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BREEDING STUDIES ON SOME BARLEY DISEASES

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ABSTRACT*: 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 and 2002/ 2003.*

The main objectives of this study were, 1)-Studying the inheritance of the resistance to barley powdery mildew and leaf rust diseases caused by (Erysiphe graminis f.sp. hordei) and (Puccinia hordei) respectively and, 2)-Studying the inheritance of some agronomic traits and grain yield and its components. The obtained results can be summarized as follows:

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 other two genetic components (additive and dominance) exhibited equal role in this concern.*
4) *Highly significant and negative heterotic effects relative to mid-parent were obtained from all the studied crosses for powdery mildew disease 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. Narrow sense heritability estimates were high and approximately equal to that of broad sense heritability in most cases.*
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) 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 improve resistance to powdery mildew and leaf rust diseases resistance.

7)In some 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, most of correlation coeofficients were not significant. Also, it was negatively correlated with days to heading and maturity in only one cross. 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.

Key Words***: powdery mildew, leaf rust, barley gene action, heterosis and heritability***

INTRODUCTION

Barley (*Hordeum vulgare* L.) is as ancient crop as the origin of agriculture itself. It is more tolerant to drought and to saline and alkaline soils than other cereals. Like other cereals it has utility as a feed and food grain, and since ancient times it has been the preferred grain in preparing malt and as a starch source for alcoholic beverages. Its largest use is for animal feed. Barley is the world's fourth most important crop.

In the United States, 50% of the total production is used for livestock fodder, 37% for the brewing industry (80% for beer, 14% distilled alcohol, 6% malt syrup). Until the sixteenth century, barley flour was used instead of wheat to make bread (Bukantis and Goodman, 1980).

In Egypt barley (*Hordeum vulgare* L.) is one of the most important winter cereal crops grown mainly in rainfed areas conditions where limited water supply is a feature such as in the Northwest Coastal region and North of Sinai, also grow over wide range of soil variability and under many diverse climatic conditions compared with many other grain crops. So, it can be grown in irrigated saline lands and poor soil conditions. It has also been grown in the newly reclaimed lands and the old ones.

Barley in Egypt is mainly used for animal feed (Both grain and straw) and bread making by Bedouins. Moreover, there is a growing interest in utilizing barley malt. Also, it is considered as a one of the highest nutrient cereal crops having high protein contents, many chemical compounds and elements that are not found in other cereals. Furthermore, it has large

amounts of dietary fibers which are important for intestinal function and lowering blood cholesterol.

Most of the Egyptian barley varieties are susceptible to many foliar diseases such as powdery mildew, rusts, net blotch, leaf stripe, covered and loose smuts. Powdery mildew (*Erysiphe graminis* f.sp. *hordei*) and leaf rust (*Puccinia hordei*) diseases are the main diseases attack barley during the growing season under Egyptian condition, causing considerable losses in yield with deleterious effect on quality of grain.

The main approach to the problem of barley diseases control is breeding for resistant cultivars, which exhibit a high level of resistance to all or to the most common physiologic races of each casual organism even under diverse climatic condition. In Egypt, few information is available about the inheritance of those diseases. Therefore, the object of this research was to study:

1) **The inheritance of barley powdery mildew *(Erysiphe graminis f.sp. hordei)* and leaf rust *(Puccinia hordei)* diseases.**
2) **The phenotypic, genotypic and path coefficients correlations between each of powdery mildew, leaf rust diseases infection and grain yield, its components and some other agronomic traits among all characters studied.**

MATERIALS AND METHODS

This study was carried out at the Experimental Farm of Sakha Agricultural Research Station, North region of Nile Delta, Kafr El-Sheikh Governorate., Agricultural Research Center (ARC), Egypt.

In 2000/2001 season, six parental genotypes consisted of three local spring barley cultivars P_1 (Giza 125), P_2 (Giza 124), P_3 (Giza 123) and three parents introduced from ICARDA P_4 ($Line_1$), P_5 ($Line_2$), P_6 ($Line_3$). They sown to produce hybrid seeds of the five crosses, namely cross 1 (Giza 125 X $Line_3$), 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 $Line_3$). The parents of crosses were chosen to covering all diseases reactions. The name, pedigree, origin, powdery mildew and leaf rust reactions of the chosen six parental genotypes are given in Table (1). In 2001/2002 season, the parents and hybrid combination seeds of F_1's were sown to produce the F_2 and their back crosses (BC_1, BC_2) and the test cross of some crosses, (cross $_1$ and cross $_3$). Reaction types of the two diseases in certain crosses combinations in different generations are presented in Table (2).

Table (1): Genotypes name, origin, pedigree and their reaction to barley powdery mildew and leaf rust diseases caused by (*Erysiphe graminis* DC f.sp. hordei) and (*Puccinia hordei*), respectively .

No.of cross	Parents	Origin	Pedigree	Reaction type of powdery mildew disease	Reaction type of leaf rust disease
1	Giza 125 (P_1)	Egypt	Giza $_{117}$/Bahteem$_{52}$//Giza$_{118}$/FAO$_{86}$	(S)	(S)
2	Giza 124 (P_2)	Egypt	Giza $_{117}$/Bahteem$_{52}$//Giza$_{118}$/FAO$_{86}$.Line366.16.2	(S)	(S)
3	Giza 123 (P_3)	Egypt	Giza $_{117}$//FAO$_{86}$	(S)	(S)
4	Line 1 (P_4)	ICARDA	Campillo Llerena/Daphne//Sen"S" CMB 87A-658-M-3M-3Y-1B-0Y	(R)	(R)
5	Line 2 (P_5)	ICARDA	Gloria"S"/Come"S"//Orge Fichedrett 3270/Row906.73 CMB 87-634C-1Y-2B-1Y-2M-0Y	(R)	(MR)
6	Line 3 (P_6)	ICARDA	Aths/Lignee686 ICB 82-0979-5AP-0AP-0AP-8AP-0TR	(MR)	(R)

* P1 to P6 refers to parents.

- Susceptible (S)
- Resistant (R)
- Moderately resistant (MR)

Table (2): Reaction types of the two diseases (powdery mildew and leaf rust) in certain crosses combinations in different generations.

No. of cross	Crosses	Reaction types to powdery mildew disease	Reaction types to leaf rust disease	Backcross (1)	Backcross (2)	Test cross
1	(P1) x (P6)	(S) X (MR)	(S) X (R)	C1 X (P1)	C1 X (P6)	F1 X (P1)
2	(P2) X (P3)	(S) X (S)	(S) X (S)	C2 X (P2)	C2 X (P3)	--
3	(P2) X (P5)	(S) X (R)	(S) X (MR)	C3 X (P2)	C3 X (P5)	F1 X (P2)
4	(P4) X (P5)	(R) X (R)	(R) X (MR)	C4 X (P4)	C4 X (P5)	--
5	(P4) X (P6)	(R) X (MR)	(R) X (R)	C5 X (P4)	C5 X (P6)	--

* P1 to P6 refers to the parents.

-(P_1)Giza 125 -(P_4) Line 1 -Susceptible (S)
-(P_2)Giza 124 -(P_5) Line 2 -Resistant (R)
-(P_3)Giza 123 -(P_6) Line 3 -Moderately resistant (MR)

In 2002/2003 season, the six populations 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 $10F_2$) in addition to two border rows. All recommended culture practices were applied at proper time.

The experiment was surrounded by highly susceptible barley cultivars to powdery mildew and leaf rust Giza 123 and Giza 126, respectively as a spreader (under nature infection condition) including powdery mildew and leaf rust diseases. Also, artificial infection with pathogen for powdery mildew and leaf rust diseases for all plants was done. Methods of preparing the pathogen for each disease was as outline by Plant Pathology Research

Institute, Barley disease Section, Agricultural Research Centre, Giza, Egypt. Concerning the two diseases, the data were recorded under the field natural infection of Sakha Agricultural Research Station.

Disease score was recorded according to Saari and Prescott (1975) as estimate of the mean percentage of leaf area covered with the fungus at growth stage 10.5 on the feek' s scale (Large,1954).Plants were rated according to the intensity of the disease on the leaf. Generally, varieties relatively free from disease (score 0) are considered immune, varieties with score (1-3) are resistance, cultivars that have been scored (4) are moderately resistant and those showed score (5-6) are moderately susceptible, while those with scores (7-8) are classed as susceptible .In addition, totally infected varieties (score 9) are reported to be very susceptible. For the inheritance studies, the field response from (0–4) considered as a resistance (R) and from (5–9) considered as susceptible one. Logarithm transformation was done for powdery mildew reaction before providing the analysis of variance.

Leaf rust data were recorded under field condition at Sakha Agric. Res. State because it is considered as a hot spot to leaf rust diseases, severity (from 0 to 100) and response according to the scale of (Peterson *et al*. 1948 and Stubbes *et al.* 1986). In this method resistance, moderately resistance, intermediate, moderately susceptible and susceptible field responses are symbolized as R, MR, M, MS and S, respectively. For the inheritance studies the field response R, MR and M will be pooled together and were considered as a resistance, while MS and S were considered as susceptible one, Stakman *et al*. (1962).

For the quantitative analysis, field response was converted into an average coefficient of the infection according to the methods of Stubbes *et al*. (1986). In this methods, an average coefficient of infection could be calculated by multiplying infection severity by assigned constant values namely, 0.2, 0.4, 0.6, 0.8, and 1.0 for R, MR, M, MS and S infection types, respectively. (For example, 5MR = 5 X 0.4 = 2.0 and so on).

In each cross, the mean and the variance were calculated for (P_1, P_2, F_1, BC_1, BC_2 and F_2) generations. The population means and variance were used to estimate the type of gene action. One tail F ratio was calculated to test the significance of F_2 variance using the following formula (Allard, 1960)

$$F = \frac{\text{Variance of } F_2}{\text{Variance of } E}$$

Where

$$E = \frac{\overline{VF_1} + \overline{VP_1} + \overline{VP_2}}{3}$$

If the F ratio was significant, the Gamble's procedure (1962) was used to estimate the components of genetic effect. When the F ratio was not

significant, it would be an indication that the variation within the F_2 generation was due to mainly environmental effects. The " t " test was used to test the significant difference between the two parents in each cross. The three nonallelic gene interaction scales A,B and C were competed together with their significancy, Mather (1949) and Hayman and Mather (1955).

Generation mean analysis were done using Gamble procedures (1962).

The two types of epistasic effects (E1 and E2) were computed according to Mather and Jinks (1971).

Heterosis was expressed as the deviation of F_1 generation from the mid-parent values, as follows:

$$\text{Heterosis}\,\% = \frac{\overline{F}_1 - \overline{MP}}{\overline{MP}} \text{ x } 100$$

To test the significance of the above estimate of heterosis, the variance of heterosis deviation was calculated as a linear function of three variances. Variances of heterosis deviation $= \overline{VF}_1 + \frac{1}{4}\overline{VP}_1 + \frac{1}{4}\overline{VP}_2$ .Inbreeding depression, potence ratio, heritability in both broad and narrow senses and expected genetic advance under selection (Δg) were calculated.

Phenotypic and genotypic correlation were estimated according to Johnson *et al. (*1966).Path coefficients analysis was done according to Singh and Chaudhary (1997).

RESULTS AND DISCUSSION

A-Inheritance of resistance to powdery mildew and leaf rust diseases.

A-1- Parental mean performance

Parental mean values of resistance to powdery mildew and leaf rust diseases in the five crosses are presented in (Table 3).

Table (3): Parental mean infection values for the five crosses for powdery mildew and leaf rust resistance diseases.

Character	Cross 1		Cross 2		Cross 3		Cross 4		Cross 5	
	P_1	P_6	P_2	P_3	P_2	P_5	P_4	P_5	P_4	P_6
Powdery mildew	70.08	32.06	60.71	66.87	58.93	18.63	8.87	7.92	17.21	34.02
Leaf rust	77.00	0.74	71.33	61.67	74.33	31.60	2.06	29.33	0.38	0.32

P_1 to P_6 refers to parents.
Giza 125 (P_1), Giza 124 (P_2), Giza 123 (P_3), Line$_1$(P_4), Line$_1$(P_5), Line$_1$(P_6).

Wide significant differences were detected in this respect for powdery mildew and leaf rust diseases resistance in most crosses studied as shown in the following parts of this study.

For powdery mildew, mean values ranged from 7.92 for P_5 (Line$_2$) to 70.08 for P_1 (Giza 125).

Respecting to leaf rust, mean values ranged from 0.32 for P_6(Line$_3$) to 77.00 for P_1 (Giza 125).

The significance differences among two parents and F_2 plants for the five crosses respecting to their resistances to powdery mildew and leaf rust diseases are presented in (Table 4). Highly significant differences among F_2 plants were detected for powdery mildew and leaf rust diseases resistance in all crosses indicated that, the variances among F_2 plants were mainly due to genetic variability and that allowed to partitioning the total genetic variance to its components.

Table (4): T-test of the differences between parents and the F-test for significant of the genetic variances among F_2 plants in the five crosses studied for powdery mildew and leaf rust resistance diseases.

Character	Cross 1		Cross 2		Cross 3		Cross 4		Cross 5	
	P_1 vs. P_6	F_2	P_2 vs. P_3	F_2	P_2 vs. P_5	F_2	P_4 vs. P	F_2	P_4 vs. P_6	F_2
Powdery mildew	**	**	**	**	**	**	ns	**	**	**
Leaf rust	**	**	**	**	**	**	**	**	ns	*

(*) and (**) significant at 0.01 and 0.05 levels of probability, respectively, (Cross 1) Giza 125 ($P_{1)}$ X Line 3 ($P_{6)}$, (Cross 2) Giza 124 ($P_{2)}$ X Giza 123 ($P_{3)}$, (Cross 3) Giza 124 ($P_{2)}$ X Line 2 ($P_{5)}$, (Cross 4) Line 1 ($P_{4)}$ X Line 2 ($P_{5)}$, (Cross 5) Line 1 ($P_{4)}$ X Line 3 ($P_{6)}$.

The results of t-test (Table 4) indicated highly significant differences between the two parents of each cross for most cases, except P_4 ($Line_1$) in cross 4 for powdery mildew disease and P_4 ($Line_1$) in cross 5 for leaf rust disease.

The types of gene action were estimated by two different methods generation means and generation variances.

A-3-a-Generation mean:

The scaling tests of the powdery mildew and leaf rust diseases are presented in (Table 5). Most values of A, B and C were significant for most crosses studied, indicating the presence of non allelic interaction in these cases.

Table (5): Scaling test parameters A, B and C for powdery mildew (P.M) and leaf rust (L.R) diseases in the five crosses studied .

Character	Cross	Scaling test		
		A	B	C
Powdery mildew	1	-21.035 **	-11.495 **	-37.942 **
	2	-7.570 **	-3.065	-21.949 **
	3	-2.936 *	24.482 **	14.011 **
	4	-0.001	4.017	18.024 **
	5	5.370 **	4.250 *	4.957
Leaf rust	1	-47.384 **	11.663 *	22.715 **
	2	13.742 **	-20.000 **	-16.475 **
	3	-27.966 **	7.098 **	-38.172 **
	4	-1.214	-9.558 **	-5.964 **
	5	0.551 *	0.393	1.264 **

(*) and (**) significant at 0.01 and 0.05 levels of probability, respectively, (Cross 1) Giza 125 ($P_{1)}$ X Line 3 ($P_{6)}$, (Cross 2) Giza 124 ($P_{2)}$ X Giza 123 ($P_{3)}$, (Cross 3) Giza 124 ($P_{2)}$ X Line 2 ($P_{5)}$, (Cross 4) Line 1 ($P_{4)}$ X Line 2 ($P_{5)}$, (Cross 5) Line 1 ($P_{4)}$ X Line 3 ($P_{6)}$.

Powdery mildew disease resistance

With respect to powdery mildew (Table 6) highly significant mean effect (m) was found for all crosses.

Significantly positive additive gene effects were detected in cross 1 (Giza 125 X $Line_3$) and cross 3 (Giza 124 X $Line_2$), but it was significant and negative in cross 2 (Giza 124 X Giza 123), cross 4 ($Line_1$X $Line_2$) and cross 5 ($Line_1$X $Line_3$). Many authors suggested the importance role of additive variance in the inheritance of this disease such as Jones and Davies (1985), Heun (1987), Zeun and Buchenauer (1991), Balkema and Mastebroek (1993), Maroof *et al.* (1994), Hanifi and Gallais (1999), Backes *et al.* (2003).

Significant negative dominance gene effects were obtained from cross 1 (Giza 125 X $Line_3$), cross 3 (Giza 124 X $Line_2$) and cross 4 ($Line_1$X $Line_2$). Similar results were obtained by Riggs *et al.* (1985), Thomas *et al.* (1988), Hossain and Sparrow (1991) and Czembor and Czembor (2001), where they found that the resistance to powdery mildew was controlled by dominant genes. Positive and non-significant dominance effects were recorded for cross 2 and cross 5.

Additive X additive epistatic effects were highly significant and positive in cross 2 (Giza 124 X Giza 123), also significant and positive in cross 3 (Giza 124 X $Line_2$), but highly significant and negative effects were detected in cross 4 ($Line_1$ X $Line_2$).

The additive X dominance epistatic effects were significant and highly significant negative in both cross 1 (Giza 125 X Line $_3$) and cross 3 (Giza 124 X $Line_2$), respectively

Dominance X dominance gene effects were found to be highly significant and positive values in cross 1 (Giza 125 X Line $_3$), on the other hand, highly significant and negative value of this effect was detected in cross 3 (Giza 124 X $Line_2$), and cross 5 ($Line_1$ X $Line_3$).

Table (6): Type of gene action estimated by generation means for powdery mildew (P.M) and leaf rust (LR) diseases in the five crosses studied.

		Gene action					
	Cross	(m)	(a)	(d)	(aa)	(ad)	(dd)
Powdery mildew	1	32.35**	14.24**	-13.06**	5.41	-4.77*	27.12**
	2	55.82**	-5.33**	6.36	11.31**	-2.25	-0.68
	3	33.60**	6.44**	-9.83**	7.54*	-13.71**	-29.08**
	4	11.16**	-1.53	-17.49**	-14.01**	-2.01	9.99
	5	25.17**	-7.85**	1.30	4.66	0.56	-14.29**
Leaf rust	1	26.08**	8.61**	-95.37	-58.44**	-29.52**	94.16
	2	63.30**	21.70**	12.05**	10.22**	16.87**	-3.96
	3	33.47**	3.83**	-2.60	17.30**	-17.53**	3.56
	4	7.11**	-9.46**	-19.00**	-4.81*	4.17**	15.58**
	5	0.77**	0.11	-0.11	-0.32	0.08	-0.62

(*) and (**) significant at 0.01 and 0.05 levels of probability, respectively, (Cross 1) Giza 125 ($P_{1)}$ X Line 3 ($P_{6)}$, (Cross 2) Giza 124 ($P_{2)}$ X Giza 123 ($P_{3)}$, (Cross 3) Giza 124 ($P_{2)}$ X Line 2 ($P_{5)}$, (Cross 4) Line 1 ($P_{4)}$ X Line 2 ($P_{5)}$, (Cross 5) Line 1 ($P_{4)}$ X Line 3 ($P_{6)}$.

Leaf rust disease resistance

With regard to resistance to leaf rust disease (Table 6), highly significant mean effect (m) was found for all crosses.

Highly significant and positive additive gene effects were detected in cross 1 (Giza 125 X Line $_3$), cross 2 (Giza 124 X Giza 123) and cross 3 (Giza 124 X Line$_2$), but it was highly significant and negative in cross 4 (Line$_1$ X Line$_2$).These results were in accordance with the findings of Walther (1990), (1991), Qi-X *et al. (*1998), and Backes *et al. (*2003), they reported the importance role of additive genetic effects in controlling this disease.

Highly significant and positive of dominance gene effects were only obtained in cross 2 (Giza 124 X Giza 123), but it was highly significant and negative in both cross 1 (Giza 125 X Line $_3$) and cross 4 (Line$_1$ X Line2). Many authors came to similar results such as Walther (1987), Steffenson (1994), Kudla (1994), Pickering *et al.* (1998), Ivandic *et al. (*1998), Brooks *et al. (*2000), Park and Karakousis (2002) and Kopahnke *et al. (*2004) where they found a dominant gene conferring resistance to leaf rust disease.

Additive X additive epistatic effects were positive and highly significant in cross 2 (Giza 124 X Giza 123) and cross 3 (Giza 124 X Line$_2$), but it was significant and negative in cross 1 (Giza 125 X Line $_3$) and cross 4 (Line$_1$ X Line$_2$). Similar results in this concern were obtained by Bjarko and Line (1988) , Das *et al.* (1992) and Yadav *et al.* (1998) in wheat, where they reported that the additive X additive genetic interaction controlling the inheritance of leaf rust resistance.

Additive X dominance epistatic effects were highly significant and positive in cross 2 (Giza 124 X Giza 123) and cross 4 (Line$_1$ X Line$_2$), but it was highly significant and negative in cross 1 (Giza 125 X Line $_3$) and cross 3 (Giza 124 X Line$_2$).

Dominance X dominance epistatic effects were highly significant and positive in cross 1 (Giza 125 X Line $_3$) and cross 4 (Line$_1$ X Line$_2$). In this respect, Yadav and Narsingh (1999) in wheat, stated that dominance X dominance was predominated complementary type of epistasis. On the other hand, Aglan (2003), Awaad *et al.* (2003) and Said (2003) in wheat, recorded the importance role of additive X additive, additive X dominance and dominance X dominance in the inheritance of leaf rust disease.

A-3-b-Heterosis, inbreeding depression and potance ratio

Heterosis percentage, inbreeding depression percent and potence ratio values together with their test of significance for powdery mildew and leaf rust diseases resistance are presented in (Table 7).

Table (7): Heterosis, inbreeding depression and potence ratio for powdery mildew(P.M) and leaf rust (LR) diseases in the five crosses studied.

Character	Cross	Heterosis	Inbreeding depression %	Potence ratio
Powdery mildew	1	-36.16**	0.77	-0.97
	2	-7.77**	5.11	1.61
	3	-44.78**	-56.90**	-0.86
	4	-41.44**	-127.04**	-7.26
	5	-13.12**	-13.12	0.40
Leaf rust	1	-95.01**	-1244.53**	-0.97
	2	2.76**	7.37	0.38
	3	-37.57**	-1.23	-0.93
	4	-90.44**	-373.82**	1.04
	5	60.00**	-37.67**	7.00

(*) and (**) significant at 0.01 and 0.05 levels of probability, respectively, (ns) non- significant, (Cross 1) Giza 125 (P_1) X $Line_3$ (P_6), (Cross 2) Giza 124 (P_2) X Giza 123 (P_3), (Cross 3) Giza 124 (P_2) X $Line_2$ (P_5), (Cross 4) $Line_1$ (P_4) X $Line_2$ (P_5), (Cross 5) $Line_1$ (P_4) X $Line_3$ (P_6).

Powdery mildew disease resistance

Highly significant and negative heterotic values relative to mid-parent were obtained from all crosses studied. Similar results were obtained by Hussein *et al.* (1983). Heterosis in F_1 reached to (28.3%) above the high resistant parent. Heun (1987), found significant varietal heterosis effects and Eid (1998), in diallel crosses found heterotic effects of powdery mildew disease relative to mid and better parents under four nitrogen treatments.

For inbreeding depression, highly significant and negative values were detected for cross 3 (Giza 124 X $Line_2$) and cross 4 ($Line_1$ X $Line_2$). Non-significant values were obtained from cross 1 (Giza 125 X $Line_3$), cross 2 (Giza 124 X Giza 123) and cross 5 ($Line_1$ X $Line_3$). Significant effects for both heterosis and inbreeding depression were associated for the crosses 3 (Giza 124 X $Line_2$) and cross 4 ($Line_1$ X $Line_2$), consequently the expression of heterosis in F_1 was following by considerable reduction in F_2 performance.

Potence ratio was exceeding unity in cross 2 (Giza 124 X Giza 123) and cross 4 ($Line_1$ X $Line_2$) indicating the existence of over dominance in this respect Maroof *et al. (*1994) found in a set of 28 F1, that dominance effects were important and even overdominance is likely to be present at a number of loci.

Values of potence ratio were less than unity in cross 1 (Giza 125 X Line $_3$), cross 3 (Giza 124 X $Line_2$) and cross 5 ($Line_1$ X $Line_3$), indicating partial dominance in these cases. In this respect, Hussein *et al.* (1983), studied four varieties of barley, to powdery mildew resistance, results indicated that the ratios of average dominance were in the range of partial dominance.

Leaf rust disease resistance

Highly significant and negative heterotic effects relative to mid-parent were detected in all crosses except cross 2 (Giza 124 X Giza 123) and cross 5 ($Line_1$ X $Line_3$) which showed highly significant and positive values (Table 7).

Inbreeding depression estimates were highly significant and negative in all crosses except cross 2 (Giza 124 X Giza 123) and cross 3 (Giza 124 X $Line_2$). Significant effects for both heterosis and inbreeding depression were associated for the cross 1 (Giza 125 X $Line_3$), cross 4 ($Line_1$ X $Line_2$) and cross 5 ($Line_1$ X $Line_3$). In these cases, the expression of heterosis in F1 followed by considerable reduction in F2 performance which is logic and expected.

Potence ratio exceeding unity in cross 4 ($Line_1$ X $Line_2$) and cross 5 ($Line_1$ X $Line_3$) this result indicated the existence of overdominance effect in this respect. While, potence ratios were less than unity in the other crosses, indicated partial dominance effect was existed. In this respect, Walther (1987) recorded partial dominance for some few genes. While, Jin-Y *et al.* (1996) recorded incomplete and complete dominance effects in some studied barley genotypes.

Generally, highly significant and negative considerable heterotic effects were detected for powdery mildew disease resistance in all crosses, also highly significant and negative considerable heterotic effects for leaf rust disease resistance were detected in most crosses except cross 2 (Giza 124 X Giza 123) and cross 5 ($Line_1$ X $Line_3$). They had highly significant and positive considerable heterotic effects for leaf rust disease resistance. Moreover, overdominance and dominance ranges were more frequented for powdery mildew and leaf rust diseases resistance.

A-3-d- Heritability estimates and predicted genetic advance from selection:

Heritability estimates in both broad and narrow sense and expected genetic advanced for powdery mildew and leaf rust diseases resistance are presented in (Table 8).

Powdery mildew disease resistance:

Regarding to powdery mildew disease resistance, heritability estimates in broad sense were moderate to high with values ranged from 45.70 for cross 4 ($Line_1$ X $Line_2$) to 79.57 for cross 1 (Giza 125 X Line $_3$). Also, narrow senses estimated values varied from moderate to high, the values of narrow sense ranged from 40.29 for cross 2 (Giza 124 X Giza 123) to 70.72 for cross 1 (Giza 125 X Line $_3$). Many authors came to similar results such as Hussein *et al.* (1983), who studied four varieties of barley, i.e; Giza $_{117,}$ Sahrawi, Emir and Wing in 4X4 diallel crosses to study powdery mildew resistance in barley. The results indicated that heritability estimates were 73% and 83% in the narrow sense and 99% and 87% in the broad sense, respectively and Backes *et al.* (1995), showed that the heritability in narrow sense reached to 56% for this trait.

Table (8): Heretability percentage in broad (h^2b) and narrow (h^2n) sences and expected genetic advance from selection (Δg) for powdery mildew (P.M) and leaf rust (LR) diseases in the five crosses studied .

Character	Cross	Heritability Percentage		Expected genetic advance	
		h^2(b)	h^2(n)	Δg	Δg%
Powdery mildew	1	79.57	70.72	15.91	13.34
	2	72.52	40.29	6.71	10.27
	3	70.66	58.79	8.76	16.75
	4	45.70	45.15	13.32	8.67
	5	47.80	45.50	7.08	12.40
Leaf rust	1	92.73	75.86	16.47	14.82
	2	57.40	39.42	5.16	12.82
	3	58.56	50.28	6.35	16.89
	4	76.80	70.75	18.14	41.59
	5	43.92	16.82	0.29	41.25

(*) and (**) significant at 0.01 and 0.05 levels of probability, respectively, (ns) non- significant, (Cross 1) Giza 125 (P_1) X $Line_3$ (P_6), (Cross 2) Giza 124 (P_2) X Giza 123 (P_3), (Cross 3) Giza 124 (P_2) X $Line_2$ (P_5), (Cross 4) $Line_1$ (P_4) X $Line_2$ (P_5), (Cross 5) $Line_1$ (P_4) X $Line_3$ (P_6).

Estimates of the genetic advance from selection (Δg) ranged from 7.08 for cross 5 ($Line_1$ X $Line_3$) to 15.91 for cross 1 (Giza 125 X $Line_3$), estimates of predicted genetic advance from selection as percentage of F_2 mean (Δg %) ranged from 8.67% for cross 4 ($Line_1$ X $Line_2$) to 16.75% for cross 3 (Giza 124 X $Line_2$).

As previously shown, cross 3 (Giza 124 X $Line_2$) and cross 1 (Giza 125 X $Line_3$) were the best crosses based on most statistical and genetical parameters studied. They may be used in barley breeding program for improving resistance to powdery mildew disease.

Leaf rust disease resistance

With respect to leaf rust disease resistance, heritability estimates were low to high in broad sense with values ranged from 43.92 for cross 5 ($Line_1$ X $Line_3$) to 92.73 for cross 1 (Giza 125 X $Line_3$). Walther *et al. (*2000), found in results for the transfer of new resistances against leaf rust (*Puccinia hordei*) from Hordeum bulbosum into winter barley, that resistance to pathogens proved to be stable and of good heritability, with differences occurring which depended on the combinations used.

Narrow sense heritability estimates were low to high with values ranged from 16.82 for cross 5 ($Line_1$ X $Line_3$) to 75.86 for cross 4 (G125 X $Line_3$). Jacobs and Broers (1989) found heritability estimates in broad sense ranged from 59% to 90%. Das *et al.* (1992) in wheat, found that heritability estimates

ranged from 45.7% for cross Sonoita 81 X Tanager "s" to 92.2 %for cross Yecora 7oX Galvez 87. Modan *et al.* (1992) in wheat, reported that the narrow-sense heritability varied from 45 to 92%. Said (2003) in wheat, found high heritability estimates in broad and narrow senses for leaf rust disease resistance. These results were partially contrasted with our results. It may be due to estimation methods of heritability and the environmental conditions

Regarding to estimates of the genetic advance from selection (Δg). It ranged from 0.29 for cross 5 ($Line_1$ X $Line_3$) to 18.14 for cross 4 ($Line_1$ X $Line_2$). The predicted genetic advance from selection as percentage of F_2 mean (Δg%) ranged from 12.82% for cross 2 (Giza 124 X Giza 123) to 41.59% for cross 4 ($Line_1$ X $Line_2$).

Generally, the estimates of heritability in broad sense were approximately high and moderate in most crosses studied, indicating the phenotypic variability was mostly attributed to genetic effects. The cross 1 (Giza 125 X $Line_3$), cross 3 (Giza 124 X $Line_2$) and cross 4 ($Line_1$ X $Line_2$) gave the highest and desirable values of heritability in narrow and broad sense for the powdery mildew and leaf rust diseases resistance. Also, the three crosses gave the highly desirable values of the expected genetic advance from selection (Δg%). At the same time, most of the previous crosses exhibited desirable mean performance values and genetic variance components (Tables 3 and 8).

A-3-f-Correlation coefficients:

Estimates of phenotypic (rph) and genotypic (rg) correlation coefficients among powdery mildew, leaf rust diseases and the other studied traits for all crosses are presented in (Table 9a, 9b, 9c, 9d and 9e).

In general, in most cases there were no considerable and significant phenotypic and genotypic correlation coefficients found between powdery mildew, leaf rust diseases and some studied traits. In the other words, most of the sex coefficients were not valuable or had non-predictable values applying selection procedures when selection procedures will be applied in future.

The obtained data of these coefficients could be summarized in the following points:

1- The phenotypic correlation coefficients for powdery mildew disease were considered and significant with grain yield /plant (rph = -0.155*) in cross 1 (Giza 125 X $Line_3$), with biological yield/plant (rph = 0.181*) in cross 2 (Giza 124 X Giza 123), with number of grains/spike (rph = -0.182*) in cross 3 (Giza 124 X Line $_2$) and with days to maturity (rph = -0.144*) in cross 5 ($Line_1$ X $Line_3$).

2-The genotypic correlation coefficients were not significant between powdery mildew with grain yield /plant (rg = -0.217), grain weight/spike (rg = -0.273) and spike length (rg = -0.202) in cross 1 (Giza 125 X $Line_3$), with 1000 kernels weight (rg = 0.144), days to heading (rg = 0.200), plant height (rg = 0.257) and biological yield/plant (rg = 0.563) in cross 2 (Giza 124 X

Giza 123), with number of spikes/plant (rg = -0.241), number of grains/spike (rg = -0.245) and plant height (rg = -0.195) in cross 3 (Giza 124 X Line $_2$), with number of spikes/plant (rg = 0.310), days to maturity (rg = 0.133) and biological yield/plant (rg = 0.259) in cross 4 (Line$_1$ X Line$_2$), and with number of spikes/plant (rg = 0.570), grain weight/spike (rg = 0.196) and days to maturity (rg = -0.196) and plant height (rg = -0.156) in cross 5 (Line$_1$ X Line$_3$).

3-The phenotypic correlation coefficients for leaf rust disease were significant with days to heading (rph = 0.211) and plant height (rph = -0.151*) in cross 1 (Giza 125 X Line$_3$) and with number of spikes/plant (rph = 0.149*), grain weight/spike (rph = 0.157*) and biological yield/plant (rph = 0.182*) in cross 5 (Line$_1$ X Line$_3$).**

4-The genotypic correlation coefficients for leaf rust disease were not significant between leaf rust with grain weight/spike (rg = 0.216), days to heading (rg = 0.262), and plant height (rg = -0.185) in cross 1 (Giza 125 X Line$_3$), with number of spikes/plant (rg = 0.260), number of grains/spike (rg = -0.192)), days to heading (rg = -0.267), plant height (rg = -0.572), biological yield/plant (rg = 0.421) and spike length (rg = 0.245) in cross 2 (Giza 124 X Giza 123), with grain weight/spike (rg = 0.175) and days to heading (rg = 0.113) in cross 3 (Giza 124 X Line $_2$), with number of spikes/plant (rg = -0.191), plant height (rg = -0.196) and biological yield/plant (rg = 0.306) in cross 4 (Line$_1$ X Line$_2$) and with grain yield /plant (rg = -0.278), grain weight/spike (rg = 0.406), 1000 kernels weight (rg = 0.206), days to heading (rg = 0.416), plant height (rg = -0.374) and biological yield/plant (rg = 0.387) and spike length (rg = 0.339) in cross 5 (Line$_1$ X Line$_3$).

Generally, as previously shown 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, most of correlation coefficient were not significant. Also, it was negatively correlated with days to heading and maturity in only one cross. 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.

Table (9 a): Phenotypic (rph) and genotypic (rg) correlation coefficients among the powdery mildew and leaf rust diseases and the other studied traits for cross 1 (Giza 125 X Line 3).

Characters	Powdery mildew		Leaf rust	
	(rph)	(rg)	(rph)	(rg)
Grain yield/plant	-0.155*	-0.217	-0.021	-0.023
No. of spikes/plant	-0.065	-0.010	-0.002	0.050
No. of grains/spike	0.081	0.124	-0.035	-0.048
Grain weight/spike	-0.084	-0.273	0.130	0.216
1000 kernels weight	-0.013	-0.014	-0.002	0.048
Days to heading	-0.087	-0.047	0.211**	0.262
Days to maturity	0.068	0.057	0.086	0.080
Plant height	-0.054	-0.042	-0.151*	-0.185
Biological yield/plant	0.036	-0.008	-0.119	-0.134
Spike length	0.047	-0.202	0.086	0.112
Powdery mildew	--	--	-0.019	-0.024
Leaf rust	--	--	--	--

Phenotypic correlation (rph), genotypic correlation (rg) correlation.
*,** Significant at 0.05 and 0.01 levels of probability, respectively.

Table (9 b): Phenotypic (rph) and genotypic (rg) correlation coefficients among the powdery mildew and leaf rust diseases and the other studied traits for cross 2 (Giza 124 X Giza 123).

Characters	Powdery mildew		Leaf rust	
	(rph)	(rg)	(rph)	(rg)
Grain yield/plant	-0.106	-0.131	-0.017	-0.068
No. of spikes/plant	0.067	0.064	0.029	0.260
No. of grains/spike	-0.039	-0.021	-0.095	-0.192
Grain weight/spike	-0.047	-0.008	-0.090	-0.121
1000 kernels weight	0.105	0.144	0.006	0.071
Days to heading	0.066	0.200	-0.044	-0.267
Days to maturity	0.007	0.024	0.057	0.083
Plant height	0.031	0.257	-0.045	-0.572
Biological yield/plant	0.181*	0.563	0.045	0.421
Spike length	0.000	0.000	0.045	0.245
powdery mildew	--	--	0.000	0.000
Leaf rust	--	--	--	--

Phenotypic correlation (rph), genotypic correlation (rg) correlation.
*,** Significant at 0.05 and 0.01 levels of probability, respectively.

Table (9 c): Phenotypic (rph)and genotypic (rg) correlation coefficients among the powdery mildew and leaf rust diseases and the other studied traits for cross 3 (Giza 124 X Line 2).

Characters	Powdery mildew		Leaf rust	
	(rph)	(rg)	(rph)	(rg)
Grain yield/plant	-0.052	-0.039	-0.072	-0.062
No. of spikes/plant	-0.101	-0.241	0.008	-0.042
No. of grains/spike	-0.182*	-0.245	-0.087	-0.081
Grain weight/spike	-0.102	-0.063	0.032	0.175
1000 kernels weight	-0.008	0.007	0.078	0.138
Days to heading	-0.006	-0.035	0.045	0.113
Days to maturity	0.032	0.043	0.060	0.099
Plant height	-0.106	-0.195	-0.037	-0.033
Biological yield/plant	-0.044	0.044	-0.054	-0.032
Spike length	0.000	0.000	0.029	-0.087
powdery mildew	--	--	0.000	0.000
Leaf rust	--	--	--	--

Phenotypic correlation (rph), genotypic correlation (rg) correlation.
***,** Significant at 0.05 and 0.01 levels of probability, respectively.**

Table (9 d): Phenotypic (rph)and genotypic (rg) correlation coefficients among the powdery mildew and leaf rust diseases and the other studied traits for cross 4 (Line1 X Line2).

Characters	Powdery mildew		Leaf rust	
	(rph)	(rg)	(rph)	(rg)
Grain yield/plant	0.081	0.055	-0.039	-0.062
No. of spikes/plant	0.077	0.310	-0.068	-0.191
No. of grains/spike	0.015	0.043	0.036	-0.121
Grain weight/spike	0.043	0.011	0.077	0.063
1000 kernels weight	0.060	0.092	0.022	0.022
Days to heading	0.040	0.017	-0.017	0.004
Days to maturity	0.012	0.133	0.024	0.052
Plant height	0.061	-0.065	-0.070	-0.196
Biological yield/plant	0.013	0.259	0.059	0.306
Spike length	0.000	0.000	0.078	-0.012
powdery mildew	--	--	0.000	0.000
Leaf rust	--	--	--	--

Phenotypic correlation (rph), genotypic correlation (rg) correlation.
***,** Significant at 0.05 and 0.01 levels of probability, respectively.**

Table (9 e): Phenotypic (rph) and genotypic (rg) correlation coefficients among the powdery mildew and leaf rust diseases and the other studied traits for cross 5 (Line 1 X Line 3).

Characters	Powdery mildew		Leaf rust	
	(rph)	(rg)	(rph)	(rg)
Grain yield/plant	-0.017	0.069	-0.033	-0.278
No. of spikes/plant	0.070	0.570	0.149*	-0.021
No. of grains/spike	-0.047	-0.036	-0.028	0.036
Grain weight/spike	0.003	0.196	0.157**	0.406
1000 kernels weight	0.053	0.042	-0.055	-0.206
Days to heading	-0.027	-0.079	0.029	0.419
Days to maturity	-0.144*	-0.196	-0.005	-0.109
Plant height	0.036	0.156	-0.070	-0.374
Biological yield/plant	-0.004	-0128	0.182**	0.387
Spike length	0.000	0.000	0.031	0.339
Powdery mildew	--	--	0.000	0.000
Leaf rust	--	--	--	--

Phenotypic correlation (rph), genotypic correlation (rg) correlation.
*,** Significant at 0.05 and 0.01 levels of probability, respectively.

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دراسات في التربية على بعض أمراض الشعير

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(٢) قسم بحوث الشعير . محطة بحوث سخا معهد بحوث المحاصيل الحقلية

الملخص العربى

هذا البحث تم إجراءه فى مزرعة معهد البحوث الزراعية . مركز البحوث الزراعية . كفرالشيخ خلال موسمى الزراعة ٢٠٠٠/٢٠٠١م ، ٢٠٠١/٢٠٠٢م بهدف :.

١- دراسة سلوك صفة المقاومة للبياض الدقيقى وصداء الأوراق.

٢- دراسة سلوك بعض الصفات المحصولية ومحصول الحبوب ومكوناته.

تم قراءة نسبة الإصابة وكل من مرض البياض الدقيقى وصداء الأوراق محصول الحبوب/نبات ، عدد السنابل/نبات ، عدد الحبوب السنبلة وزن حبوب السنبلة وزن ١٠٠٠ حبة، تاريخ التزهير وتاريخ النضج، طول النبات، محصول الحبوب، والقش/نبات، طول السنبلة.

ويمكن إيجاز أهم النتائج فيما يلي:.

١- لوحظ وجود اختلافات كبيرة ومعنوية بين كل الأباء الداخلة فى الدراسة والهجن الناتجة منها فى كل الثوابت الإحصائية المدروسة.

٢- أعطى الهجن الأول (جـ ١٢٥ × سلالة ٣) والرابع (سلالة ١ × سلالة ٢) والخامس (سلالة ١ × سلالة ٢) أقل المتوسطات بالنسبه لكل من البياض الدقيقى وصداء الأوراق.

٣- كان لكل من التأثير الجينى المضيف والسيادى والتفوق دور هام فى وراثة صفةى المقاومة لمرض البياض الدقيقى وصداء الأوراق ، أما الفعل الجينى المضيف كان أكبر من حيث أهمية عن الفعل الجينى السيادى فى وراثة صفة المقاومة عرض البياض الدقيقى.

فى حين تساوت أهمية كل من الفعل الجينى المضيف والسيادى فى وراثة المقاومة لمرض صداء الأوراق.

٤- قوة الهجين كانت عالية المعنوية وسالبة لمرض البياض الدقيقى فى كل الهجن وكانت عالية وسالبة لمرض صداء الأوراق فى كل الهجن ماعدا الهجن النباتى (جـ ١٢٣ × جـ ١٢٤) والخامس (سلالة ١ × سلالة ٣) حيث كانت عالية وموجبة.

٥- أعطت بعض الهجن قيما عالية مرغوبة لكل من الكفاءة الوراثية بمعناها الواسع والضيق لمقاومة البياض الدقيقى وصداء الأوراق وهى الهجن الأول (جـ ١٢٥ × سلالة ٣) والثانى (جـ ١٢٣ × جـ ١٢٤) والثالث (جـ ١٢٤ × سلالة ٢) لمقاومة البياض الدقيقى بينما الهجن الأولى (جـ ١٢٥ × سلالة ٣) والرابع (سلالة ١ × سلالة ٢) لمقانمة صدأ الأوراق فى حين أعطى الهجين الثانى (جـ ١٢٣ × جـ ١٢٤) مرغوبة ومتوسطة بالنسبه للتحسين الوراثى الراجع للانتخاب.

٦- اختلاف صفات المقاومة لمرض البياض الدقيقى فى كل من (سلالة ٢) و (سلالة ٣) فقد دلت النتائج أن (سلالة ٣) فى الهجين الأول (جـ ١٢٥ × سلالة ٣) من المحتمل أن تحمل زوج من الجينات المكملة السائدة فى طبيعتها لمقاومة مرض البياض الدقيقى فى F_2. بينما تحمل جين مفرد سائد فى عشيرة الـ Test Cross بينما حازت سلالة ٢ فى الهجين ٣ (جـ ١٢٤ × سلالة ٢) على زوج من الجينات السائدة لمقاومة مرض البياض الدقيقى فى كلا من الجيل الثانى وعشيرة الـ Test Cross.

٧- اختلاف جين أو جينات المقاومة لمرض صداء الأوراق فى كل من (سلالة ٢) و (سلالة ٣) حيث حازت سلالة ٣ فى الهجين الأول (جـ ١٢٥ × سلالة ٣) على زوج من الجينات المكملة السائدة فى طبيعتها لمقاومة صدأ الأوراق فى F_2 فى حين حازت عشيرة Test Cross على زوج من الجينات المكملة المنتخبة ، بينما حازت (سلالة ٢) فى الهجين الثالث (جـ ١٢٤ × سلالة ٢) على جين مفرد سائد فى الجيل الثانى بينما حازت على زوج من الجينات المكملة المنتخبة فى عشيرة الـ Test Cross لصفة المقاومة لمرض صداء الأوراق.

٨- فى معظم حالات أمراض البياض الدقيقى وصداء الأوراق كان الارتباط سالب بمحصول الحبوب/نبات وبعض مكوناته مثل عدد السنيبلات/نبات ، عدد الحبوب/سنبلة ، وزن حبوب/السنبلة ، وزن ١٠٠٠ حبة والمحصول البيولوجى/نبات أيضا كان سالب الارتباط مع عدد أيام الطرد للسنابل والنضج.

هذه النتائج تشير أن مرض البياض الدقيقى لم يكن السبب الوحيد لنقص المحصول ، أيضا التربية للتبكير ممكن يكون الطريق الأفضل للهروب من الإصابة بالأمراض وذلك فى بعض الحالات المدروسة.