SUMMARY

Breeding studies on some barley diseases

This investigation was carried out at the Experimental Farm of Sakha Agricultural Research Station, Agricultural Research Center (ARC), Kafr El-Sheikh Governorate, during the period from 2000/2001 to 2001/ 2003.

The main objectives of this study may be defined in the following points:

1)-Studying the nature inheritance of resistance to barley powdery mildew and leaf rust diseases caused by (***Erysiphe graminis f.sp. hordei***) and (***Puccinia hordei***) respectively.

2)-Studying the nature inheritance of some agronomic traits and grain yield and its components.

(A)- Experimental design :

In 2000/2001 season, six parental genotypes consisted of three local spring barley cultivars P_1 (Giza 125), P_2 (Giza 124) and P_3 (Giza 123) were susceptible to powdery mildew and leaf rust diseases. Meanwhile, the three others parents introduced from ICARDA P_4 ($Line_1$), P_5 ($Line_2$) and P_6 (Line3) were resistance to powdery mildew and leaf rust diseases. They sown to produce hybrid seeds of the five crosses, cross 1 (Giza 125 -S X $Line_3$ –R), cross 2 (Giza 124 -S X Giza 123 –R), cross 3 (Giza 124 –S X $Line_2$ –R), cross 4 ($Line_1$ –R X $Line_2$ -R) and cross 5 ($Line_1$ –R X $Line_3$ –R).

In 2001/2002 season, the parents and their hybrid seeds of the five crosses were sown to produce the crosses of F_2 and the two back crosses (BC_1 and BC_2) .

In 2002/2003 season, all five generations of each cross [the two parents, F_1, F_2, BC_1 and BC_2] were planted in rows, 3 m long, using a randomized complete block design with three replications. The spaces between rows were 25 cm, while it was 20 cm between plants. Each plot consisted of 24 rows ($2P_1$, $2P_2$, $2F_1$, $4BC_1$, $4BC_2$ and $10F_2$). All usually and recommended culture practices were applied at proper time.

The experiment was surrounded by highly susceptible barley cultivars to powdery mildew and leaf rust as a spreader (under nature infection condition).

The data were recorded on powdery mildew and leaf rust diseases and agronomic traits and yield components grain yield/plant (gm), number of spikes/plant, number of grains/spike, grain weight /spike (gm), 1000-kernel weigh (gm), days to heading, days to maturity, Plant height (cm), biological yield (gm), and spike length (cm).

The following statistical and genetical parameters were estimated for different traits: mean, variances, standard deviation, coefficient of variability, type of gene actions, generation mean Gamble's 1962 and generation variance Mather's 1949 methods, heterosis, inbreeding depression, potence ratio, heritability estimates in narrow and broad senses and predicted genetic advance from selection, phenotypic and genotypic correlations and path coefficient analysis. Finally, the distribution ratios of nature of inheritance to resistance for powdery mildew and leaf rust diseases were estimated using chi square (X^2) test.

B-Inheritance of resistance to powdery mildew and leaf rust diseases :

1)- wide differences were detected between each parent within each cross and between the crosses themselves for the powdery mildew and leaf rust diseases resistance.

2)-the most desirable and lowest mean values for powdery mildew and leaf rust diseases were obtained from P_2 ($Line_3$), F_1, BC_1 and BC_2 in cross 1 (Giza 125 X $Line_3$); P_2 (Giza 123) and BC_2 in cross 2 (Giza 124 X Giza 123); P_2($Line_2$), F_1 and F_2 in cross 3 (Giza 124 X $Line_2$); P_1($Line_1$), F_1, F_2, BC_1 and BC_2 in cross 4 ($Line_1$ X $Line_2$) and P_1($Line_1$), P_2 ($Line_3$), F_1, F_2, BC_1 and BC_2 in cross 5 ($Line_1$ X $Line_3$).

3)-Additive, dominance and epistatic effects played an important role in the inheritance of resistance to powdery mildew and leaf rust diseases, but the additive genetic component was found to be greater in its magnitude than dominance effect in the inheritance of resistance to powdery mildew disease. While, the two genetic components (additive and dominance) exhibited equal role and had considered magnitude in the inheritance of resistance to leaf rust disease.

4)-Highly significant and negative heterotic effects relative to mid-parent were obtained from all studied crosses for powdery mildew diseases resistance. Also, highly significant and negative heterotic values were obtained for all crosses studied for leaf rust disease resistance except cross 2 (Giza 124 X Giza 123) and cross 5 (Line1 X Line3) which showed highly significant and positive heterotic effects.

5)-The estimates of heritability to powdery mildew and leaf rust diseases resistance in broad sense were approximately high in most studied crosses, indicating that the phenotypic variability was mostly attributed to genetic effects. Narrow sense heritability estimates were high and approximately equal to that of broad sense heritability in most cases, referring the importance role of additive gene effects for powdery mildew and leaf rust diseases resistance.

6)-High and desirable values of heritability in narrow and broad sense for powdery mildew diseases resistance were obtained from three

crosses, cross 1 (Giza 125 X Line3), cross 2 (Giza 124 X Giza 123) cross 2 (Giza 124 X Giza 123) and cross 3 (Giza 124 X Line2) and for leaf rust diseases resistance were obtained from cross 1 (Giza 125 X Line3) and cross 4 (Line1 X Line2). On the other hand, cross 1 (Giza 125 X Line3) and cross 3 (Giza 124 X Line2) gave high values of Δg % to powdery mildew diseases resistance, while, cross 4 (Line1 X Line2) and cross 5 (Line1 X Line3) had high values of Δg % for leaf rust diseases resistance indicating the possibility of using these crosses in barley breeding programs to improving resistance to powdery mildew and leaf rust diseases resistance.

7)- Resistance analysis using χ^2 test for powdery mildew and leaf rust diseases resistance suggested the following results:

A)- A gene or genes conferring powdery mildew resistance in P5 (Line2) and P6 (Line3) are not the same. For the first cross (Giza 125-P_1 X Line3-P_6), the result indicated resistant parent $P_6(Line_3)$ had two complementarily dominant genes for F_2 population. Meanwhile, in the test cross population, the resistant parent $P_6(Line_3)$ had single dominant gene controlling the powdery mildew resistance. Moreover, cross 3 (Giza 124-P_2 X $Line_2$-P_5) suggested that the resistant parent $P_5(Line_2)$ had one dominant gene in both F_2 and test cross population conferring powdery mildew resistance.

B)- A gene or genes conferring leaf rust resistance in P5 (Line2) and P6 (Line3) are not the same. In cross 1 (Giza 125 X $Line_3$) the result indicated the resistant parent $P_6(Line_3)$ had two complementary dominant genes conferring leaf rust resistance for F_2 population. while had two complementary recessive genes in the test cross population controlling the leaf rust resistance. In cross 3 (Giza 124 X $Line_2$), the resistance parent $P_5(Line_2)$ had single dominant gene conferring leaf rust resistance in F_2

population. While, in the test cross population the resistant parent P_5($Line_2$) had had two complementary recessive genes controlling the leaf rust resistance.

8)-In most cases the powdery mildew and leaf rust diseases were negatively correlated with grain yield/plant and some of its components like number of spikes/plant, number of grains/spike, grains weight/spikes, 1000 kernels weight and biological yield/plant, Also, it was negatively correlated with days to heading and maturity. These results mean that powdery mildew disease was not only the cause of yield reduction. also breeding for earliness might be the better way to escape disease infection.

9)-Considerable and positive direct effect was obtained between powdery mildew disease infection and each of number of spikes/plant in cross 1 (Giza 125 X $Line_3$) cross 4 ($Line_1$ X $Line_2$) and cross 5 ($Line_1$ X $Line_3$); number of grains/spike in cross 1 (Giza 125 X $Line_3$), cross 2 (Giza 124 X Giza 123), cross 4 ($Line_1$ X $Line_2$) and cross 5 ($Line_1$ X $Line_3$); days to heading in cross 2 (Giza 124 X Giza 123), cross 3 (Giza 124 X $Line_2$), cross 4 ($Line_1$ X $Line_2$) and cross 5 ($Line_1$ X $Line_3$); days to maturity in cross 1 (Giza 125 X $Line_3$), cross 2 (Giza 124 X Giza 123) and cross 4 ($Line_1$ X $Line_2$); biological yield/plant in cross 1 (Giza 125 X $Line_3$), cross 2 (Giza 124 X Giza 123), cross 4 ($Line_1$ X $Line_2$) and cross 5 ($Line_1$ X $Line_3$), spike length in cross 1 (Giza 125 X $Line_3$), cross 2 (Giza 124 X Giza 123) and cross 3 (Giza 124 X $Line_2$) and leaf rust disease in cross 2 (Giza 124 X Giza 123), cross 3 (Giza 124 X $Line_2$), cross 4 ($Line_1$ X $Line_2$) and cross 5 ($Line_1$ X $Line_3$).

10)-Considerable and positive direct effect was detected between leaf rust disease infection and each of grain yield/plant in cross 3 (Giza 124 X $Line_2$) and cross 4 ($Line_1$ X $Line_2$); number of spikes/plant in cross 2 (Giza 124 X Giza 123) and cross 4 ($Line_1$ X $Line_2$); number of

grains/spike in cross 2 (Giza 124 X Giza 123), cross 3 (Giza 124 X $Line_2$) and cross 5 ($Line_1$ X $Line_3$); 1000 kernels weight in cross 3 (Giza 124 X $Line_2$), cross 4 ($Line_1$ X $Line_2$) and cross 5 ($Line_1$ X $Line_3$); days to heading in cross 1 (Giza 125 X $Line_3$), cross 2 (Giza 124 X Giza 123), cross 3 (Giza 124 X $Line_2$) and cross 4 ($Line_1$ X $Line_2$); days to maturity in cross 1 (Giza 125 X $Line_3$), cross 3 (Giza 124 X $Line_2$) and cross 5 ($Line_1$ X $Line_3$); plant height in cross 2 (Giza 124 X Giza 123), cross 3 (Giza 124 X $Line_2$) and cross 4 ($Line_1$ X $Line_2$); spike length in cross 1 (Giza 125 X $Line_3$), cross 2 (Giza 124 X Giza 123), cross 4 ($Line_1$ X $Line_2$) and cross 5 ($Line_1$ X $Line_3$) and powdery mildew disease in all crosses.

C-Agronomic traits

1)-The highest yielding crosses were cross 2 (Giza 124 X Giza 123), cross 5 (Line1 X Line3) and cross 1 (Giza 125 X Line3) where they gave 62.39 g/plant, 50.66 g/plant and 44.94 g/plant, respectively. At the same time, the two crosses, cross 5 (Line1 X Line3) and cross 1 (Giza 125 X Line3) were resistant to powdery mildew and leaf rust diseases. Meanwhile, the lowest yield/ plant was obtained from cross 4 (Line1 X Line2) where it gave 42.75 g/plant. It was also resistant to powdery mildew and leaf rust disease.

2)-The highest values of number of spikes per plant, number of kernels per spike, grain weight per spike and 1000-kernels weight were obtained from cross 2 (Giza 124 X Giza 123), where their overall mean were 22.67 spikes, 74.40 kernels, 4.40 g/spike and 49.25 g, respectively.

3)-The earlier heading cross was cross 2 (Giza 124 X Giza 123) where its value was 85.60 days. While, the earlier maturing cross was cross 5 (Line1 X Line3) where its value was 132.10 days.

4)-The tallest genotypes were cross 1 (Giza 125 X Line3), cross 2 (Giza 124 X Giza 123) and cross 3 (Giza 124 X Line2), where their values were 137.50, 131.10 and 126.90 cm, respectively.

5)-The highest values of biological yield/plant and spike length were obtained from cross 2 (Giza 124 X Giza 123), where its values were 206.50 g/plant and 9.72 cm, respectively.

6)-From the previous results it could be concluded that the two crosses, cross 2 (Giza 124 X Giza 123) and cross 5 ($Line_1$ X $Line_3$) gave the most desirable and highest mean values in most studied traits including grain yield/plant and some of its components, where they gave 62.39 and 50.66 for grain/plant, respectively. At the same time, cross 5 ($Line_1$ X $Line_3$) was also resistant to powdery mildew it is gave low values of average infection, 22.25 for powdery mildew disease and 0.56 for leaf rust disease.

7)-The most desirable and /or significant values of most genetic effects, for grain yield /plant were detected in most crosses. While, the most desirable and significant values of additive gene effects for number of spikes/plant were defined in cross 1 (Giza 125 X Line3) and cross 3 (Giza 124 X Line2), for number of kernels/ spike in cross 5 (Line1 X Line3), for grain weight/spike in cross 1 (Giza 125 X Line3), cross 3 (Giza 124 X Line2) and cross 5 (Line1 X Line3), for 1000-kernels weight in all crosses except cross 3 (Giza 124 X Line2), for days to heading for all crosses, for days to maturity for all crosses except cross 4 (Line1 X Line2), for plant height for all crosses except cross 2 (Giza 124 X Giza 123), for biological yield/plant for all crosses except cross 4 (Line1 X Line2) and for spike length cross 2 (Giza 124 X Giza 123), cross 3 (Giza 124 X Line2) and cross 5 (Line1 X Line3).

8)-The additive, additive X additive and dominance X dominance gene effects were the most importance genetic effects controlled the inheritance of most studied traits including grain yield and some of its components. Moreover, cross 5 ($Line_1$ X $Line_3$) was the most superior cross where it had the highest amounts of all genetic effects particularly for grain yield/plant and some of its components. This cross also exhibited high and desirable mean performances in that concern.

9)-The results indicated that desirable and positively significant heterotic effects were obtained from cross 2 (Giza 124 X Giza 123) and cross 5 ($Line_1$ X $Line_3$) for grain yield/plant; cross 2 (Giza 124 X Giza 123)and cross 3 (Giza 124 X $Line_2$) for number of spikes/plant; cross 1 (Giza 125 X $Line_3$) and cross 5 ($Line_1$ X $Line_3$) for number of grains/spike; cross 2 (Giza 124 X Giza 123) cross 3 (Giza 124 X $Line_2$) cross 4 ($Line_1$ X $Line_2$) and cross 5 ($Line_1$ X $Line_3$) for grain weight/spike; cross 3 (Giza 124 X $Line_2$) for 1000 kernels weight; cross 1 (Giza 125 X $Line_3$) for towards earliness for days to heading; cross 4 ($Line_1$ X $Line_2$) for days to maturity (towards earliness); cross 1 (Giza 125 X $Line_3$), cross 2 (Giza 124 X Giza 123) and cross 5 ($Line_1$ X $Line_3$) for biological yield/plant; cross 1 (Giza 125 X $Line_3$), cross 3 (Giza 124 X $Line_2$) and cross 5 ($Line_1$ X $Line_3$) for tall plants; cross 2 (Giza 124 X Giza 123) and cross 4 ($Line_1$ X $Line_2$) for short plant, and cross 2 (Giza 124 X Giza 123) and cross 3 (Giza 124 X $Line_2$) for spike length.

10)-The two crosses, cross 2 (Giza 124 X Giza 123) and cross 5 ($Line_1$ X $Line_3$) considered the most superior crosses where they gave highly significant and positive heterotic effects for grain yield/plant, grain weight/spike and biological yield/plant.

11)-The results indicated that the importance role of both additive and dominance genetic variance components in cross 1 (Giza 125 X $Line_3$),

cross 2 (Giza 124 X Giza 123), cross 3 (Giza 124 X $Line_2$) and cross 5 ($Line_1$ X $Line_3$) for grain yield/plant. The two crosses, cross 2 (Giza 124 X Giza 123) and cross 5 ($Line_1$ X $Line_3$) gave desirable and high mean performances, gene effect values and genetic variance components besides their good resistance to the two studied diseases. Consequently, it could recommended that the two previous crosses could be used in different ways of breeding programs to improving yielding ability and resistance for the two diseases.

12)-Additive genetic variance component played the major role than dominance variance in the inheritance most of the studied traits including grain yield/plant and some of its components.

13)-Epistatic variance, i. e, type 1 and 2 were significant and important in the inheritance grain weight/spike and spike length in all studied crosses.

14)-High heritability estimates relative to narrow and broad senses were obtained from cross 1 (Giza 125 X $Line_3$), cross 4 ($Line_1$ X $Line_2$) and cross 5 (Line1 X Line3) for grain yield/plant; from cross 5 (Line1 X Line3) for number of spikes/plant; from cross 1 (Giza 125 X $Line_3$), cross 2 (Giza 124 X Giza 123) and cross 4 ($Line_1$ X $Line_2$) for number of grains/spike; from cross 4 ($Line_1$ X $Line_2$) and cross 5 (Line1 X Line3) for grain weight/spike; from cross 4 ($Line_1$ X $Line_2$) for 1000 kernels weight; from all crosses for days to heading and days to maturity; from cross 1 (Giza 125 X $Line_3$), cross 2 (Giza 124 X Giza 123) and cross 4 ($Line_1$ X $Line_2$) for plant height; from cross 1 (Giza 125 X $Line_3$) and cross 4 ($Line_1$ X $Line_2$) for biological yield/plant.

15)-Estimates of genetic advance from selection based on the F_2 means gave the highest values in the two crosses, cross 2 (Giza 124 X Giza 123) and cross 5 (Line1 X Line3). Also, the two crosses had high and

desirable performance values besides they were the most superior crosses according to their favorable genetic components particularly additive and dominance genetic variance or genetic effects. Moreover, they processed some genes responsible their resistance to the two studied diseases. Consequently, the two previous crosses may be utilized or used in barley breeding programs for improving different traits including grain yield and its components and resistance to the two studied diseases .

16)-The predicted genetic advance from selection in cross 1 (Giza 125 X Line3), cross 4 (Line1 X Line2) and cross 5 (Line1 X Line3) were 16.53%, 13.76% and 14.52% for grain yield, respectively.

17)-Most values of phenotypic and genotypic correlation coefficients were non-considerable and significant among different attributes including yield and other studied traits. Few cases, such as (rph) in cross 1 (Giza 125 X Line3) between grain yield per plant with number of spikes per plant, number of grains per spike and grain weight per spike, in cross 2 (Giza 124 X Giza 123) and cross 3 (Giza 124 X $Line_2$) between grain yield per plant with number of spikes per plant, in cross 4 ($Line_1$ X $Line_2$) and cross 5 (Line1 X Line3) between grain yield per plant with number of spikes per plant and biological yield per plant and between number of spikes per plant with biological yield per plant in cross 5 (Line1 X Line3). In these cases, the phenotypic correlation was positively significant.

18)- Number of spikes/plant had considerable and strong direct effect on grain yield/plant in all studied crosses.