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SUMMARY

The present investigation aimed to build up data on the performance of some commercial Egyptian wheat cultivars grown at different locations in Egypt. The study included determining the frequencies of virulence on *Lr* genes and gene postulation at the greenhouse conditions as well as estimating the differences in the partial resistance level of the tested cultivars under disease stress in the field. In addition to the impact of leaf rust infection on grain yield and the inheritance of genetic levels of partial resistance to wheat leaf rust.

Frequency of virulence gene(s):

To study the frequency of virulence gene(s) in the leaf rust population in Egypt during 1997/98 - 2000/01, different rust cultures were tested against a set of eleven leaf rust monogenic lines (*Lr*'s) and seven local wheat cultivars. The results obtained can be summarized as follows:-

- The frequency of virulence of isolates on lines possessing the resistance genes *Lr* 24, *Lr* 36 and *Lr* 46 were the lowest among the tested lines and should be considered in breeding for resistance.
- Shifts in virulences in the different seasons were found on most of the *Lr* genes and local varieties.

- No dramatic shifts were observed on lines carrying the genes *Lr*'s ; 12, 13, 22b, 35 and the cv. Thatcher.
- The least frequencies were found on *Lr*'s ; 24, 36 and 46. On the other hand, high virulence frequencies, more than 80%, were found with *Lr*'s ; 12, 13 and 22b, whereas, 51-72% with *Lr*'s ; 34, 35 and 37.
- Increasing in virulence frequencies was shown on all varieties except cvs. Sakha 61, Sakha 69 and Sakha 93.

Postulated genes:

The postulated genes for leaf rust resistance in the seven local wheat cultivars, revealed the presence of 5 out of 11 resistance genes. It was obvious that *Lr*'s ; 35, 37 and 46 proved to be the most frequent genes. Each was expected in 3 out of the seven wheat cultivars comprising 27.27% of the tested cultivars. *Lr* 35 (Sakha 8, Sakha 93 and Sids 1) ; *Lr* 37 (Sakha 69, Sakha 93, and Sids 1) ; *Lr* 46 (Sakha 69, Sakha 93 and Sids 1) whereas, *Lr* 12 (Sids 1) and *Lr* 13 (Sakha 93), representing 9.09% each.

On the other hand, resistance genes *Lr* 22 b, *Lr* 24, *Lr* 34, *Lr* 41 and *Lr* 45 were not detected in any of the tested wheat cultivars.

Rust response to leaf rust infection:

Six local wheat cultivars were used to study their response to leaf rust infection under natural conditions at five different

locations of Egypt for four seasons (1997/98 - 2000/01). Results can be summarized as follows:-

- No leaf rust Symptoms appeared on wheat plants before booting stage. At heading stage the disease appeared at different levels according to the location, the genotype and the prevailing leaf rust physiological races.
- All the tested cultivars were susceptible in terms of infection types showing different levels of rust severity ranging from 4.75 to 75% and being more than 50% with cvs. Sakha 69, Sakha 92, Sakha 93 and Sids 1 at El-Nubariya location.
- The highest rust severity was recorded at El-Nubariya location which can be considered the hot spot for leaf rust incidence and development. The least rust severity was recorded at Fayed, Shibin El-Kom and Sakha locations.
- The wheat cultivars Sakha 8, Sakha 69, Sakha 92 and Sakha 93 rusted at low rates (slow - rusters) during the four seasons than the cvs. Sakha 61 and Sids 1 (fast - rusters).
- Rust severity was first recorded on the fast-rusting cvs. Sakha 61 and Sids 1 and later on the partially resistant cvs. Sakha 8 and Sakha 69.

Components of partial resistance to leaf rust:

Six wheat cultivars i.e. Sakha 8, Sakha 61, Sakha 69, Sakha 92, Sakha 93 and Sids 1 were used to determine the components

of partial resistance to leaf rust under field conditions at the two locations ; Sakha and Shibin El-Kom in four growing seasons (1997/98 - 2000/01).

- Under field conditions, the values of leaf rust incidence, rust severity, final rust severity (FRS), rate of disease increase (r-value) and area under disease progress curve (AUDPC) were found to be lower in the cvs. Sakha 8 and Sakha 69 than in the cvs. Sakha 61, Sakha 92, Sakha 93 and Sids 1 under the same field conditions at the two locations during the four growing seasons.

Final rust severity (FRS):

- According to the final rust severity, the tested wheat cultivars could be classified into two main groups. The first included partially resistant cvs. Sakha 8 and Sakha 69 showing low values of FRS (less than 32.66%). The second group included the fast rusting cvs. Sakha 61 and Sids 1 (more than 62.30% FRS). The cvs. Sakha 92 and Sakha 93 could be considered as intermediates.

Rate of disease increase (r-value):

- Rate of disease increase was significantly higher at Sakha location than that at Shibin El-Kom location in most of the tested cultivars either being partially resistant or highly susceptible.

- Partially resistant cvs. exhibited lower rates of disease increase than the fast-rusting ones under the same field conditions in both locations during the four growing seasons.
- Wheat cultivars Sakha 8, Sakha 69, Sakha 92 and Sakha 93 showing lower rates of r-value, could be considered as partially resistant cultivars. Whereas, cvs. Sakha 61 and Sids 1, having the highest r-values as fast - rusting cultivars.

Area under disease progress curve (AUDPC):

- Area under disease progress curve was more accurate estimate, more sensitive criterion and more suitable parameter for estimating and measuring the leaf rust partial resistance.
- The combined data at two locations during the four growing seasons 1997/98 - 2000/01, indicated that the partially resistant cultivars Sakha 8 and Sakha 69 exhibited the lowest values of AUDPC (did not exceed up to 266.13), whereas, the fast-rusting cultivars showed the highest values (more than 597.35) under field conditions.
- The estimated values of AUDPC were higher at Sakha location than those at Shubin El-Kom.
- The two wheat cultivars Sakha 8 and Sakha 69 exhibited high level of partial resistance (slow-rusters) in all seasons and locations.
- The cvs. Sakha 92 and Sakha 93 exhibited an intermediate values of AUDPC, whereas, the cvs. Sakha 61 and Sids 1 were fast-rusters with relatively high values of AUDPC.

- AUDPC values were 222.25 and 266.3 for partially resistant (slow-rusting) cultivars Sakha 8 and Sakha 69, respectively. Whereas, it were 597.35 and 946.61 for the fast-rusting cultivars Sakha 61 and Sids 1, respectively.

Effect of leaf rust on grain yield of wheat:

- To determine the loss in yield due to leaf rust, two methods were maintained: (1) using single wheat tillers as experimental units to estimate the actual loss %. (2) measuring yield loss in protected and rust-infected plots as field experimental units.
- The two parameters spike weight and yield / plot were affected by leaf rust infection and can be used to determine the loss in yield due to leaf rust infection under the Egyptian conditions.
- Artificial inoculation depressed the grain yield of wheat in terms of spike weight of the two wheat cvs. Sakha 61 and Sids 1. Whereas, the partially resistant cvs. Sakha 8 and Sakha 69 were the least affected ones.
- According to the values of coefficient of determination (R^2), cvs. Sakha 8 and Sakha 69 which showed lower levels of actual yield loss % (0.11 and 1.89%, respectively) are considered as partially resistant wheat cultivars to leaf rust. Whereas, the cvs. Sakha 61 (3.8%) and Sids 1 (3.91%) considered as fast - rusters but tolerant to leaf rust.

- The tested cultivars showed highly significant differences in grain yield per plot. The cvs. Sakha 8 and Sakha 69 were less leaf-rusted, exhibiting significantly lower levels of actual loss % as compared with the cvs. Sakha 61 and Sids 1 having higher levels of actual loss % in grain yield.
- Combined data analysis of three years (1998/99 - 2000/01) showed that the grain yield per plot of all tested cultivars was significantly affected by rust infection. Also, the grain yield of protected plants of the tested cultivars was higher than that of the infected ones.

Inheritance of partial leaf rust resistance in some Egyptian wheat cultivars

Identifications of Adult - plant leaf rust resistance genes:

Plants of F_2 segregations from the crosses between the five wheat cultivars i.e. Sakha 8, Sakha 61, Sakha 69, Sakha 92 and Sids 1 and eight monogenic lines i.e. *Lr* 12, *Lr* 13, *Lr* 24, *Lr* 34, *Lr* 35, *Lr* 36, *Lr* 37 and *Lr* 41 were tested under field conditions with a mixture of leaf rust physiological races.

The obtained results were as follows:-

- The leaf rust resistance gene *Lr* 12 is found in cv. Sakha 8 and may be responsible for its resistance under field conditions.
- The four wheat cultivars, Sakha 8, Sakha 69, Sakha 92 and Sids 1, have the adult plant resistance gene *Lr* 13.

- The leaf rust resistance gene *Lr 24* may be responsible for resistance in the wheat cultivar Sakha 8.
- The leaf rust resistance gene *Lr 34* is identified in the three wheat cultivars ; Sakha 8, Sakha 61 and Sakha 92.
- The leaf rust resistance gene *Lr 35* is existing in cultivar Sakha 92.
- The two wheat cultivars Sakha 61 and Sakha 92 have the adult plant resistance gene *Lr 36*.
- The wheat cultivar Sakha 69 carries the resistance gene *Lr 37*.
- The adult plant resistance gene *Lr 41* is found in the wheat cultivar Sids 1 tested under field conditions.

Genetic analysis of partial resistance:

The inheritance and genetic nature of partial resistance was studied in eight parental wheat varieties and their F_1 and F_2 crosses, using the qualitative and quantitative methods of analysis. Results obtained could be summarized as follows:-

- Partial leaf rust resistance in the tested wheat cultivars is a quantitative trait (not simple), with dominance effects being more pronounced in its genetic expression.
- This type of resistance was controlled by one, two or three gene pairs in most cases at adult plant stage.
- The heritability estimates in its broad - sense were generally high (ranged from 74.04 to 97.84%). These results indicated

that the selection for partial resistance materials in the early generations, was possible, while delaying it to late ones is more effective, due to the importance role of dominance effects in the expression of this trait.