# INHERITANCE AND NATURE OF RESISTANCE TO DOWNY MILDEW DISEASE IN CUCUMBER (*Cucumis sativus* L.)

**By**

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## ABSTRACT

The inbred lines of cucumber (***Cucumis sativus*** L.) $TX_{300}$, $TX_{301}$, $TX_{303}$ and $TX_{306}$ (susceptible to downy mildew) were crossed separately as female parents ($P_1$ ) with $TX_{302}$ (resistant to downy mildew) as male parent ($P_2$ ). Some characters of growth and yield components in relation to resistance to downy mildew in plant populations of the parents, $F_1$, $F_2$ and backcrosses to both parents were evaluated.

Results indicated that two pairs of dominant and recessive interaction genes controlled resistance to downy mildew disease. Susceptibility was dominant over resistance and the resistant dominant gene "R" expressed itself only in the presence of the recessive gene "s". Leaf area, number of days from planting to the first male or female flower anthesis, yield/plant, sex ratio and set percentage were found to be inherited quantitatively. The nature of dominance for some components of resistance to downy mildew disease of cucumber caused by ***Pseudoperonospora cubensis*** (Berk and Curtis) Rostovzen ranged from partial dominance to over dominance in the different cross. Evaluating resistance by different criteria showed that, the broad and narrow sense heritability for resistance ranged from low to above intermediate and high in the different crosses.

The leaves of resistant male parent ($TX_{302}$) contained higher phenols (free, conjugated and total phenols) and lower sugars (reducing, non-reducing and total sugars) contents than any of the susceptible female parents ($TX_{300}$, $TX_{301}$, $TX_{303}$ and $TX_{306}$). Highly significant positive correlation was detected between disease resistance and each of leaf area, number of days from planting to the first female flower anthesis and sex ratio. Meanwhile, it was negatively correlated with both fruit weight and yield/plant. Highly significant correlation was also detected between yield/plant and each of leaf area, number of days from planting to the first male or female flower anthesis, disease resistance, sex ratio and set percentage.

## INTRODUCTION

Cucumber (***Cucumis sativus*** L.) is one of the most popular and favorite vegetable crops in different parts of the world. It is used either as fresh fruits or in pickling industry. In Egypt, the cultivated area during the last few years tended to be decreased as a result of the increase in downy mildew disease (Abd-El-Hafez *et al.*, 1990). The efficient method for controlling such disease is through using resistant cultivars suitable for the environmental conditions in Egypt with high fruit quality. Fletcher (1992) found that the need for genetic resistance would increase with the further reduction in the limits on pesticide use and an increasing public awareness and importance of pesticide pollution.

Downy mildew caused by ***Pseudoperonospora cubensis*** (Berk and Curtis) Rostovzen is one of the most destructive diseases which causes considerable losses in cucurbit crops in many regions of the world (Palti and Cohen, 1980; Lehman, 1991; St-Amand and Wehner, 1991; Tsai *et al.*, 1992).

Mahajan and Gill (1993) reported that disease rating was negatively correlated with net weight, growth weight, number of leaves and leaf size index. Path analysis indicated that the direct effect of growth weight on disease rating was very high in a negative direction. Also, Dhiman *et al.* (1995) found that the occurrence of downy mildew had a positive and significant correlation with days to first picking during 1990, as well as with its pooled values over three years. Neikov and Alexandrove (1995) reported that yield had a significant positive correlation with fruit number and weight and significantly negative correlation with percentage infection with downy mildew. The true leaf area was significantly correlated with length of petioles, internodes on the main stem and lateral branches. In neither case leaf size was correlated with fruiting potential ( Mizusawa *et al.*, 1996), while yield per plant had strong positive association with main vein length, number of secondary branches, leaf area, fruiting percentage, number of fruits per plant, fruit weight and fruit length both at genotypic and phenotypic levels (Saikia *et al.*, 1995 ; Paiva ,1997).

The mode of inheritance of downy mildew disease resistance in cucumber plants was extensively investigated. Abd-El-Hafez *et al.* (1990) mentioned that resistance to downy mildew in cucumber plants is controlled by two pairs of dominant and recessive interaction genes (13 susceptible

: 3 resistant). Meanwhile, Angelov (1995) found that the inheritance of ***P. cubensis*** resistance in lines 5-1-1 and 5-1-2-2 proved to be dominant.

Chemical constituents of cucumber plants, *i.e.,* total phenols and sugars (reducing, non-reducing and total) varies between resistance and susceptible plants to downy mildew (Helal *et al.,* 1978; Jindal *et al.,* 1979; Merghany, 1989 on mellon; Abd El Hafez *et al.,* 1990 ; Fang *et al.,* 1994). Abd El Hafez et al. (1990) found a negative strong correlation between the degree of susceptibility and total phenols and strong positive correlation between the degree of infection and soluble and non-soluble sugars.

The objectives of this research were to study the inheritance of resistance to downy mildew in cucumber plants and reveal the nature of resistance. Such information is important when designing a breeding program for developing cultivars that are resistant to downy mildew.

## MATERIALS AND METHODS

This study was conducted at the Experimental Farm of the Faculty of Agriculture, Moshtohor, Zagazig University. Seeds of five parental cucumber lines were planted in the field in the summer season of 1995. The seeds of the five cucumber lines were obtained from the National Germplasm Resources Laboratory, Beltsville, U.S.A. Four inbred lines, *i.e.*, $TX_{300}$, $TX_{301}$, $TX_{303}$ and $TX_{306}$ (susceptible to downy mildew disease) were crossed as female parents ($P_{1i}$) with male ($P_{2i}$) inbred line $TX_{302}$ (resistant to downy mildew diseases) to obtain F1 seeds.

The parental seeds as well as the $F_1$ seeds of the crosses $TX_{300}$ X $TX_{302}$, $TX_{301}$ X $TX_{302}$, $TX_{303}$ X $TX_{302}$, and $TX_{306}$ X $TX_{302}$ were produced and stored in the refrigerator in sealed bottles under temperature of 7± 3C°, to the next season.

On April 8$^{th}$ , 1996, part of the stored seeds of the parental lines and $F_1$ hybrids were planted in the field. The $F_1$ plants for each cross were divided into two groups. The first group were selfed to obtain $F_2$ seeds; while plants of the second one were backcrossed to each parental line to obtain the seeds of both $Bc_1$ and $Bc_2$.

On April, 6, 1997, seeds of the parental lines, $F_1$, $F_2$, $Bc_1$ and $Bc_2$ were planted in the field. The field experiment was performed in a randomized complete block design with three replicates. Each replicate contained 10 plants from each parental line and $F_1$ hybrid, 40 plants from each $F_2$ and 20 plants from each backcross. Seeds were planted on one side of the ridges 1.0 m wide and 3.0 m long with one seed per hill, 30 cm a part.

All cultural practices, *i.e.*, irrigation and fertilization were practiced as commonly followed. The grown plants were exposed to natural infection with downy mildew without using any fungicides for disease control, where the prevailing disease naturally occurs.

**Disease assessment:**

Each individual plant in the populations of $P_1$, $P_2$, $F_1$, $F_2$, $Bc_1$ and $Bc_2$ was assessed for downy mildew disease incidence using the method described by (Reuveni, 1983) with some modifications as follows:

| Disease rating | Description | Disease reaction |
|---|---|---|
| 0 | No symptoms | Highly Resistant |
| 1 | 1-10 scattered small lesions per leaf. Less than 25% of leaf area turned yellowish. | Resistant |
| 2 | 11-20 scattered small lesions per leaf. Yellowing covered >25-50% of leaf area. | Moderate resistant |
| 3 | 21-40 scattered or coalesced lesions per leaf. Yellowing covered >50% of leaf area. | Moderate susceptible |
| 4 | More than 40 coalesced lesions per leaf. The infected area turned brown and died. Yellowing covere>75% of leaf area. | Susceptible |

**Chemical analysis:**

Ten plants were chosen randomly from population of each of the parental inbred lines as well as their $F_1$, at the full bloom stage, for the purpose of chemical analysis. Three healthy leaves were removed from each individual plant, thoroughly washed with sterilized distilled water, dried between two filter paper, cut to small pieces, weighted and extracted with ethyl alcohol. The resultant extracts were used for determination of both phenolic and sugar contents in mg per 100 g fresh weight of leaves. The method described by Snell and Snell (1953) was used for assaying phenolic contents (free, conjugated and total phenols), meanwhile the method of Forsee (1938) was used for assaying sugar contents (reducing, non-reduced and total sugars).

All plants in parental, $F_1$, $F_2$, $Bc_1$ and $Bc_2$ populations were daily observed for determining earliness of male and female flowering (calculated as number of days elapsed from sowing time to the anthesis of the first male or female flower, respectively) number of male and female flowers/plant. Sex ratio (male: female flower ratio) was then calculated. After harvesting, the total yield/plant (gm) and number of fruits/plant were recorded then the average of both fruit weight (gm), fruit length (cm), fruit diameter (cm) as well as fruit set percentage (number of fruits / total female flowers) were calculated. At the end, stem length (cm), number of branches/plant, average of leaf area ($cm^2$) in five leaves/plant (by weight) and the node-number carrying the first male or female flowers were also determined. Relationships between these characters and resistance against infection with downy mildew were also studied.

**Data analysis:**

Segregation ratios of $F_2$ and backcross populations were tested for goodness of fit to a certain theoretical ratio with chi-square test according to the method described by Strickberger (1976). Estimates of the mean and its standard error and total variance for all populations were calculated using the methods described by Briggs and Knowles (1977).

The nature of dominance was determined by calculating the potence ratio (P) using the following equation given by Smith (1952).

$$\text{Potence ratio (P)} = \frac{F_1 - M.P}{1/2\,(P_2 - P_1)}$$

Where: $F_1 = F_1$ mean, $P_1$ = The smaller parent mean, $P_2$ = The larger parent mean and M.P = Mid- parent value = ½ $(P_2 - P_1)$.

Heritability in the broad sense (BSH) was estimated using the following method described by Allard (1960):

$$BSH = \frac{VF_2 1 - (VF_1 + VP_1 + VP_2)}{\frac{3}{VF_2}} \times 100$$

Heritability in the narrow sense (NSH) was estimated using the following formula described by Mather and Jinkes (1971):

$$NSH = \frac{2VF_2 - (VBc_1 + VBc_2}{VF_2} \times 100$$

The minimum number of the gene pairs differentiating the two parental lines was estimated using the following method given by Castle and Wright (1921):

$$N = \frac{D^2}{8(VF_2 - VF_1}$$

Where: N = minimum number of gene pairs by which the parental lines differ, D = Mean of larger parent – Mean of smaller parent, $VF_2$ = Variance of $F_2$ population and $VF_1$ = Variance of $F_1$ population.

Phenotypic correlation's between studied characters in the $F_2$ populations of the crosses were calculated by the method mentioned by Briggs and Knowles (1977).

## RESULTS AND DISCUTION

**Downy mildew disease reaction:**

Data presented in Table (1) showed that all plants of the inbred lines used as female parents, *i.e.*, $TX_{300}$, $TX_{301}$, $TX_{303}$ and $TX_{306}$ were susceptible while those of the male parent $TX_{302}$ were resistant to downy mildew disease. The means of disease ratings for the above mentioned five inbred lines were 3.53, 2.70, 3.63, 3.53 and 0.00, respectively. Thus, the inbred line $TX_{301}$ can be classified as moderately susceptible if compared with the other tested female lines. The $F_1$ plants showed susceptible reaction against downy mildew-infection but they slightly differed in disease ratings if compared with its parental susceptible lines. For example, $F_1$ plants from $TX_{301}$ X $TX_{302}$ cross were more susceptible (3.06 disease ratings) while those from $TX_{303}$ X $TX_{302}$ cross were less susceptible than their parental susceptible lines $TX_{301}$ and $TX_{303}$, respectively. These results may indicate the dominance of susceptibility over resistance. The segregation of the $F_2$ populations was followed to the ratio 13 susceptible: 3, resistant suggested that two pairs of genes for resistance have differentiated in the two

parents. When backcrosses were made to the resistant parent, *i.e.* $TX_{302}$ (donor), the resultant plants were segregated according to the ratio 1 resistant: 1 moderately resistant : 1 moderately susceptible : 1 susceptible. However, all plants in the backcrosses made to the susceptible parent were mostly susceptible to downy mildew disease. These results indicate that parents were different in pairs of epistatic interaction and expressed dominant and recessive interaction.

Susceptibility to downy mildew disease was completely dominant over resistance while resistance was a recessive character in the four crosses. Segregation in $F_2$ followed the ratio of 13 susceptible to 3 resistant. Thus, two pairs of genes of dominant and recessive interaction governed the inheritance of this character. These genes were tentatively designated RRss for the resistant parent and rrSS for the susceptible parents. The dominant gene "S" responsible for expression of susceptibility inhibited the action of the dominant gene "R" responsible for resistance, which is and make it like the recessive gene "r". Backcrosses with the resistant parent confirmed this assumption where a ratio of 1 susceptible: 1 resistant was obtained. Evidently, two pairs of genes may interact, the interaction being epistastic where two non-allelic resistance genes are required to confer resistance, one dominont gene may be dominant over the other and one recessive gene may be dominant over the other. Each parent possessed two pairs of genes, one of a homozygous dominant and other in a recessive conditions.

Table 1: Frequency distributions and segregation's for leaf reaction to downy mildew in parents, $F_1$, $F_2$, $Bc_1$ and $Bc_2$ generations derived from crosses between some cucumber inbred lines.

| Generation | **Total No. of** Plants | **No. of plants in disease reaction classes** 0 | 1 | 2 | 3 | 4 | **Observed No. of plants** Res. | Susc | **Ratio** | $\mathbf{X^2_{0.05}}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| $TX_{300}$ $P_1$ (**Susceptible**) | 30 | - | - | 3 | 8 | 19 | - | 30 | - | |
| $TX_{302}$ $P_2$ (**Resistant**) | 30 | 30 | - | - | - | - | 30 | - | - | |
| $F_1$ | 30 | - | - | 10 | 12 | 8 | - | 30 | - | |
| $F_2$ | 120 | 14 | 12 | 34 | 19 | 41 | 26 | 94 | 3 13 | 0.672 |
| $Bc_1(F_1 X P_1)$ | 60 | - | - | 25 | 19 | 16 | - | 60 | - | |
| $Bc_2 (F_1 X P_2)$ | 60 | 15 | 10 | 10 | 10 | 15 | - | - | 1:1:1:1 | 3.334 |
| $TX_{301}$ $P_1$ (**Susceptible**) | 30 | - | - | 17 | 5 | 8 | - | 30 | - | |
| $TX_{302}$ $P_2$ (**Resistant**) | 30 | 30 | - | - | - | - | 30 | - | - | |
| $F_1$ | 30 | - | - | 7 | 14 | 9 | - | 30 | - | |
| $F_2$ | 20 | 15 | 8 | 22 | 30 | 45 | 23 | 97 | 3:13 | 0.013 |
| $Bc_1(F_1 X P_1)$ | 60 | - | - | 19 | 9 | 32 | - | 60 | - | |
| $Bc_2 (F_1 X P_2)$ | 60 | 15 | 15 | 8 | 9 | 13 | - | - | 1:1:1:1 | 6.934 |
| $TX_{303}$ $P_1$ (**Susceptible**) | 30 | - | - | 1 | 9 | 20 | - | 30 | - | |
| $TX_{302}$ $P_2$ (**Resistant**) | 30 | 30 | - | - | - | - | 30 | - | - | |
| $F_1$ | 30 | - | - | 14 | 7 | 9 | - | 30 | - | |
| $F_2$ | 120 | 19 | 6 | 44 | 25 | 26 | 25 | 95 | 3:13 | 0.341 |
| $Bc_1(F_1 X P_1)$ | 60 | - | - | 20 | 17 | 23 | - | 60 | - | |
| $Bc_2 (F_1 X P_2)$ | 60 | 13 | 14 | 9 | 9 | 15 | - | - | 1:1:1:1 | 7.000 |
| $TX_{306}$ $P_1$ (**Susceptible**) | 30 | - | - | 3 | 8 | 19 | - | 30 | - | |
| $TX_{302}$ $P_2$ (**Resistant**) | 30 | 30 | - | - | - | - | 30 | - | - | |
| $F_1$ | 30 | - | - | 5 | 12 | 13 | - | 30 | - | |
| $F_2$ | 120 | 14 | 12 | 26 | 25 | 43 | 26 | 94 | 3:13 | 0.672 |
| $Bc_1(F_1 X P_1)$ | 60 | - | - | 11 | 20 | 29 | - | 60 | - | |
| $Bc_2 (F_1 X P_2)$ | 60 | 16 | 13 | 8 | 10 | 13 | - | - | 1:1:1:1 | 4.398 |

For studying downy mildew disease through the four crosses, the following analysis are suggested:

| | | |
|---|---|---|
| $P_1$ | rrSS | Susceptible |
| $P_2$ | RRss | Resistant |
| $F_1$ | RrSs | Susceptible |
| $F_2$ | 1 RRSS | |
| | 2 RrSS | 13 (Susceptible |
| | 2 RRSs | |
| | 4 RrSs | |
| | 1 rrSS | |
| | 2 rr Ss | |
| | 1 rrss | |
| | 1 RRss | 3 (Resistant) |
| | 2 Rrss | |
| $Bc_1$ | 1 RrSS | Susceptible |
| | 1 RrSs | Susceptible |
| | 1 rrSS | Susceptible |
| | 1 rrSs | Susceptible |
| $Bc_2$ | 1RRSs | Susceptible |
| | 1RRss | Resistant |
| | 1RrSs | Moderate susceptible (considered as susceptible) |
| | 1Rrss | Moderate resistant (considered as resistant) |

Many investigators studies the mode of inheritance to downy mildew disease in cucumber plants, *i.e.*, Vitchenoko and Meleshkina (1991); Om *et al*. (1992), Yurina *et al.*, (1995), and Serquen *et al.* (1997) and Shetty (1983) on ridgegrourd, as well as Kim (1996) on melo. Abd El-Hafez *et al.* (1990) mentioned that resistance to downy mildew in cucumber plants is controlled by two pairs of dominant and recessive interaction genes (13 susceptible: 3 resistant). Meanwhile, Angelov (1995) found that the inheritance of ***P. cubensis*** resistance proved to be dominant in melo.

**Inheritance pattern for some tested criteria :**

**1. Leaf area:**

Data in Table (2) showed that the inbred line $TX_{302}$ had the lowest leaf area compared with the other parental lines. The average leaf area was 73.22; 83.63; 13.49; 80.40 and 93.01cm2 for $TX_{300}$, $TX_{301}$, $TX_{302}$, $TX_{303}$ and $TX_{306}$, respectively. The frequency distribution for leaf area in $P_1$, $P_2$, $F_1$, $F_2$, $Bc_1$ and $Bc_2$ populations for all crosses indicated the quantitative inheritance pattern for this character. In this regard, highly significant differences were detected between the populations of all crosses. Leaf area may be one of several factors responsible for disease resistance. The smaller leaf area may trapped smaller inoculum of plant pathogen(s) However, it is worth mentioning here that leaf

Table (2): Frequency distributions for leaf area in different populations for the crosses between some cucumber inbred lines.

| Population | Range of leaf area ($cm^2$) 25 | 50 | 75 | 100 | 125 | Total No. of Plants | Mean ± SE | Variance |
|---|---|---|---|---|---|---|---|---|
| $P_1$ ($TX_{300}$ **Susceptible**) | - | - | - | 20 | 10 | 30 | 73.22 ± 2.91 | 82.45 |
| $P_2$ ($TX_{302}$ **Resistant**) | 30 | - | - | - | - | 30 | 13.49 ± 2.91 | 2.89 |
| $F_1$ | 3 | 26 | 1 | - | - | 30 | 36.34 ± 2.91 | 78.50 |
| $F_2$ | 17 | 26 | 71 | 5 | 1 | 120 | 42.87 ± 1.45 | 443.94 |
| $Bc_1(F_1 X P_1)$ | 11 | 35 | 9 | 4 | 1 | 60 | 43.34 ± 2.05 | 320.41 |
| $Bc_2 (F_1 X P_2)$ | 22 | 24 | 8 | 5 | 1 | 60 | 38.70 ± 2.05 | 270.60 |
| $LSD^{0.05}_{0.01}$ | | | | | | | $^{19.73}_{25.97}$ | |
| $P_1$ ($TX_{301}$ **Susceptible**) | - | - | - | 3 | 27 | 30 | 83.63 ± 2.54 | 59.75 |
| $P_2$ ($TX_{302}$ **Resistant**) | 30 | - | - | - | - | 30 | 13.50 ± 2.54 | 2.89 |
| $F_1$ | 3 | 30 | 7 | - | - | 30 | 41.54 ± 2.54 | 137.12 |
| $F_2$ | 7 | 30 | 77 | 5 | 1 | 120 | 16.15 ± 1.27 | 260.82 |
| $Bc_1(F_1 X P_1)$ | 3 | 30 | 23 | 4 | - | 60 | 47.11 ± 1.80 | 271.92 |
| $Bc_2 (F_1 X P_2)$ | 19 | 35 | 6 | - | - | 60 | 30.29 ± 1.80 | 167.96 |
| $LSD^{0.05}_{0.01}$ | | | | | | | $^{17.26}_{22.71}$ | |
| $P_1$ ($TX_{303}$ **Susceptible**) | - | - | 7 | 23 | - | 30 | 80.40 ± 3.53 | 32.09 |
| $P_2$ ($TX_{302}$ **Resistant**) | 30 | - | - | - | - | 30 | 13.50 ± 3.53 | 2.89 |
| $F_1$ | - | 9 | 19 | 2 | - | 30 | 56.80 ± 3.53 | 165.38 |
| $F_2$ | 24 | 28 | 56 | 8 | 4 | 120 | 45.60 ± 1.76 | 592.44 |
| $Bc_1(F_1 X P_1)$ | 10 | 25 | 22 | 3 | - | 60 | 43.80 ± 2.49 | 371.33 |
| $Bc_2 (F_1 X P_2)$ | 21 | 29 | 8 | 1 | 1 | 60 | 34.40 ± 2.49 | 382.59 |
| $LSD^{0.05}_{0.01}$ | | | | | | | $^{10.58}_{13.92}$ | |
| $P_1$ ($TX_{306}$ **Susceptible**) | - | - | - | 23 | 7 | 30 | 93.01 ± 2.71 | 66.10 |
| $P_2$ ($TX_{302}$ **Resistant**) | 30 | - | - | - | - | 30 | 13.50 ± 2.71 | 2.89 |
| $F_1$ | 5 | 21 | 4 | - | - | 30 | 36.63 ± 2.71 | 132.71 |
| $F_2$ | 12 | 29 | 75 | 3 | 1 | 120 | 41.23 ± 1.36 | 497.74 |
| $Bc_1(F_1 X P_1)$ | 7 | 26 | 20 | 5 | 2 | 60 | 49.68 ± 1.92 | 294.32 |
| $Bc_2 (F_1 X P_2)$ | 18 | 31 | 11 | - | - | 60 | 34.09 ± 1.92 | 323.80 |
| $LSD^{0.05}_{0.01}$ | | | | | | | $^{18.42}_{24.25}$ | |

area could be the final result of some components, which may have a direct or indirect effect on resistance to downy mildew disease.

Results in Table (3) presented that potence ratio calculated for the leaf arrea in four crosses indicated that slight partial dominance for female partent in the crosses $TX_{300}$ X $TX_{302}$, $TX_{301}$ X $TX_{302}$ and $TX_{306}$ X $TX_{302}$. Meanwhile, there were slight partial dominance for female partent in the crosses $_{300}$ X $TX_{302}$, dominance for the male partent in the cross $TX_{303}$ X $TX_{302}$. With regard to broad and narrow sense heritability, all crosses had values above 74 and 31%, respectively. These indicated that the greater portion of phenotypic variance was due to genetic variance and additive variance and small part was due to environmental components. Accordingly, selection for resistance to downy mildew diseases in cucumber plants would be effective in these four crosses with regard to small leaf area. Concerning to number of the gene pairs, data in Table (3) showed that the minimum number of the gene pairs differentiating the two parental line for leaf area was from 1 to 5 pairs.

**2. Earliness of male flowering:**

Data presented in Table (4) indicated that the first male flower anthesis appeared more early (the lowest number of days from planting to the first male flower anthesis) in the resistant inbred line $TX_{302}$ (average 32.73 days) compared with 41.40, 42.17, 42.0 and 42.10 days for $TX_{300}$, $TX_{301}$, $TX_{303}$ and $TX_{306}$, respectively. Highly significant differences were found between the populations of all crosses. The frequency distributions for number of days from planting to the first male flower anthesis in the $P_1$, $P_2$, $F_1$, $F_2$, $Bc_1$ and $Bc_2$ populations for all crosses suggested that this character was inherited quantitatively, because its frequency distribution in the $F_2$ generation was continuous.

Data in Table (4) showed that there were slight partial dominance for the male parent. This is true in four crosses, except the cross $TX_{303}$ X $TX_{302}$ where there were over dominance to the male parent. With regard to broad and narrow sense heritability, all crosses had values above 70% and 37%,

respectively. The minimum number of the gene pairs differentiating the two parental line for number of day from planting to the first male flower anthesis was from one to three pairs. These findings agreed with the results reported by Miller and Quisenberry (1997) on cucumber, and Abd El-Hafez *et al*. (1982) on watermelon, who reported that the days to first flower appeared to be controlled by relatively few genes.

**3- Earliness of female flowering:**

Data in Table (5) indicated that the number of days from planting to the first female flower anthesis was significantly higher in the male inbred line $TX_{302}$ (62.53 days) than the other female parents, *i.e*. $TX_{300}$ (46.13 days), $TX_{301}$ (45.83 days), $TX_{303}$ (45.20 days) and $TX_{306}$ (44.83 days). In all crosses, frequency distribution for number of days from planting to the first female flower anthesis in the $P_1$, $P_2$, $F_1$, $F_2$, $Bc_1$ and $Bc_2$ populations indicated the quantitatively inheritance pattern for this character. The differences between the populations of all crosses were highly significant.

**Table 3:** Potance ratio, broad and narrow sense heritability and minimum number of effective gene pairs estimates for the studied characters in the crosses between some cucumber inbred lines.

| Characters | Estimates | $TX_{300}$ X $TX_{302}$ | $TX_{301}$ X $TX_{302}$ | $TX_{303}$ X $TX_{302}$ | $TX_{306}$ X $TX_{302}$ |
|---|---|---|---|---|---|
| **Leaf area** | Potence ratio | 0.24 | 0.20 | -0.27 | 0.42 |
| | BSH | 87.70 | 74.47 | 88.73 | 86.49 |
| | NSH | 66.87 | 31.35 | 72.74 | 75.81 |
| | No. of Genes | 1 | 5 | 5 | 2 |
| **No. of days from planting to the first male flower anthesis** | Potence ratio | -0.97 | -0.67 | -2.03 | -0.25 |
| | BSH | 71.31 | 76.17 | 91.81 | 87.80 |
| | NSH | 37.57 | 44.81 | 73.72 | 66.88 |
| | No. of Genes | 1 | 1 | 3 | 1 |
| **No. of days from planting to the first female flower anthesis** | Potence ratio | -0.43 | -0.58 | 0.15 | -0.06 |
| | BSH | 65.30 | 66.33 | 62.65 | 86.45 |
| | NSH | 40.83 | 33.21 | 34.74 | 60.51 |
| | No. of Genes | 3 | 3 | 6 | 2 |
| **Yield/plant (g)** | Potence ratio | -2.57 | -3.71 | -2.02 | -3.75 |
| | BSH | 65.25 | 70.07 | 67.95 | 60.46 |
| | NSH | 7.06 | 45.16 | 47.45 | 14.12 |
| | No. of Genes | 3 | 3 | 3 | 3 |
| **Sex ratio** | Potence ratio | -0.21 | -0.55 | -0.86 | -0.38 |
| | BSH | 59.18 | 38.85 | 72.23 | 50.86 |
| | NSH | 29.29 | 36.69 | 30.01 | 41.37 |
| | No. of Genes | 2 | 5 | 1 | 2 |
| **Set percentage** | Potence ratio | -10.31 | -5.52 | -1.16 | -1.92 |
| | BSH | 31.66 | 23.06 | 24.97 | 20.70 |
| | NSH | 27.88 | 13.55 | 9.71 | 10.95 |
| | No. of Genes | 2 | 3 | 2 | 2 |

Table 4: Frequency distributions for number of days from planting to the first male flower anthesis in different populations for the crosses between some cucumber inbred lines.

| Population | Range of days No. from planting to the first male flower anthises | | | | | Total No. of Plants | Mean ± SE | Variance |
|---|---|---|---|---|---|---|---|---|
| | 35 | 40 | 45 | 50 | 55 | | | |
| $P_1$ ($TX_{300}$ **Susceptible**) | - | 5 | 25 | - | - | 30 | 41.40 ± 0.67 | 3.93 |
| $P_2$ ($TX_{302}$ **Resistant**) | 30 | - | - | - | - | 30 | 32.73 ± 0.67 | 0.88 |
| $F_1$ | 2 | 14 | 4 | 10 | - | 30 | 41.10 ± 0.67 | 13.40 |
| $F_2$ | 9 | 40 | 59 | 11 | 1 | 120 | 40.83 ± 0.34 | 21.16 |
| $Bc_1(F_1 X P_1)$ | 1 | 14 | 23 | 22 | - | 60 | 42.78 ± 0.47 | 16.56 |
| $Bc_2 (F_1 X P_2)$ | 2 | 20 | 26 | 11 | 1 | 60 | 41.58 ± 0.47 | 17.81 |
| $LSD^{0.05}_{0.01}$ | | | | | | | $^{4.56}_{6.00}$ | |
| $P_1$ ($TX_{301}$ **Susceptible**) | - | - | - | 30 | - | 30 | 42.17 ± 0.79 | 2.07 |
| $P_2$ ($TX_{302}$ **Resistant**) | 30 | - | - | - | - | 30 | 32.73 ± 0.79 | 0.88 |
| $F_1$ | 2 | 14 | 9 | 5 | - | 30 | 40.60 ± 0.79 | 16.00 |
| $F_2$ | 4 | 45 | 49 | 20 | 2 | 120 | 41.20 ± 0.40 | 26.51 |
| $Bc_1(F_1 X P_1)$ | - | 13 | 22 | 25 | - | 60 | 43.12 ± 0.56 | 14.90 |
| $Bc_2 (F_1 X P_2)$ | 22 | 12 | 9 | 14 | 3 | 60 | 39.95 ± 0.56 | 26.24 |
| $LSD^{0.05}_{0.01}$ | | | | | | | $^{5.38}_{7.08}$ | |
| $P_1$ ($TX_{303}$ **Susceptible**) | - | - | - | 30 | - | 30 | 42.00 ± 0.66 | 1.04 |
| $P_2$ ($TX_{302}$ **Resistant**) | 30 | - | - | - | - | 30 | 32.73 ± 0.66 | 0.88 |
| $F_1$ | - | - | 1 | 28 | 1 | 30 | 46.77 ± 0.66 | 3.28 |
| $F_2$ | 6 | 41 | 44 | 25 | 4 | 120 | 41.66 ± 0.33 | 21.16 |
| $Bc_1(F_1 X P_1)$ | 4 | 10 | 24 | 22 | - | 60 | 42.40 ± 0.47 | 13.62 |
| $Bc_2 (F_1 X P_2)$ | 1 | 7 | 15 | 36 | 1 | 60 | 44.37 ± 0.47 | 13.10 |
| $LSD^{0.05}_{0.01}$ | | | | | | | $^{4.49}_{5.91}$ | |
| $P_1$ ($TX_{306}$ **Susceptible**) | - | - | 30 | - | - | 30 | 42.10 ± 0.89 | 1.74 |
| $P_2$ ($TX_{302}$ **Resistant**) | 30 | - | - | - | - | 30 | 32.73 ± 0.89 | 0.88 |
| $F_1$ | 7 | 12 | 6 | 5 | - | 30 | 38.61 ± 0.89 | 22.28 |
| $F_2$ | 1 | 38 | 44 | 30 | 7 | 120 | 42.24 ± 0.44 | 68.06 |
| $Bc_1(F_1 X P_1)$ | 1 | 22 | 14 | 19 | 4 | 60 | 42.40 ± 0.63 | 45.40 |
| $Bc_2 (F_1 X P_2)$ | 1 | 24 | 18 | 12 | 5 | 60 | 42.28 ± 0.63 | 45.20 |
| $LSD^{0.05}_{0.01}$ | | | | | | | $^{6.04}_{7.95}$ | |

Table 5: Frequency distributions for number of days from planting to the first female flower anthesis in different populations for the crosses between some cucumber inbred lines.

| Population | Range of days No. from planting to the first female flower anthises | | | | | | | Total No. of Plants | Mean ± SE | Variance |
|---|---|---|---|---|---|---|---|---|---|---|
| | 40 | 45 | 50 | 55 | 60 | 65 | 70 | | | |
| $P_1$ ($TX_{300}$ **Susceptible**) | - | 15 | 11 | 4 | - | - | - | 30 | 46.13 ± 0.64 | 8.41 |
| $P_2$ ($TX_{302}$ **Resistant**) | - | - | - | - | - | 28 | 2 | 30 | 62.53 ± 0.64 | 2.82 |
| $F_1$ | 1 | 3 | 6 | 19 | 1 | - | - | 30 | 50.83 ± 0.64 | 7.84 |
| $F_2$ | 2 | 14 | 40 | 59 | 5 | - | - | 120 | 50.26 ± 0.32 | 18.32 |
| $Bc_1$($F_1$ X $P_1$) | - | 6 | 5 | 36 | 13 | - | - | 60 | 52.68 ± 0.45 | 15.76 |
| $Bc_2$ ($F_1$ X $P_2$) | - | 1 | 11 | 42 | 6 | - | - | 60 | 52.78 ± 0.45 | 13.40 |
| $LSD^{0.05}_{0.01}$ | | | | | | | | | $^{4.35}_{5.72}$ | |
| $P_1$ ($TX_{301}$ **Susceptible**) | - | 11 | 14 | 5 | - | - | - | 30 | 45.83 ± 0.69 | 10.76 |
| $P_2$ ($TX_{302}$ **Resistant**) | - | - | - | - | - | 28 | 2 | 30 | 62.53 ± 0.69 | 2.82 |
| $F_1$ | - | 3 | 14 | 12 | 1 | - | - | 30 | 49.33 ± 0.69 | 10.18 |
| $F_2$ | 9 | 19 | 41 | 47 | 4 | - | - | 120 | 48.73 ± 0.34 | 23.52 |
| $Bc_1$($F_1$ X $P_1$) | - | - | 25 | 26 | 9 | - | - | 60 | 52.03 ± 0.49 | 19.99 |
| $Bc_2$ ($F_1$ X $P_2$) | - | - | 3 | 37 | 20 | - | - | 60 | 54.18 ± 0.49 | 19.24 |
| $LSD^{0.05}_{0.01}$ | | | | | | | | | $^{4.68}_{6.17}$ | |
| $P_1$ ($TX_{303}$ **Susceptible**) | - | 19 | 11 | - | - | - | - | 30 | 45.20 ± 0.59 | 5.15 |
| $P_2$ ($TX_{302}$ **Resistant**) | - | - | - | - | - | 28 | 2 | 30 | 62.53 ± 0.59 | 2.82 |
| $F_1$ | - | 1 | 1 | 16 | 12 | - | - | 30 | 55.20 ± 0.59 | 7.45 |
| $F_2$ | - | 4 | 35 | 67 | 14 | - | - | 120 | 52.03 ± 0.29 | 13.76 |
| $Bc_1$($F_1$ X $P_1$) | - | - | 8 | 37 | 15 | - | - | 60 | 53.80 ± 0.41 | 10.56 |
| $Bc_2$ ($F_1$ X $P_2$) | - | - | 13 | 18 | 29 | - | - | 60 | 54.68 ± 0.41 | 12.18 |
| $LSD^{0.05}_{0.01}$ | | | | | | | | | $^{3.98}_{5.24}$ | |
| $P_1$ ($TX_{306}$ **Susceptible**) | - | 14 | 16 | - | - | - | - | 30 | 44.83 ± 0.87 | 2.28 |
| $P_2$ ($TX_{302}$ **Resistant**) | - | - | - | - | - | 28 | 2 | 30 | 62.53 ± 0.87 | 2.82 |
| $F_1$ | - | - | 6 | 17 | 7 | - | - | 30 | 53.17 ± 0.87 | 9.00 |
| $F_2$ | 12 | 25 | 28 | 47 | 8 | - | - | 120 | 48.88 ± 0.44 | 34.69 |
| $Bc_1$($F_1$ X $P_1$) | 2 | 2 | 15 | 20 | 21 | - | - | 60 | 52.92 ± 0.62 | 26.11 |
| $Bc_2$ ($F_1$ X $P_2$) | 2 | 17 | 13 | 27 | 1 | - | - | 60 | 48.83 ± 0.62 | 22.28 |
| $LSD^{0.05}_{0.01}$ | | | | | | | | | $^{5.92}_{7.79}$ | |

Data in Table (3) showed that there were slight partial dominance for the female parent with regard to female flower anthesis. This is true in four crosses except the cross TX303 X TX302 where there were slight partial dominance with male parent in case of female flower anthesis. These results were in accordance with Doijoje and Sulladma (1988) on pumpkin, Pershin *et al*. (1988) and Shabana (1992) on cucumber, who mentioned that values of potence ratio exhibited partial dominance for early flowering in all crosses studied. With regard to broad and narrow sense heritability, all crosses had values above 62% and 33%, respectively. These indicated that the greater portion of phenotypic variance was due to genetic variance and additive variance and small part was due to environmental components. Accordingly, selection would be effective in these four crosses. These results agree with those obtained by El-Shawaf and Baker (1981), Abd El-Hafez *et al*. (1982), Rubino and Welhner (1986), Vijay (1987) and Shabana (1992). The minimum number of the gene pairs differentiating in the two parental lines for number of days from planting to the first female flower anthesis was from 2 to 6 pairs. Shabana (1992) who found that the differences among parents in flowering time were found to be controlled by one group of genes in all crosses studied.

**4. Sex ratio:**

Using sex ratio as a measurement for resistance to downy mildew disease, it was found that inbred line $TX_{302}$ had the highest sex ratio comparing to the other parental lines (Table 5). The sex ratio was 2.71, 2.53, 10.63, 2.53 and 3.24 for $TX_{300}$, $TX_{301}$, $TX_{302}$, $TX_{303}$ and $TX_{306}$, respectively. The frequency distribution for sex ratio in $P_1$, $P_2$, $F_1$, $F_2$, $Bc_1$ and $Bc_2$ populations for all crosses presented in Table (6) indicated the quantitative inheritance pattern for this character. Significant differences were detected between the populations in all crosses in Table (6).

Data in Table (3) showed that there were slight partial dominance for the female parent in sex ratio. Broad and narrow sense heritability were less than 50% and 31%, respectively. These suggesting that the

greater part of phenotypic variance was due to environmental components and non-additive deviations. Thus, selection would be effective, when applying suitable breeding procedure in most four crosses with regard to thise character. These results agree with those obtained by El-Shawaf and Baker (1981), Abd El-Hafez *et al*. (1982), Rubino and Welhner (1986), Vijay (1987) and Shabana (1992) who found that all crosses under study had values above 80% and 66% of narrow and broad sense heritabilites of number of female flowers per plant, respectively. With regard to number of the gene pairs, the data in Table (3) showed that the minimum number of the gene pairs differentiating the two parental line for sex ratio was from 1 to 5 pairs of gene. Such number of group of the gene in sex ratio is, more or less, agreeable with those found with male and female flowers. These findings agreed with the results reported by Shabana (1992) who found that the differences among parents in number of pistillate flower per plant were found to be controlled by one group of genes in all the crosses studied.

Table 6: Frequency distributions for sex ratio in different populations for the crosses between some cucumber inbred lines.

| Population | Range of sex ratio | | | | | Total No. of Plants | Mean ± SE | Variance |
|---|---|---|---|---|---|---|---|---|
| | 5 | 10 | 15 | 20 | 25 | | | |
| $P_1$ ($TX_{300}$ **Susceptible**) | 27 | 3 | - | - | - | 30 | 2.71 ± 0.53 | 1.90 |
| $P_2$ ($TX_{302}$ **Resistant**) | 4 | 14 | 9 | 1 | 2 | 30 | 10.63 ± 0.53 | 4.53 |
| $F_1$ | 16 | 10 | 4 | - | - | 30 | 5.85 ± 0.53 | 5.57 |
| $F_2$ | 40 | 73 | 3 | - | - | 120 | 4.49 ± 0.26 | 9.80 |
| $Bc_1(F_1 X P_1)$ | 46 | 14 | - | - | - | 60 | 3.21 ± 0.37 | 8.31 |
| $Bc_2 (F_1 X P_2)$ | 43 | 17 | - | - | - | 60 | 4.09 ± 0.37 | 8.42 |
| $LSD^{0.05}_{0.01}$ | | | | | | | $^{3.59}_{4.72}$ | |
| $P_1$ ($TX_{301}$ **Susceptible**) | 26 | 4 | - | - | - | 30 | 2.53 ± 0.50 | 2.79 |
| $P_2$ ($TX_{302}$ **Resistant**) | 4 | 14 | 9 | 1 | 2 | 30 | 10.63 ± 0.50 | 4.53 |
| $F_1$ | 22 | 6 | 2 | - | - | 30 | 4.37 ± 0.50 | 4.88 |
| $F_2$ | 34 | 85 | 1 | - | - | 120 | 4.22 ± 0.25 | 6.65 |
| $Bc_1(F_1 X P_1)$ | 51 | 9 | - | - | - | 60 | 3.44 ± 0.36 | 5.24 |
| $Bc_2 (F_1 X P_2)$ | 36 | 24 | - | - | - | 60 | 4.16 ± 0.36 | 5.62 |
| $LSD^{0.05}_{0.01}$ | | | | | | | $^{3.42}_{4.50}$ | |
| $P_1$ ($TX_{303}$ **Susceptible**) | 29 | 1 | - | - | - | 30 | 2.35 ± 0.45 | 1.08 |
| $P_2$ ($TX_{302}$ **Resistant**) | 4 | 14 | 9 | 1 | 2 | 30 | 10.63 ± 0.45 | 4.53 |
| $F_1$ | 29 | 1 | - | - | - | 30 | 2.92 ± 0.45 | 1.08 |
| $F_2$ | 1 | 92 | 26 | 1 | - | 120 | 3.97 ± 0.22 | 8.03 |
| $Bc_1(F_1 X P_1)$ | 56 | 4 | - | - | - | 60 | 3.37 ± 0.32 | 6.69 |
| $Bc_2 (F_1 X P_2)$ | 49 | 11 | - | - | - | 60 | 4.06 ± 0.32 | 6.96 |
| $LSD^{0.05}_{0.01}$ | | | | | | | $^{3.04}_{4.00}$ | |
| $P_1$ ($TX_{306}$ **Susceptible**) | 26 | 4 | - | - | - | 30 | 3.24 ± 0.53 | 2.99 |
| $P_2$ ($TX_{302}$ **Resistant**) | 4 | 14 | 9 | 1 | 2 | 30 | 10.63 ± 0.53 | 4.53 |
| $F_1$ | 16 | 11 | 3 | - | - | 30 | 5.53 ± 0.53 | 2.99 |
| $F_2$ | 20 | 97 | 3 | - | - | 120 | 3.52 ± 0.26 | 7.13 |
| $Bc_1(F_1 X P_1)$ | 50 | 10 | - | - | - | 60 | 3.24 ± 0.37 | 5.31 |
| $Bc_2 (F_1 X P_2)$ | 50 | 10 | - | - | - | 60 | 2.89 ± 0.37 | 6.00 |
| $LSD^{0.05}_{0.01}$ | | | | | | | $^{3.58}_{4.71}$ | |

**5. Set percentage:**

Data presented in Table (7) indicated that the inbred line TX302 had the lowest set percentage (43.09%) compared to the other parental lines { $TX_{300}$ (45.52%), $TX_{301}$ (47.62%),$TX_{303}$ (58.44%), and $TX_{306}$ (63.36%)}. Set percentage were found to be an efficient measure for resistant to downy mildew disease. A highly significant differences were found between the populations of all crosses in Table (7). The frequency distribution for set percentage in $P_1$, $P_2$, $F_1$, $F_2$, $Bc_1$ and $Bc_2$ of all crosses indicated that this character was inherited quantitatively because the frequency distribution in the $F_2$ generation was continuous.

There were over dominance for the male parents in crosses for set percentage (Table, 3). These results were in accordance with Doijoje and Sulladma (1988); Pershin et al., (1988) and Shabana (1992) who found that the value of potence ratio indicated over dominance of high over low number of fruits per plant. Broad and narrow sense heritability of set percentage were less than 50% and 31%, respectively. Thus, selection would be non-effective in most four crosses with regard to this character. But, for impraving this trait, selection of parents for crossing and having relatively high NSH, *i.e.*, $TX_{300}$ X $TX_{302}$, so selection in segregating generation would be effective. Concerning to number of the gene pairs, in Table (3) showed that set percentage were found to be controlled by from 2 to 3 group of genes in all crosses studied. These findings agreed with the results reported by Shabana (1992) on number of pistilate flower per plant.

**6. Yield/plant:**

Total yield/plant of the parental lines presented in Table (8) show that the parental line $TX_{302}$ had the lowest yield/plant (163.39 g) followed by $TX_{301}$ (364.75 g), $TX_{306}$ (389.83 g), $TX_{300}$ (401.82 g) and $TX_{303}$ (430.75 g). There were highly significant differences between the populations of all crosses presented in Table (8). In all crosses, frequency distribution for yield/plant in the $P_1$, $P_2$, $F_1$, $F_2$, $Bc_1$ and $Bc_2$ populations indicated the quantitative inheritance pattern for this characters (Table 8).

Data presented in Table (3) show that there were over-dominance for the male p(the lowest yield/plant) in all crosses. With respect to broad and narrow sense heritability, all crosses had values above 60% and 7%, respectively. These indicated that the greater portion of phenotypic variance was due to genetic variance and dominance deviations and large part was due to environmental components. Thus, selection would be effective in crosses having high BSH and NSH with regard to this character. Concerning to number of gene pairs, data in Table (3) showed that there were three pair of genes controlled the yield/plant.

**Chemical analysis:**

The healthy leaves of the resistant male inbred line $TX_{302}$ contained higher phenolic (Free, conjugate and total phenols) and lower sugar (reduced, non-reduced and total sugars) contents than any of the susceptible female

**Table 7:** Frequency distributions for set percentage in different populations for the crosses between some cucumber inbred lines.

| Population | Range of set ratio (%) | | | | | | | | | Total No. of Plants | Mean ± SE | Variance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | **100** | | | |
| $P_1$ ($TX_{300}$ **Susceptible**) | - | 8 | 5 | 8 | 3 | 3 | 1 | 2 | - | 30 | 45.52 ± 3.57 | 307.65 |
| $P_2$ ($TX_{302}$ **Resistant**) | 6 | 6 | 5 | 7 | - | 1 | 4 | 1 | - | 30 | 40.39 ± 3.57 | 553.19 |
| $F_1$ | - | - | - | 6 | 6 | 7 | 6 | 3 | 2 | 30 | 66.90 ± 3.57 | 243.98 |
| $F_2$ | - | 1 | 3 | 15 | 15 | 28 | 22 | 19 | 17 | 120 | 75.10 ± 1.79 | 538.90 |
| $Bc_1$($F_1$ X $P_1$) | - | 1 | - | 8 | 12 | 10 | 7 | 13 | 9 | 60 | 72.35 ± 2.52 | 490.46 |
| $Bc_2$ ($F_1$ X $P_2$) | - | - | 2 | 10 | 8 | 10 | 14 | 7 | 9 | 60 | 70.42 ± 2.52 | 437.09 |
| $LSD^{0.05}_{0.01}$ | | | | | | | | | | | $^{29.24}_{31.91}$ | |
| $P_1$ ($TX_{301}$ **Susceptible**) | 1 | 2 | 10 | 7 | 5 | 3 | - | 1 | 1 | 30 | 47.62 ± 3.54 | 308.00 |
| $P_2$ ($TX_{302}$ **Resistant**) | 6 | 6 | 4 | 7 | - | 1 | 4 | 1 | 1 | 30 | 43.09 ± 3.54 | 553.19 |
| $F_1$ | 1 | 3 | - | 10 | 5 | 2 | 5 | 2 | 2 | 30 | 57.86 ± 3.54 | 438.06 |
| $F_2$ | - | 1 | 4 | 15 | 20 | 20 | 24 | 20 | 16 | 120 | 71.69 ± 1.77 | 562.90 |
| $Bc_1$($F_1$ X $P_1$) | - | - | 2 | 10 | 12 | 7 | 11 | 8 | 10 | 60 | 68.86 ± 2.51 | 489.66 |
| $Bc_2$ ($F_1$ X $P_2$) | - | 1 | 2 | 10 | 6 | 13 | 12 | 9 | 7 | 60 | 69.45 ± 2.51 | 559.86 |
| $LSD^{0.05}_{0.01}$ | | | | | | | | | | | $^{24.07}_{31.68}$ | |
| $P_1$ ($TX_{303}$ **Susceptible**) | - | 3 | 5 | 3 | 6 | 5 | 4 | 1 | 3 | 30 | 58.44 ± 3.52 | 492.40 |
| $P_2$ ($TX_{302}$ **Resistant**) | 6 | 6 | 4 | 7 | - | 1 | 4 | 1 | 1 | 30 | 43.09 ± 3.52 | 553.19 |
| $F_1$ | - | 2 | 5 | 3 | 8 | 2 | 5 | 4 | 1 | 30 | 59.71 ± 3.52 | 410.06 |
| $F_2$ | - | - | 4 | 14 | 35 | 20 | 16 | 16 | 15 | 120 | 69.71 ± 1.76 | 646.70 |
| $Bc_1$($F_1$ X $P_1$) | - | - | 2 | 3 | 9 | 7 | 19 | 11 | 9 | 60 | 74.20 ± 2.49 | 580.90 |
| $Bc_2$ ($F_1$ X $P_2$) | - | - | 1 | 7 | 4 | 8 | 9 | 14 | 17 | 60 | 77.73 ± 2.41 | 649.69 |
| $LSD^{0.05}_{0.01}$ | | | | | | | | | | | $^{23.92}_{31.49}$ | |
| $P_1$ ($TX_{306}$ **Susceptible**) | - | 2 | 4 | 5 | 5 | 2 | 6 | 1 | 5 | 30 | 63.36 ± 3.60 | 552.72 |
| $P_2$ ($TX_{302}$ **Resistant**) | 6 | 6 | 4 | 7 | - | 1 | 4 | 1 | 1 | 30 | 43.09 ± 3.60 | 553.19 |
| $F_1$ | - | - | 1 | 6 | 5 | 4 | - | 7 | 7 | 30 | 72.65 ± 3.60 | 457.53 |
| $F_2$ | - | - | 1 | 11 | 18 | 19 | 28 | 25 | 18 | 120 | 73.90 ± 0.26 | 657.21 |
| $Bc_1$($F_1$ X $P_1$) | - | - | - | 9 | 7 | 6 | 15 | 15 | 8 | 60 | 74.24 ± 2.54 | 569.94 |
| $Bc_2$ ($F_1$ X $P_2$) | - | 1 | 2 | 9 | 15 | 5 | 9 | 10 | 9 | 60 | 69.28 ± 2.54 | 672.49 |
| $LSD^{0.05}_{0.01}$ | | | | | | | | | | | $^{24.42}_{32.15}$ | |

inbred lines, *i.e.*, $TX_{300}$, $TX_{301}$, $TX_{303}$ and $TX_{306}$ (Table 9). On the other hand, amounts of both phenolic and sugar contents in leaves of $F_1$ plants in all tested crosses were intermediate between the male (resistant) and female (susceptible)
parents. The relatively high sugars content of susceptible plants may served as a rich source of food for ***Pseudoperonospora cubensis*** resulting in higher level of susceptibility. In fact, biochemical defense in plants might occur through inhibitors present in plant cells and/or defficiency in nutrients essential for the pathogen(s). The present results suggested that defense mechanisms of a chemical nature are responsible for the resistance to infection with downy mildew disease caused by ***Pseudoperonospora cubensis***. These results agree with Helal *et al.* (1978) on powdery mildew in cucumber, Merghony (1989) on crosses in ***Cucumis melo*** and Abd El-Hafez *et al.* (1990) on downy mildew in cucumber, they reported that plants of moderately resistant cultivars contained higher levels of phenolic compound than the susceptible one. The relatively high sugars content of susceptible plants may served as a rich source of food for ***Pseudoperonospora cubensis*** resulting in higher level of susceptibility. These findings corroborate that of Helal *et al.* (1979) on cucumber, Jindal *et al*. (1979) on muskmelon, Merghany (1989) on ***Cucumis melo***, Abd El-Hafez *et al.* (1990) on cucumber and Fang *et al.* (1994) on cucumber, they showed that the resistant cultivars contained soluble sugars levels less than the susceptible cultivars.

**Simple correlation:**

Highly significant positive correlation coefficients were found between some measurements of resistance to downy mildew disease obtained from $F_2$ plants of the cross $TX_{300}$ X $TX_{302}$ (Table 10), *i.e.*, between leaf area or number of days from planting to the first female flower anthesis and disease reaction; fruit weight and yield/plant and between sex ratio and disease reaction or set percentage.

Meanwhile, there were highly significant negative correlation between leaf area and fruit weight or yield/plant; number of days from planting to the first male flower anthesis and sex ratio; number of days from planting to the first female flower anthesis and yield/plant and between fruit weight or yield/plant and disease reaction. There was also significant positive correlation between leaf area and number of days from planting to the first female flower anthesis or sex ratio. Meanwhile, there was negative correlation between yield/plant and disease reaction. This means that there was strong positive correlation between disease reaction and leaf area or number of days from planting to the first female flower anthesis and between sex ratio, while negative correlation with fruit weight or yield/plant. This conclusion was supported by Mahajan and Gill (1993) who mentioned that disease rating was negatively correlated with net weight, gross weight, number of leaves and leaf size index.

Data presented in Table (11) showed that there were highly significant positive correlation between leaf area and number of branches/plant or disease reaction and between sex ratio, and set percentage. Meanwhile, there were highly significant negative correlation between leaf area and fruit weight or

**Table 8:** Frequency distributions for yield per plant in different populations for the crosses between some cucumber inbred lines.

| Population | Range of yield per plant (kg) | | | | | | | | Total No. of Plants | Mean ± SE | Variance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 150 | 300 | 450 | 600 | 750 | 900 | 1050 | 1200 | | | |
| $P_1$ ($TX_{300}$ **Susceptible**) | - | - | 10 | 8 | 9 | 3 | - | - | 30 | 401.82 ± 36.39 | 22413.08 |
| $P_2$ ($TX_{302}$ **Resistant**) | 19 | 9 | 2 | - | - | - | - | - | 30 | 163.39 ± 36.39 | 5718.38 |
| $F_1$ | - | - | 6 | 10 | 10 | 3 | 1 | - | 30 | 588.50 ± 36.39 | 22183.12 |
| $F_2$ | - | 3 | 27 | 37 | 21 | 18 | 8 | 6 | 120 | 616.20 ± 18.20 | 48259.30 |
| $Bc_1$($F_1$ X $P_1$) | - | 1 | 5 | 10 | 9 | 17 | 10 | 8 | 60 | 766.89 ± 25.73 | 46659.26 |
| $Bc_2$ ($F_1$ X $P_2$) | - | 9 | 14 | 14 | 13 | 6 | 3 | 1 | 60 | 542.40 ± 25.73 | 46452.81 |
| LSD $^{0.05}_{0.01}$ | | | | | | | | | | $^{247.08}_{325.24}$ | |
| $P_1$ ($TX_{301}$ **Susceptible**) | 2 | 7 | 15 | 5 | 1 | - | - | - | 30 | 364.75 ± 35.46 | 13287.17 |
| $P_2$ ($TX_{302}$ **Resistant**) | 19 | 9 | 2 | - | - | - | - | - | 30 | 163.39 ± 35.46 | 5718.38 |
| $F_1$ | - | 2 | 5 | 6 | 6 | 7 | 4 | - | 30 | 637.39 ± 35.46 | 29094.13 |
| $F_2$ | 11 | 26 | 37 | 19 | 17 | 6 | 2 | 2 | 120 | 577.78 ± 17.73 | 53573.73 |
| $Bc_1$($F_1$ X $P_1$) | - | - | 11 | 17 | 14 | 13 | 2 | 3 | 60 | 653.51 ± 25.07 | 39069.48 |
| $Bc_2$ ($F_1$ X $P_2$) | - | 6 | 18 | 21 | 7 | 5 | 3 | - | 60 | 509.05 ± 25.07 | 43881.87 |
| LSD $^{0.05}_{0.01}$ | | | | | | | | | | $^{240.75}_{316.90}$ | |
| $P_1$ ($TX_{303}$ **Susceptible**) | - | 3 | 17 | 8 | 2 | - | - | - | 30 | 430.75 ± 25.59 | 11231.76 |
| $P_2$ ($TX_{302}$ **Resistant**) | 19 | 9 | 2 | - | - | - | - | - | 30 | 163.39 ± 25.59 | 5718.38 |
| $F_1$ | - | 3 | 5 | 12 | 5 | 5 | - | - | 30 | 549.34 ± 25.59 | 11244.48 |
| $F_2$ | 2 | 10 | 45 | 34 | 20 | 7 | 1 | 1 | 120 | 501.25 ± 12.80 | 29319.71 |
| $Bc_1$($F_1$ X $P_1$) | - | 1 | 12 | 29 | 16 | 2 | - | - | 60 | 530.90 ± 18.10 | 28706.53 |
| $Bc_2$ ($F_1$ X $P_2$) | - | 9 | 32 | 11 | 7 | 1 | - | - | 60 | 435.50 ± 18.10 | 16019.97 |
| LSD $^{0.05}_{0.01}$ | | | | | | | | | | $^{173.76}_{228.73}$ | |
| $P_1$ ($TX_{306}$ **Susceptible**) | - | 10 | 11 | 8 | 1 | - | - | - | 30 | 389.83 ± 74.56 | 15742.72 |
| $P_2$ ($TX_{302}$ **Resistant**) | 19 | 9 | 2 | - | - | - | - | - | 30 | 163.39 ± 74.56 | 5718.38 |
| $F_1$ | - | - | 4 | 6 | 11 | 4 | 2 | 3 | 30 | 700.84 ± 74.56 | 29852.93 |
| $F_2$ | 2 | 3 | 6 | 19 | 25 | 32 | 17 | 16 | 120 | 852.06 ± 37.28 | 43259.84 |
| $Bc_1$($F_1$ X $P_1$) | - | 5 | 12 | 15 | 21 | 6 | 1 | - | 60 | 568.90 ± 52.72 | 40132.11 |
| $Bc_2$ ($F_1$ X $P_2$) | - | 9 | 8 | 14 | 21 | 7 | - | 1 | 60 | 550.43 ± 52.72 | 40279.32 |
| LSD $^{0.05}_{0.01}$ | | | | | | | | | | $^{506.22}_{666.36}$ | |

**Table 9:** Leaf chemical composition in $P_1$, $P_2$ and $F_1$ generations drived from crosses between some cucumber inbred lines as affected by downy mildew disease.

| ***Parents*** | ***Crosses ($F_1$)*** | **Phenols (mg/100 g fresh weight)** | | | **Sugars (mg/100 g fresh weight)** | | |
|---|---|---|---|---|---|---|---|
| | | **Free** | Conjugate | Total | **Reducing** | ***Non-reduce*** | Total |
| $P_1$ ($TX_{300}$) | | 41.04 | 27.49 | 68.52 | 151.32 | 49.40 | 200.72 |
| $P_1$ ($TX_{301}$) | | 44.74 | 20.07 | 64.81 | 152.71 | 40.39 | 193.09 |
| $P_1$ ($TX_{303}$) | | 60.72 | 5.75 | 66.48 | 154.44 | 32.76 | 187.20 |
| $P_1$ ($TX_{306}$) | | 67.63 | 26.98 | 94.60 | 204.53 | 59.80 | 264.33 |
| $P_2$ ($TX_{302}$) | | 104.16 | 61.28 | 165.44 | 87.79 | 15.67 | 103.44 |
| | $TX_{300}$ X $TX_{302}$ | 60.72 | 36.05 | 96.78 | 119.60 | 30.33 | 149.92 |
| | $TX_{301}$ X $TX_{302}$ | 73.76 | 40.65 | 114.42 | 115.96 | 17.85 | 133.81 |
| | $TX_{303}$ X $TX_{302}$ | 78.88 | 17.38 | 96.26 | 119.42 | 22.36 | 141.78 |
| | $TX_{306}$ X $TX_{302}$ | 82.97 | 36.43 | 119.40 | 106.08 | 43.33 | 149.41 |
| L.S.D. at | 0.05 | **27.01** | **57.59** | **47.59** | **47.64** | **30.21** | **53.19** |
| | 0.01 | **36.72** | **NS** | **64.68** | **64.76** | **NS** | **72.29** |

yield/plant; number of days from planting to the first male flower anthesis and sex ratio; number of days from planting to the first female flower anthesis and yield/plant and between fruit weight and disease reaction. Also, there were significant positive correlation between number of branches/plant and disease reaction; leaf area and number of days from planting to the first female flower anthesis and between yield/plant and set percentage. Moreover, there were significant negative correlation between number of branches/plant and yield/plant and set percentage; number of days from planting to the first female flower anthesis and fruit weight and between disease reaction and set percentage. These results indicated that disease reaction was had highly significant positive correlation with leaf area and highly significant negative correlation with fruit weight or yield/plant. Moreover, disease reaction was had significant positive correlation with number of branches/plant and significant negative correlation with set percentage. These results are in agreement with those of Dhiman *et al.* (1995) who reported that the occurrence of downy mildew had a positive and significant correlation with days to first picking as well as with its pooled value.

A significant correlation was observed between some of the different measurements of resistance used in evaluating the $F_2$ plants of the cross $TX_{303}$ X $TX_{302}$ (Table 12). Highly significant positive correlation's were found between leaf area and disease reaction and between sex ratio and set percentage. On the other side, there were highly significant negative correlation between leaf area and yield/plant; number of days from planting to the first male flower anthesis and female flower and between yield/plant and disease reaction or sex ratio. In addition, there were significant positive correlation between leaf area or disease reaction and sex ratio. From the previous results, it may be concluded that disease reaction were closely correlated with leaf area or yield/plant and correlated with sex ratio. These results corroborate those of Neikov and Alexandrova (1995) reported that yield was significantly correlated with fruit number and weight and also (negatively) with percentage infection with downy mildew.

The correlation coefficients calculated for measurements of resistance to downy mildew disease from data of $F_2$ generation of cross $TX_{306}$ X $TX_{302}$ (Table 13) were significant. The data indicated also that there were highly significant positive correlation between leaf area and number of days from planting to the first female flower anthesis or disease reaction ; number of days from planting to the first female flower anthesis and male or disease reaction as well as sex ratio; and between sex ratio and disease reaction or set percentage. On the other hand, there were highly significant negative correlation between leaf area and fruit weight or yield/plant; number of days from planting to the first male flower anthesis and sex ratio and between fruit weight or yield/plant and disease reaction. Moreover, there were significant positive correlation between fruit weight and yield/plant. It can be concluded that disease reaction were positively and highly correlated with leaf area, number of days from planting to the first female flower anthesis and sex ratio. Meanwhile, there were negative strong correlation between disease reaction and fruit weight or yield/plant. These results agreed with those reported by Mizusawa *et al.* (1996) who found that true leaf area was significantly correlated with length of

**Table 10: Correlation coefficients between some measurements of resistance in the $F_2$ of the cross between $P_1$ ($TX_{300}$ – Susceptible line) and $P_2$ ($TX_{302}$ – Resistant line).**

| ***Characters*** | Leaf area | No. of days from planting to the first male flower anthesis | **Female** | Fruit weight | Yield/plant | Disease | Sex ratio | Set percentage |
|---|---|---|---|---|---|---|---|---|
| No. of branch/plant | 0.046 | 0.167 | -0.021 | -0.076 | -0.091 | 0.102 | -0.050 | 0.036 |
| Leaf area | | 0.088 | 0.225* | -0.339** | -0.608** | 0.691** | 0.176* | 0.027 |
| No. of days from planting to the first male flower anthesis | | | 0.089 | 0.070 | -0.018 | 0.099 | -0.282** | -0.159 |
| Female | | | | -0.145 | -0.298** | 0.321** | 0.116 | 0.094 |
| Fruit weight | | | | | 0.584** | -0.385** | -0.012 | -0.195* |
| Yield/plant | | | | | | -0.813** | -0.177 | 0.172 |
| Disease | | | | | | | 0.266** | -0.129 |
| Sec ratio | | | | | | | | 0.496** |
| Set percentage | | | | | | | | |

*: Significant at 5% level of significance **: Significant at 1% level of significance

**Table 11: Correlation coefficients between some measurements of resistance in the $F_2$ of the cross between $P_1$ ($TX_{301}$ – Susceptible line) and $P_2$ ($TX_{302}$ – Resistant line).**

| ***Characters*** | **Leaf area** | No. of days from planting to the first male flower anthesis | **Female** | Fruit weight | Yield/plant | Disease | Sex ratio | Set percentage |
|---|---|---|---|---|---|---|---|---|
| No. of branch/plant | 0.272** | 0.062 | 0.049 | -0.083 | -0.207* | 0.193* | 0.024 | -0.186* |
| Leaf area | | 0.026 | 0.209* | -.0522** | -0.555** | 0590** | -0.025 | -0.098 |
| No. of days from planting to the first male flower anthesis | | | -0.123 | -0.119 | -0.130 | 0.068 | -0.294** | 0.096 |
| Female | | | | -0.206* | -0.277** | 0.119 | 0.083 | 0.017 |
| Fruit weight | | | | | 0.730** | -0.606** | 0.177 | 0.051 |
| Yield/plant | | | | | | -0.780** | -0.040 | 0.230* |
| Disease | | | | | | | -0.039 | -0.188* |
| Sec ratio | | | | | | | | 0.419** |
| Set percentage | | | | | | | | |

*: Significant at 5% level of significance **: Significant at 1% level of significance

**Table 12: Correlation coefficients between some measurements of resistance in the $F_2$ of the cross between $P_1$ ($TX_{303}$ – Susceptible line) and $P_2$ ($TX_{302}$ – Resistant line).**

| ***Characters*** | **Leaf area** | No. of days from planting to the first male flower anthesis | **Female** | Fruit weight | Yield/plant | Disease | Sex ratio | Set percentage |
|---|---|---|---|---|---|---|---|---|
| No. of branch/plant | 0.037 | -0.105 | 0.037 | 0.126 | -0.037 | 0.016 | -0.017 | 0.044 |
| Leaf area | | -0.039 | 0.079 | 0.047 | -0.783** | 0.606** | 0.198* | -0.063 |
| No. of days from planting to the first male flower anthesis | | | -0.348** | -0.051 | -0.048 | 0.123 | -0.170 | 0.148 |
| Female | | | | 0.007 | -0.076 | -0.001 | 0.094 | -0.006 |
| Fruit weight | | | | | -0.035 | 0.101 | 0.101 | 0.134 |
| Yield/plant | | | | | | -0.772** | -0.270** | 0.048 |
| Disease | | | | | | | 0.188* | 0.171 |
| Sec ratio | | | | | | | | 0.257** |
| Set percentage | | | | | | | | |

*: Significant at 5% level of significance **: Significant at 1% level of significance

**Table 13: Correlation coefficients between some measurements of resistance in the $F_2$ of the cross between $P_1$ ($TX_{306}$ – Susceptible line) and $P_2$ ($TX_{302}$ – Resistant line).**

| ***Characters*** | **Leaf area** | No. of days from planting to the first male flower anthesis | **Female** | Fruit weight | Yield/plant | Disease | Sex ratio | Set percentage |
|---|---|---|---|---|---|---|---|---|
| No. of branch/plant | 0.068 | 0.172 | 0.140 | 0.001 | 0.011 | 0.028 | -0.118 | -0.036 |
| Leaf area | | 0.121 | 0.301** | -0.533** | -0.273** | 0.769** | 0.153 | -0.054 |
| No. of days from planting to the first male flower anthesis | | | 0.437** | -0.137 | -0.111 | 0.152 | -0.233** | 0.003 |
| Female | | | | -0.046 | -0.138 | 0.286** | 0.330** | 0.134 |
| Fruit weight | | | | | 0.225* | -0.550** | 0.166 | 0.033 |
| Yield/plant | | | | | | -0.309** | -0.048 | 0.076 |
| Disease | | | | | | | 0.255** | 0.078 |
| Sec ratio | | | | | | | | 0.545** |
| Set percentage | | | | | | | | |

*: Significant at 5% level of significance **: Significant at 1% level of significance

**Table 14: Multiple correlation coefficients between fruit yield/plant and its studies components in the $F_2$ of the cross between $P_1$ ($TX_{300}$ – Susceptible line) and $P_2$ ($TX_{302}$ – Resistant line).**

| Crosses | Involved indepent variables | R-Square | Multiple R | Significance |
|---|---|---|---|---|
| **($TX_{300}$ X $TX_{302}$)** | Leaf area | 0.680 | 0.825 | ** |
| | No. of days from planting to the first male flower anthesis | | | |
| | No. of days from planting to the first male flower anthesis | | | |
| | Disease | | | |
| | Sex ratio | | | |
| | Set percentage | | | |
| **($TX_{301}$ X $TX_{302}$)** | Leaf area | 0.696 | 0.834 | ** |
| | No. of days from planting to the first male flower anthesis | | | |
| | No. of days from planting to the first male flower anthesis | | | |
| | Disease | | | |
| | Sex ratio | | | |
| | Set percentage | | | |
| **($TX_{303}$ X $TX_{302}$)** | Leaf area | 0.781 | 0.884 | ** |
| | No. of days from planting to the first male flower anthesis | | | |
| | No. of days from planting to the first male flower anthesis | | | |
| | Disease | | | |
| | Sex ratio | | | |
| | Set percentage | | | |
| **($TX_{306}$ X $TX_{302}$)** | Leaf area | 0.113 | 0.337 | * |
| | No. of days from planting to the first male flower anthises | | | |
| | No. of days from planting to the first male flower anthises | | | |
| | Disease | | | |
| | Sex ratio | | | |
| | Set percentage | | | |

*: Significant at 5% level of significance **: Significant at 1% level of significance

petioles, internodes on the main stem and lateral branches. In neither case was leaf size correlated with fruiting potential.

The results presented in Table (14) showed highly significant correlation between yield/plant and some component characters i.e. leaf area, number of days from planting to the first male or female flower anthesis; disease reaction; sex ratio and set percentage. This results were highly significant in the crosses $TX_{300}$ X $TX_{302}$, $TX_{301}$ X $TX_{302}$ and $TX_{303}$ X $TX_{302,}$ but it was sigin cross $TX_{306}$ X $TX_{302}$. These results are in agreement with Saikia *et al*, (1995) and Paiva (1997) who showed that yield/plant had strong positive association with main vine length; number of secondary branches; leaf area; fruiting percentage, number of fruits per plant; fruit weight and fruit length at genotypic and phenotypic correlations.

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**وراثة وطبيعة المقاومة لمرض البياض الزغبي في الخيار**

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**تم التهجين بين خمسة سلالات من الخيار: الأب الأول عبارة عن أربع سلالات حساسة لمرض البياض الزغبي في الخيار – والأب الثاني عبارة عن سلالة بها صفة المقاومة لهذا المرض.**
**نباتات الأباء والجيل الثاني والتهجينات الرجعية مع كلا الأبوان تم تقييمهما لصفة المقاومة للبياض الزغبي في الخيار و علاقة ذلك ببعض صفات النمو الخضري والمحصول ومكوناته.**
**أوضحت النتائج المتحصل عليها أن صفة المقاومة لمرض البياض الزغبي في الخيار يتحكم فيها زوجان من العوامل الوراثية ذات التفاعل السائد والمتنحي. صفة الحساسية للمرض سائدة علي صفة المقاومة للمرض والنباتات المقاومة يتحكم فيها عامل وراثي سائد ( R ) ولا يظهر تأثير هذا العامل الوراثي إلا في وجود العامل الوراثي المتنحي ( s). بعض الصفات الكمية المكونة لصفة المقاومة لمرض البياض الزغبي تم توريثها كميا مثل مساحة الورقة – عدد الأيام اللازمة من زراعة البذرة حتى تفتح أول زهرة مذكرة وأول زهرة مؤنثة – محصول النبات من الثمار – النسبة الجنسية ونسبة العقد.**
**طبيعة السيادة في بعض مكونات المقاومة لمرض البياض الزغبي تراوحت بين سيادة جزئية إلي سيادة متفوقة وذلك في الهجن المختلفة. نسبة التوريث بمعناها الواسع والضيق لصفة المقاومة لمرض البياض الزغبي تراوحت بين نسبة منخفضة إلي فوق متوسطة إلي عالية في التهجينات المختلفة وذلك عند قياس المقاومة بطرق مختلفة.**
**أوراق نباتات الأباء المقاومة لمرض البياض الزغبي كانت تحتوي علي أعلي كمية من الفينولات الحرة والمرتبطة والكلية بينما كانت تحتوي علي أقل كمية من السكريات المختزلة وغير المختزلة والكلية. وعلي العكس من ذلك فإن أوراق نباتات الأباء الحساسة لمرض البياض الزغبي كانت تحتوي علي أقل كمية من الفينولات الحرة والمرتبطة والكلية وكانت تحتوي علي أعلي كمية من السكريات المختزلة وغير المختزلة والكلية.**
**هناك ارتباط معنوي موجب وعالي المعنوية بين شدة المرض وكل من مساحة الورقية أو عدد الأيام اللازمة من زراعة البذرة وحتى تفتح أول زهرة مؤنثة أو النسبة الجنسية – بينما كانت العلاقة سالبة بين شدة المرض ووزن الثمرة أو محصول النبات من الثمار. علاوة علي ذلك كانت هناك علاقة عالية المعنوية بين محصول النبات من الثمار وكل من مساحة الورقة وعدد الأيام اللازمة من زراعة البذرة وحتى تفتح أول زهرة مذكرة أو أول زهرة مؤنثة وشدة المرض والنسبة الجنسية ونسبة العقد.**