AIN SHAMS UNIVERSITY
INSTITUTE OF ENVERONMENTAL
STUDIES AND RESEARCH
AGRICULTURAL DEPARTMENT

EPIDEMIOLOGY OF WHEAT LEAF RUST IN EGYPT IN RELATION TO ECOLOGICAL CONDITIONS

Thesis

presented by

HODA MOHAMAD MOHAMAD DIAB

B . SC. (plant pathology),Ain Shams university, 1967

M.SC. (plant pathology),Cairo university, 1973

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SUPERVLSORS

Prof . Dr.I.S.Elewa
Prof. of plant pathology,
Fac. of Agricuiture, Ain Shams Univ.

Prof . Dr. T.A.Abdel - HaK
prof of plant pathslogy, plant path.R.S.Instit,
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بسم الله الرحمن الرحيم

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INTRODUCTION

Wheat is considered the vital resource of food energy in Egypt. The total area under wheat production in old lands was 761950 ha, while it was 65885 ha in new reclaimed areas in 1992/1993 season with an overall production of approximately 4.7 million tons* .

Under Egyptian conditions wheat plants are subjected to attack by many diseases of which rusts are considered the most serious diseases as the cause of considerable economic loss each year. About 1000 feddans in the Manzala district was completely destroyed by stripe rust in the 1967 epidemic (**Abd-El-Hak *et al.*, 1972**).

Recently, leaf rust, *Puccinia recondita* Rob. ex. Desm. f. sp. *tritici* Eriks, became important disease in Egypt due to the existence of new virulence of the causal fungus, the instability of the physiologic races characterized this rust pathogen (**Nazim *et al.*, 1976** and **Abd-El-Hak *et al.*, 1982**).

Although number of the currently used wheat cultivars are susceptible to leaf rust in terms of infection type, some of them show low rust severity when grown under different climatic conditions of the country, the development of the disease is affected by the environmental conditions. Rust appears 30-40 days earlier in lower Egypt than in the Middle Egypt and also disease severity is higher in the north of the country than in the south within the area of the cultivar-response (**Nazim, 1971** and **Kamel *et al.*, 1976**). In our studies, we are concerning the epidemiology of this disease because of their great importance, thus the effect of different meotrological factors i.e., temperature, relative

* Central Department for Agricultural Economy, 1993.

humidity, rainfall andwind speed was studied on disease occurrence and development at different localities. Such studies have our attention on some local wheat cultivars. Some wheat cultivars are attacked by leaf rust, their yield fairly well, thus tolerance or slow-rusting which characterized by reduced rate of rust development in susceptible infection type was considered in this study to put some light on the components of this type of resistance.

Induced resistance is characterized by many advantages such as non specific, systemic, has durable effect, safe for human and environment and positive effect on plant, therefore it was found desirable to study the effect of some of abiotic agents for inducing resistance to wheat leaf rust in Egypt.

REVIEW OF LITERATURE

1. Correlation between meteorological factors and wheat leaf rust

1.1. Effect of meteorological factors or epidemiology of wheat leaf rust

Petrurson (1958) on the effect of the environmental conditions during 1951 and 1955 in Canada, he found that losses in 1953 were the highest since 1935 because of the early arrival of inoculum and abnormality wet weather, while in 1954 with the late sowing, excessive rainfall and considerable influx of inoculum, the worst epidemic was recorded in Soakatchewen, the main wheat growing area in 1955, rain late sowing and arrival of abundant inoculum in Manitoba initial another epidemic.

Environmental condition is complex term that includes many factors which must be behind a minimum threshold for disease to occur. To study the interrelationship of the independent variable (biological and meteorological) with disease development, the independed variables must be limiting or fluctuating between minimum and maximum conditions necessary for disease development. A change in one environmental factor may alter the effect of other environmental factors on disease development (**Abd-el-Hak *et al.*, 1966**).

1.1.1. Wind

Abd-el-Hak *et al.*, (1966) reported that it has been long recognized that spores of wheat rusts may be carried long distances by wind. In Egypt, meteorological data indicated that throughout the year, the Libyan desert is an area of high atmospheric pressure. In winter the depression decreased continuously from Middle Egypt to the equator. In Upper Egypt, the wind is northerly. In middle and lower Egypt weather disturbances are frequent in winter, they arise chiefly from the passage of depression along the Mediterranean from West to East. In December and January, the direction is almost due West, but South of Cairo the direction in winter is northerly. Meteorological data also showed that wind below on Egypt from all directions and thus urediospores may be carried by wind to Egypt from any neighbouring country.

The same authors studied the epidemiology of wheat rusts in Egypt, they reported that wind plays an important role in primary infection of rusts. Rust spores were found in all of year months, which means that infection can take place at any time provided that environmental conditions are favourable for rust development. Wind towards Egypt from different directors but the prevalent wind was from North West. This indicate that there is a big relation between neighbouring countries in the dissemination of urediospores from one country to another and consequently rust epidemology in open country is influenced by rust development in neighboring areas.

Joshi and Palmer (1973) reported that leaf rust speed 92 and 91 meters from inoculum source in 75 and 55 days, respectively, in 1970 and 1971. Stem rust speed 22 meters from the inoculum source in 75 days and 13 meters in 66 days in 1971. Late of January and early February is the critical period for rust development in India.

Srivastava *et al.*, (1987) reported that the time needed to dislodge urediospores of the wheat pathogen *P. recondita* is depended on wind speed. The minimum wind speed at which spores are liberated was 0.5 mls lasting for

5_s spores dislodged at higher wind speed 0.5-10.0 m/s for only $2\text{-}3_s$. A linear relationship was noted between the number of uredios-pustules produced on exposed plants and the wind speed. A high R^2 positive value of 0.9645 indicates that wind speed is the major factor indeciding the number of spores liberated.

1.1.2. Temperature

Craigie (1945) found that for the growing season, the mean temperature in Western Canada to be slightly higher in rust year than in heavy rust year, but slightly lower than in medium rust year.

Abd el-Hak *et al.*, (1966) reported that there was no significant effect concerning wheat leaf rust during 1960-1963, because of the small variation in the temperature.

Lewellan *et al.*, (1967) evaluated the effect of temperature changes on the major and minor genes in wheat for resistance to *Puccinia striformis*. They found that only minor genes were affected by different temperature profiles and these gave better resistance at higher temperature profile (15-24°C) than at a lower profile (2-18°C).

Bassioni (1971) reported that leaf rust severity on wheat was correlated with the mean temperature at Sakha and Bahtim locations, but at Alexandria, there was a high correlation between rust severity and minimum temperature, a negative correlation was obtained with the maximum temperature.

Eversmeyer *et al.*, (1973) used stepwise multiple regression technique to identify meteorological and biological variables useful in explaining variation in *P. graminis tritici* severities. Estimates were made at 7, 14, 21 and 30 days. The most significant variables for prediction of stem rust estimates were number of uridiospores; wheat growth stage; maximum and minimum temperatures. Coefficient of determination (R^2) for efficient combinations of these variables were 0.745, 0.664, 0.509 and 0.362 for 7, 14, 21 and 30 days, respectively.

Cookley and Lin (1981) studied the quantitative relationships between climatic variables and stripe rust epidemics on winter wheat. They found that climatic variation at Pullman since 1958 has contributed to an increase in the frequency of epidemics and severity of stripe rust on wheat cultivars. Spring temperature were highly correlated with disease development and frequency of precipitation.

Anzalone (1985) reported that the time of onset of leaf rust of wheat varies from early December to early February. Disease progress generally slows with the onset of cooler temperature in early January and then progresses faster with the onset of warmer temperatures in early March.

Singh *et al.*, (1988) reported that when wheat cultivar WI 711 was sown in November in Ludhiana, Punjab, infection by *Puccinia recondita* appeared in March and April and the disease development appeared to be affected and correlated with disease intensity. A regression equation $Y = 15.374 - 0.7743X_1 - 0.6154X_2$, where disease intensity = Y, maximum temperature = X_1 and RH = X_2 was derived with an R^2 value of 0.7383.

Park (1990) found a regression equation relating mean temperature to infection and minimum temperature to infection identified mid to late autumn as an important period in the epidemic for yellow wheat rust.

Ash *et al.*, (1991) reported a multiple regression model incorporation weather parameters explain the seasonal variation in the severity of stripe rust under Australian conditions. The model (DS% = 11.7596X. + 1.26Y) where X =

no. days in the intercrop period when the maximum temperature fall in the range of 10-20°C.

1.1.3. Relative humidity

Abd el-Hak *et al.*, (1966) studied the effect of relative humidity on the spread of leaf rust in Egypt, it was found that this rust was abundant in most years and it seems that differences in relative humidity during the period from 1960 to 1963 had no influence on the intensity of leaf rust. In U.A.R., March is considered as the critical month for leaf rust, relative humidity during this month was ranging between 62-67% in Alexandria; between 49-55% at Giza and between 45-51% at Minia. They also reported that rainfall in Egypt during the critical months for rust infection occurs mostly during Feb., medium in March and rare in April, this may explain the non-significant relation between rainfall and infections with stem and leaf rust.

Eversmeyer *et al.*, (1988) reported that two of the primary environmental factors that influence urediospores germination and the development of infection structures in *Puccinia recondita* are temperature and free moisture, usually in the form of dew on the leaf surface. He added that in the field, all source of leaf wetness (dew, rain and fog) must be considered since they may serve equally to provide the free moisture required for germination and appressorium formation. Epidemiologically, the source of moisture is important in that temperature favourabe for dew during a clear, calm night are likely to be lower than in a cloudy night, leaf temperature well below the ambient air temperature may not be optimum for spore germination and infection.

Stuckey and Zadoks (1989) reported that seedling of susceptible wheat cv. Rubis were inoculated with *P. recondita*, they were exposed to variable periods of leaf wetness with or without 1 or more interruptions of variable duration. During the interruptions, the leaves with germlings were dry. Leaf wetness periods of 6 h resulted in 60-65% of the pustules produced with 12 or 24 h wetness periods. Interruption of a 6 h leaf wetness period by 1 h dry period was damaging to the rust germlings, greatest damage was caused when this occurred C. 3-4 h after inoculation.

Park (1990) reported that the amount of rain recorded during the study is closely associated with subsequent levels of stripe rust. The equation was Y = 36.3 -2.0X (R^2 = 0.97) where X = temperature. Based on this equation, 50% infection would be expected at 18±0.2°C and virtually no infection would occur at or above 20.8±0.2°C given a 15-h moisture period.

1.1.4. Cultivars

Ghanem, Enayat *et al.*, (1984) reported that under artificial inoculation with mixture races of *Puccinia recondita* during the period 1981-1983, wheat cultivars recorded 60S, 40S and 20S for Giza 157, they were 0, Trs and 5S for Sakha 8. However, Sakha 69 recorded Trs, Trs and Trs in growing seasons 1981, 1982 and 1983, respectively.

Rao *et al.*, (1989) reported that growth stage at disease onset and initial inoculum level affected the rate of leaf rust development and the shape of disease progress curve on cultivars. Epidemics with common onset stages and different initial inoculum levels differed in AUDPC. Regression analysis showed that yield loss was directly related to (AUDPC) when the (AUDPC) ranged from 500 to 1700 in cv. McNair 1003 and 250 to 1700 in cv. Coker 762.

El-Shamey (1991) reported that at adult stage cultivars of wheat Giza 157, Giza 162, Giza 163, Sakha 8 and Sakha 69 exhibited resistant reaction when inoculated with a mixture of leaf rust races at Sakha Station.

Sherif *et al.*, (1992) studied the behaviour of the Egyptian commercial cultivars at adult stage to leaf rust disease. They recorded that the two cultivars Sakha 8 and Gemmeiza 1 had the least values of average coefficient of infection followed by other 12 cultivars.

1.2. Effect of meteorological factors on wheat leaf rust development

1.2.1. Temperature

Chester (1942) found no infection resulted when the inoculated plants with *P. recondita* were placed in moist chambers at 27°C for 24 hours then incubated at the optimum temperature.

Urries (1954) studied the reaction of differential varieties at six different temperatures from 8 to 24°C. He found that the susceptibility to wheat leaf rust increased as the temperature was raised over 8°C.

Shenouda, Ikhlas (1969) reported that there were highly significant differences between the incubation periods of *P. recondita* at 10°C, 15°C, 20°C, 25°C and 30°C tested in Sweden. Rising the temperature up to 25°C shortened the incubation period significantly then it was lengthened again at 30°C.

Broweder (1980) studying the effect of post-inoculation temperature on the expression of resistance to leaf rust in wheat had been reported that most temperature sensitive genes, became ineffective at high temperature than at low.