of the glume.
Grain from plants infected by Fusarium head blight is often shriveled and has a white chalky appearance.

Survival and spread
The disease is soil borne and inoculums of fungi survive in soil. Spores are produced on crop debris left on or near the soil surface. These spores are transmitted to leaves by the wind or by splashing rain.

Favourable conditions
Disease development is favored by cool, moist weather.

l) Helminthosporium leaf blotch (Spot Blotch)
Disease symptoms
Lesions caused by this disease are elongated to oval in shape and are generally a dark brown color.
As lesions mature, the centers often turn a light brown to tan color, surrounded by an irregular dark brown ring (21 on leaf; 22 on spike).
Primary infections tend to be on the lower leaves, beginning as chlorotic flecks or spots. These infection sites enlarge, turn dark brown, and often coalesce. When the disease is severe, affected leaves or leaf sheaths may die prematurely.

Survival and spread
The Disease is seed as well as soil borne and inoculums present in the seeds and soil are the source of primary infection.

Favorable conditions
Disease is prevalent in more humid and higher rainfall areas.

m) Seedling blight
Disease symptoms
This symptom is seen when ears become infected during the early flowering stages.
Later infections may result in infection of the grain but without obvious bleaching of the ears.
Fusarium lesions often begin in the leaf sheath at the stem base where crown roots split the leaf sheath when emerging. This infection can then spread up the leaf sheath causing long dark brown streaks at the stem base

The ear blight phase of the disease can cause yield loss but is most important as it can result in mycotoxin production in the grain.

Survival and spread
The most important source of Fusarium for wheat crops is the seed but the fungus can also survive on debris in the soil.

7. LIMITATIONS:

The current proposed expert system is specialized in the diagnosis of 13 wheat diseases:

Powdery mildew, Loose smut, Brown rust, Stripe rust /Yellow rust, Black rust, Flag smut, Hill bunt or Stinking smut, Karnal bunt, Leaf blight, Foot rot, Head scab/ Fusarium leaf blotch (Snow Mold), Helminthosporium leaf blotch (Spot Blotch), and Seedling blight.

8. SYSTEM EVALUATION:

As an initial evaluation, engineering students and others interested people in wheat production, farmers, and agriculture instructors tested this proposed system. They were satisfied with its performance, efficiency, user interface and ease of use.

9. CONCLUSION:

In this paper, a proposed expert system was presented for helping farmers in diagnosing disease with 13 different possible wheat diseases. Farmers can get the diagnosis faster and more accurate than the traditional diagnosis. This expert system does not need intensive training to be used; it is easy to use and has user friendly interface. It was developed using CLIPS and Delphi XE10.2 languages.

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