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INHERITANCE OF SOME IMPORTANT CHARACTER, AS WELL AS RESISTANCE TO POWDERY MILDEW DISEASE IN SQUASH (*Cucarbita pepo* L.).

M.K. Hatem[(1)] and Seham S. M. Ragab[(2)]

[(1)] Hort., Res. Institute, Agric. Res. Center, Giza, Egypt .
[(2)] Plant Pathology Research Institute, ARC, Egypt .

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ABSTRACT: *The present investigation was carried out at Barrage, Horticulture Research Station, during three successive summer seasons 2009, 2010 and 2011. The genetic materials used in this study were four parental lines and cultivars of squash [Cucarbita pepo (L.)] viz, M1, M3, Eskandrani and Saturn F_1. Seeds of the parents were sown in summer season of 2009 and crossed to optain the F_1 hybrids. In 2010, seeds of the eight populations viz, four parents, two F_1's(M1 X Eskandrani & M3 X Eskandrani) were planted to obtain F2 generation. In 2011, the four parents, two F_1 crosses and their two F_2 populations were planted in field experiment for evaluation and studying some traits viz, powdery mildew disease severity % (in a glasshouse and open field), Polyphenoloxidase, Peroxidase, stem length, number of leaves, average fruit weight, total fruit number/plant and total yield fruit weight. The results indicated that the inheritance of* resistance *was found to be simple with complete dominance for resistance with estimated heritability (h^2_b) ranged as 98.85% and 99.58% in the two crosses respectively. For stem length and number of leaves showed the complete dominance for the same parent (resistance parent) .The average fruit weight and total yield as fruit weight found to be controlled by more than three pairs of genes with mostly additive gene action and partial dominance for the average fruit weight for the susceptible parent (Eskandrani). Total yield as fruit weight for the best parent (M1and M3). Furthermore, the presence of many minor genes was required for the expression of these traits. The heritability for average fruit weight was 45.50% and 60.33% but for the total yield fruit weight it was 72.29% and 73.86% in the two crosses, respectively, the relatively low value heritability indicates that the average fruit weight and total yield fruit are affected by environmental conditions. Polyphenoloxidase and Preoxidase increased in F_1 and resistance parents .Significant negative correlations were found between disease severity and all traits.*

Key words: *Squash, Cucurbita pepo L., Disease severity %, Heterosis, Potence ratio, Genetical variance, Heritability (h^2_b %), Minimum number of genes.*

INTRODUCTION

Squash, *Cucurbita pepo* L. is one of the most vegetable crops in Egypt. It is a multipurpose crop valued for its tender and delicious fruits, which can be used fresh In Egypt. The cultivated area in 2010 according to statistics of the Ministry of Agriculture, reached about 83093 feddans around year for the all season and its production reached, nearly 1032015 tons with an average of 12.420 ton/fed. It is an easy crop to grow and begins production within a relatively short time after planting. Often the greatest challenge presented to growing this crop successfully is its susceptibility to diseases. One of the most important diseases attacking summer squash is powdery mildew, incited by *Sphaerotheca fuliginea* (*Schlecht. ex Fr.*) Poll. and *Erysiphe cichoracearum* DC ex Mérat (Sitterly, 1979). Manifested as circular, white spots several mm in diameter on plant leaves and stems, powdery mildew can spread quickly through the field. Eventually, it colonizes all but the youngest foliage, weakening the plants and lowering yield. Application of fungicides that are systemic or translaminar in their activity is the principal method used for powdery mildew control in cucurbits, but these have often been rendered ineffective through the development of resistance by the pathogen (McGrath, 2001). Attempts at breeding

squash (*Cucurbita pepo*) resistant to powdery mildew have heretofore been unsuccessful due mainly to association of the resistance trait with reduction in yield. The goal of the present work was to determine if heterozygous hybrids expressing partial resistance could be potentially valuable for squash growers. One heterozygous hybrid each of zucchini, cocozelle, and vegetable-marrow squash was grown alongside a leading susceptible commercial hybrid cultivar of the same type, under standard field conditions. Although fungicides were applied at recommended doses every 6 to 13 days to suppress powdery mildew, the susceptible hybrids became heavily infested later in the season. The resistant hybrids were similar to their respective commercially available susceptible hybrids in fruit appearance and other horticulturally important traits. The resistant hybrids yielded at least as well as the commercial hybrids early in the season and outyielded them later in the season (Paris and Cohen, (2002). Resistance was reportedly conferred by a single dominant gene when a resistant wild species, *C. lundelliana* Bailey, was crossed with the cultivated *C. moschata Duchesne* (Rhodes, 1964). A single incompletely dominant gene was reported to confer resistance when the resistant wild species, *C. okeechobeensis* (Small) Bailey ssp. martinezii (formerly *C. martinezii Bailey*) was used as the source of resistance in a complex cross involving *C. moschata* and *C. pepo* (Contin and Munger, 1977). Resistance within *C. moschata* was later reported to be oligogenic(Adeniji and Coyne, 1983). On the other hand, the environment, plant age, and genetic background affect disease expression (Yarwood *et al.*, 1954; Palti, 1961; Schnathorst, 1965; Aust and v. Hoyningen-Huene, 1986; Leibovich *et al.*, 1995, 1996; Lebeda and Kristkova, 2000), often making identification of resistant genotypes difficult (Cohen *et al.,* 1993; Lebeda and Kristkova, 1996). A single incompletely dominant gene was reported to confer resistance when the resistant wild species, *C. okeechobeensis* (Small) Bailey ssp. martinezii (formerly *C. martinezii* Bailey) was used as the source of resistance in a complex cross involving *C. moschata* and *C. pepo* (Contin and Munger, 1977). Cohen, *et al*., 2003 found plants of the parental accessions and their progenies were grown together in a controlled-environment chamber, exposed to the pathogenic fungus, and scored as resistant, partially resistant, or susceptible 27–33 days after sowing. The results indicated that resistance is conferred by a single incompletely dominant gene, designated *Pm-0*.

Avdiushko *et al*. (1993); Gamil (1995); Mosa (1997) and Ahmed (2005) detected an increase in the activities of peroxidase, polyphenoloxidase, lipoxygenase, chitinase and a-glucosidase in cucumber and squash leaves in the vicinity of lesions caused by dipotassium phosphate application. Orober *et al*. (1998) found an increase in the activities of peroxidase and polyphenoloxidase in all parts of the induced plants as a further consequence to the induction of systemic acquired resistance of phosphate application in cucumber against powdery mildew.

Attempts at breeding squash (*Cucurbita pepo*) resistant to powdery mildew (*Sphaerotheca fuliginea*:fr) have heretofore been unsuccessful due mainly to association of the resistance trait with reduction in yield. The goal of the present work was to determine if heterozygous hybrids expressing partial resistance could be potentially valuable for squash growers. One heterozygous hybrid each of zucchini, cocozelle, and vegetable-marrow squash was grown alongside a leading susceptible commercial hybrid cultivar of the same type, under standard field conditions.

Increasing yield, to meet the requirement of increasing population can be achieved by developing, selection and releasing new yielding cultivars or hybrids with good fruits quality through breeding and selection programs.

MATERIALS AND METHODS

- Field Experiment

The present's investigation was carried out at Barrage Horticulture Research Station, during three successive summer seasons

2009, 2010 and 2011. The genetic materials used in this study were four parental lines cultivars of squash (*Cucarbita pepo* L.) viz, the domestic cultivar Eskandarani susceptible to *Sphaerotheca fuliginea* (Schlecht. Ex Fr. Pol), race 1 and 2 (Ahmed *et al* 2001) was used. It obtained from Dept. of Vegetable Crop Res., Agric. Res. Centre, Giza while, the lines,M1, M3 were obtained from College of Horticulture, Northwest University, China and cv. Saturn (Resistance) production company Agrotip.

These parental lines were at a high degree of homozygosity since they were salved for two generations.

The four parents were planted in the field in summer 2009 and possible crosses between "M1 and Eskandrani" and "M3 and Eskandrani" were made to obtain the F_1 crosses.

These F_1's of the two crosses viz, M1 x Eskandrani and M3 x Eskandrani whose parents were widely differed in their fruit characteristics were sown in summer season of 2010 to obtain the F_2 populations.

Seeds of the eight populations viz, 4 parents, two F_1's, and two F_2 for these crosses, were planted in the field on March 14th of 2011 season for studying the inheritance of the some traits. A randomized complete block design with three replicates was adopted. Each replicate included 12 plants of each parent and F_1's and 48 plants of F_2 were planted at 50 cm apart with in plants.

The cultural practices were carried out according to the recommendations reported by Ministry of Agriculture.

Harvesting period started from late of April and continued up to late June, fruits were picked with their peduncles in the morning at three days intervals during the entire season.

- Greenhouse Experiment:-

Seeds of the eight populations studied were planted in the greenhouse on March 14th of 2011 season for studying the inheritance of some traits. Five seeds were sown per pot (30 cm diameter) containing a sandy loam soil under greenhouse conditions (20-24C°). A randomized complete block design with five replicates was adopted.

For inoculation, the conidia of *S. fuliginia* were collected from naturally infected leaves of squash plants. Conidial suspensions in sterilized water, were adjusted to $3x10^4$ conidia/ ml, then atomized onto the upper leaf surface of squash plants. The treated plants were separated into one group:

Plants of the first group were inoculated with *S. fuliginia* ($3x10^4$ conidia/ ml.) at the second and third leaf phase, and then received the treatment concerned.
The studied traits were:

[1] Disease assessment: Disease severity was estimated on an arbitrary scale of **(0-5) according** to Descalzo *et al*. (1990), where,
0 = no mildew colonies observed
1 = 1-25 colonies/leaf
3 = 51-75 colonies/ leaf
4 = 76-100 colonies/leaf
5 = > 100 colonies per leaf.

Disease severity %= خطأ! الإشارة المرجعية غير معرّفة. / خطأ! الإشارة المرجعية غير معرّفة.

$$\frac{\sum(\text{disease rating X number of leaves for that specific rating})}{\text{Maximum rating of disease severity per test leaf X total of test leaves}} \times 100$$

Examined disease severity score after two weeks of treatment in the greenhouse experiment, and after 40 days in open field experiment.

[2] Changes in phenolic compounds:
A known amounts (5g.) of cucumber fruits were cut into small portions, immediately plunged into 95% boiling ethanol for 10 min., in order to kill the tissues then extracted for 10-12 hrs in soxhlet units using 75% ethanol till the percolate was colorless. The combined ethanol extracts were filtered and rotary evaporated to near dryness at 60ºC. The dried residues were re-dissolved in a known volume (5ml) of 50% isopropanol alcohol. The later isopropanol extracts were used for determining free, total and conjugated phenols using Folin and Ciocalteu's phenol reagent as described by Snell and Snell (1953). Phenolic compounds were calculated as milligrams equivalent of

catechol/5g fresh weight of leaves.

Activities of the oxidative enzymes

Oxidative enzymes activity was determined in inoculated squash with the two tested fungi. Enzymes extract was obtained by grinding the tissues in 0.1 M sodium phosphate buffer at pH 7.1 (2 ml/g fresh weight) in china mortar. Plant tissue (g) was homogenized in a mortar with 0.2 M Tris HCl buffer (PH 7.8) containing 14 MMB. Mercapto ethanol rate of 1/3 W/V.

The extracted tissues were strained through four layers of cheesecloth. The filtrate was centrifuged at 3000 rpm for 15 minutes at 6°C. The supernatant was served in the refrigerator at -20°C till determination of enzymes (Tuzun *et al.,* 1989).

A. Polyphenoloxidase (PPO) activity

For polyphenoloxidase determination, a colorimetric method proposed by Matta and Dimond (1963) was used. The reaction mixture consists of 1.0 ml enzyme extract, 1.0 ml of 0.2 M sodium phosphate buffer at pH 7.0 and 1.0 ml of 10 M Catechol brought to final volume of 6.0 ml with distilled water. The activity of polyphenoloxidase was expressed as the change in absorbance /minute /g. fresh weight at optical density of 495 nm.

B. Peroxidase (PRO) activity:

Peroxidase activity was determined according to Allam and Hollis, (1972) by measuring the oxidation of pyrogallol to purogallin in the presence of H2O2 at 425 nm. The reaction mixture consists of 0.5 ml of 0.1 M sodium phosphate buffer solution at pH 7.0, 0.5 ml enzyme extract, 0.3 Pyrogullol, 0.1 ml 1.0% H2O2 brought to final volume of 3.0 ml with distilled water. Peroxidase activity was expressed as the change in absorbance / minute / g. fresh weight.

Peroxidase and polyphenoloxidase assays were carried out using (Spectronic 601). The control cuvette contained the same solution except that the substrate solution was replaced by distilled water. Readings were recorded every 30 S for 5 minutes in case of peroxidase and polyphenoloxidase.

[3] Stem length (cm.) and number of leaves per plant in open field: The plants were dug out at the end of season and the leaves numbers were counted. [5] Average fruit weight (gm.).

[4] Total yield as fruit number.

[5] Total yield as fruit weight/ plant (g.).

Statistical Procedures:

[1] Analysis of variance was made in order to test the levels of significance among the mean values of the tested populations for all traits, using least significance differences (L.S.D.), according to Steel and Torrie (1960).

[2] Estimates of genetic parameters were calculated according to Warner *et al.* (1980), as follows:

a) Average degree of heterosis (ADH %), was expressed as perecent increase or decrease of the performance above the mid-parents (MP) value and the high parent (HP) value (Sinha and Khanna, 1975) .

b) Potence ratio (PR) = $\overline{F_1} - MP / \frac{1}{2}(\overline{P_2} - \overline{P_1})$. (Smith, 1952).

c) Heritability (h_b^2) = V_G/V_E.

where, $\overline{P_1}, \overline{P_2} and \overline{F_1}$ are the means of P_1, P_2 and F_1, respectively. (MP) is the mid-parental value.

[3] Chi square test was used to compare the observed and the theoretical ratios (Steel and Torrie, 1960) in the studied populations.

[4] The minimum number of gene pairs responsible for various characters differences between parents of different crosses was calculated according to Castle and Wright (1921).

Frequency distribution tables were also prepared for populations for each studied trait. These tables were used in preparing histograms showing the percentage of plants in various levels of the trait.

[5] The relationships between some traits were determined by estimating the correlation coefficients (Snedecor, 1962).

All normal agricultural practices for squash production were done and the plants were left to natural infection for a disease

powdery mildew.

RESULTS AND DISCUSSION

There were no differences among replications for two studies trials. Therefore, data were pooled for genetic analysis.

[1]Inheritance of disease severity%

The crosses "M1 x Eskandrani" and "M3 x Eskandrani" were used in studying the mode of inheritance of this trait.

Data presented in Figures 1 and 2 showed highly significant difference between the two parental lines for each cross in this trait. The parental lines M1 and M3 were differ significantly than Eskandrani by about (45.22 and 46.88) and (44.22 and 47.05) in disease severity %, respectively, in pots and open field examinations. It means that the parents M1 and M3 were resistant than the parent Eskandrani. The parental lines for each cross had distinct non-overlapping ranges.

The average degree of heterosis (ADH%) was estimated as -82.45% and 3.61% based on MP and HP, respectively, in the cross M1 x Eskandrani and as -84.42% and 39.56%, based on MP and HP, respectively, in the cross M3 x Eskandrani, in the pots examination, and -83.95% and -11.36% based on MP and HP, respectively, in the cross M1 x Eskandrani and as -89.35% and 32.38%, based on MP and HP, respectively, in the cross M3 x Eskandrani, in the open field examination . This values suggest compete dominance for the resistance parents. The estimated potence values (-0.99 and -0.95, respectively in the pots examination) and as (-1.03 and -0.97, respectively in the open field examination) for the two crosses were in accordance with the suggested dominance hypothesis of the resistant parent (Table 1). It is noticed that the parent which showed fewer Disease severity % is considered as HP. All plants of resistance cultivar.

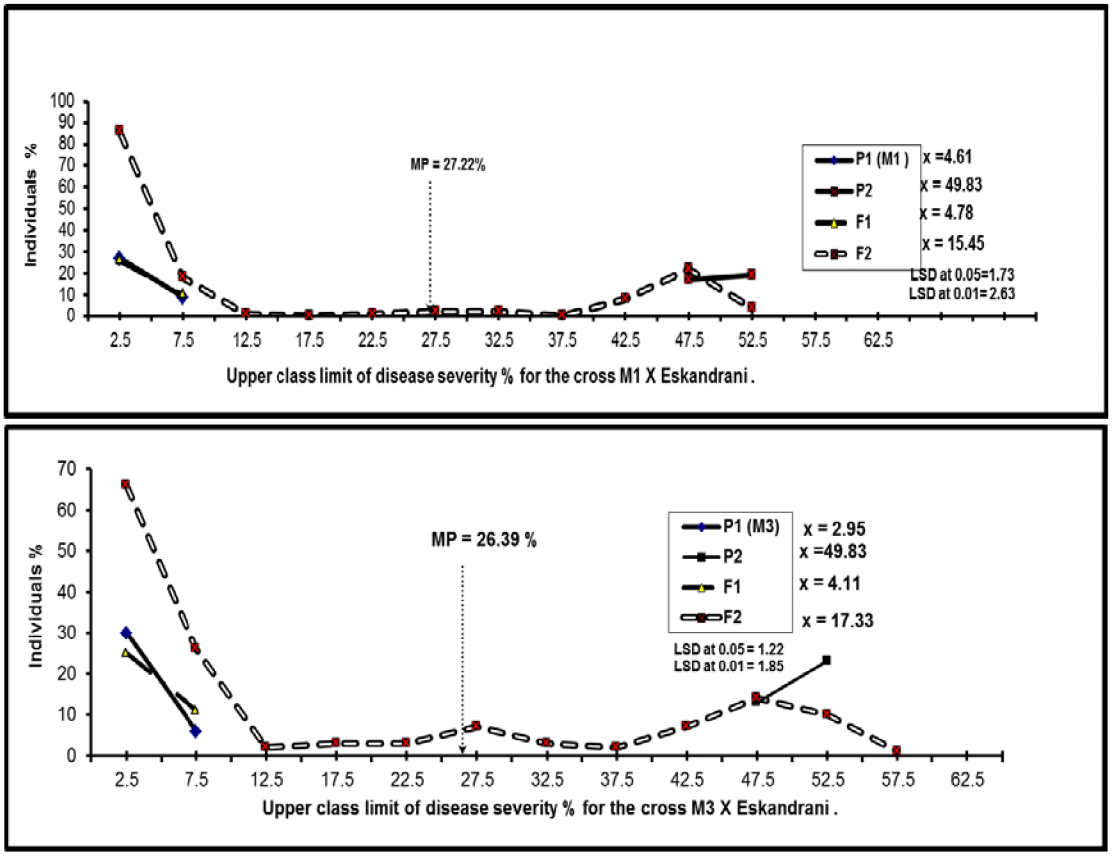


Fig. (1) : Distribution of disease severity % in parental lines , F_1 and F_2 plants for the

crosses (M1 x Eskandrani) and (M3x Eskandrani) in the examination (pots) .

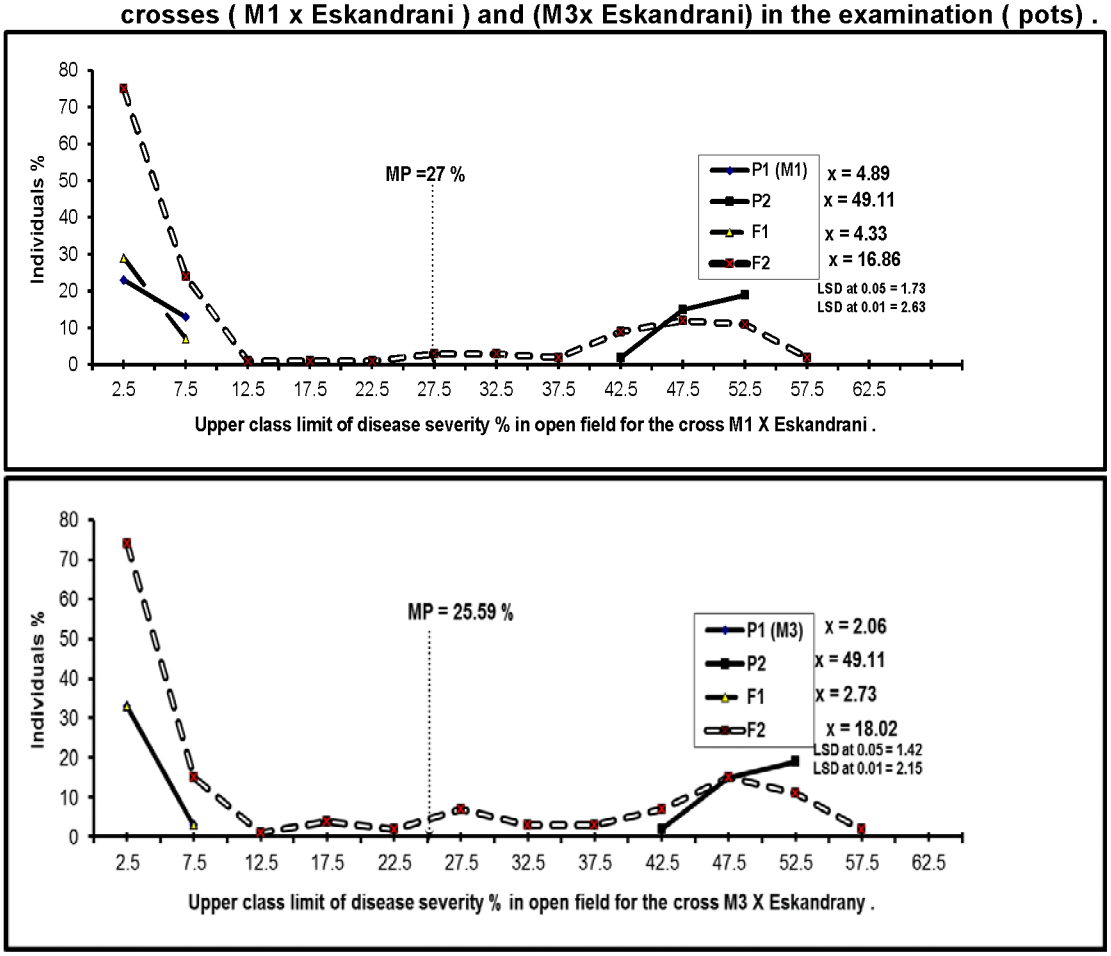


Fig. (2) : Distribution of disease severity % in parental lines , F_1 and F_2 plants for the crosses (M1 x Eskandrani) and (M3x Eskandrani) in open field .

Table (1): Estimates of genetic parameters for the resistance character.

Genetic parameters	Disease severity % in pots experiment .		Disease severity % in the open field.	
	M1 x Eskandrani	M3 x Eskandrani	M1 x Eskandrani	M3 x Eskandrani
ADH % :- - based on MP - based on BP	 -82.45 3.61	 -84.42 39.56	 -83.95 -11.36	 -89.35 32.38
Potence ratio (PR)	-0.99	-0.95	-1.03	-0.97
Heritability in broad sense (h_b^2%)	99.58	98.86	99.31	98.85
Minimum number of genes.	0.79	0.828	0.70	0.77

The distribution of F_1 plants clearly reveals complete dominance of the resistant parent. Most plants covered the range exhibited by the resistant parents (M1 and M3) in the two crosses.

In pots experiment, about 72.22% of the

F_2 plants for the cross (M1 x Eskandrani) convered the range exhibited by P_1 (M1) and F_1 population in pots in the second examination. The remaining F_2 plants (27.78%) covered the range exhibited by P_2 (Eskandrani). Meanwhile, about 61.11% of the F_2 plants for the cross (M3 x Eskandrani) covered the range exhibited by P_1 (M3) and F_1 population but the remaining F_2 plants (38.89%) covered the range exhibited by P_2 (Eskandrani), the recessive parent in the second examination in pots. Regarding open field experiment, about 68.75% of the F_2 plants for the cross (M1 x Eskandrani) covered the range exhibited by P_1 (M1) and F_1 population in open field and (31.25%) covered the range P_2 and about 61.81% of the F_2 plants for the cross (M3 x Eskandrani) covered the range exhibited by P_1 (M3) and F_1 population but the remaining F_2 plants (38.19%) covered the range exhibited by P_2 (Eskandrani), the recessive parent (Fig. 1 and 2) .These ratios are fit a 3 : 1 ratio using X^2 test with probability of 0.50 – 0.95. These distribution leads to suggest that disease severity % in these crosses is controlled by a single pair of gene with dominance of the resistant parents. Similar results were obtained by Paris and Cohen, (2002) and Rhodes, (1964).

Expected F_2 means for the two crosses were calculated according to the monogenic inheritance of the character and the dominance of resistance genes using Powers (1955) formula: $F_2 = P_1$ (¾) + P_2 (¼), where P_1 and P_2 are the means of dominant and recessive parents, respectively. The expected means (15.92 and 14.67, respectively, in pots experiment) for the two crosses and the actual means (15.45 and 17.33, respectively) for the crosses M1 x Eskandrani and M3 x Eskandrani, support the hypothesis presented. And as expected means (15.95 and 13.82, respectively, in the open field examination) for the two crosses and the actual means (16.86 and 18.02, respectively) for the crosses M1 x Eskandrani and M3 x Eskandrani, also support the hypothesis presented.

Heritability in broad-sense (h_b^2) for the crosses " M1 x Eskandrani " and " M3 x Eskandrani " was high (99.58% and 98.86% , respectively , in pots experiment) and (99.31 % and 98.85 respectively , in open field) . These values are in accordance with the monogenic inheritance of the character, since such these traits not affected by the environmental conditions. However, (h_b^2) values suggested that progress could be made in resistance to powdery mildew disease in squash by breeding and selection within segregating progenies (Table 1). Shalaby , (1975) found that broad sense heritability in squash was 86.3 % for powdery mildew resistance.

The average disease severity % in the control cultivar (Saturn cv.) was estimated as 4% in the two experiments.

[2] Stem length in open field

Data presented in Fig. (3) revealed significant difference between the two parental lines in Stem length in the two studied crosses . The parents M1 and M3 exceeded the Eskandrani by about 12.59and 10.84 Centimeter, respectively. The two parents for each cross had distinctly non-overlapping ranges.

The ADH%, based on the mid-parental values for the crosses (M1 x Eskandrani) and (M3 x Eskandrani), was estimated as 4.49% and 5.44%, respectively, indicating dominance towards the high parents (M1 x Eskandrani) and (M3 x Eskandrani). The obtained insignificant ADH% values (0.83% and -0.37%) for the two studied crosses, in relation to the high parents (best parent), suggesting complete dominance for the long stem. The estimated potence values (1.24 and 0.93, respectively) for the two crosses were in accordance with the suggested complete dominance hypothesis (Table 2). It approximately equal 1.0.

The F_1's frequency distribution for the two studied crosses were skewed towards the high parents, as expected when the characters supporting the complete dominance.

The distributions of the F_2 plants for the two studied crosses were stretched over a wide range of the stem length, indicating that

the character may be controlled by many genes. Slight skewness towards the low parents is observed. This unexpected skewness may be due to one or more of the following cases : (1) Apparent of some F_2 plants with an average stem length within the range of the low parent due to some overlapping of the phenotypes. (2) It is possible that some plants appeared lower in stem length due to some environmental factors. (3) Expression of high stem length apparently influenced by modifying genes and environment.

About 95.14% of the F_2 plants for the cross M1 x Eskandrani and 94.44% for the cross M3 x Eskandrani were covered the range exhibited by the high parents M1 and M3) for the two crosses, and F_1 populations. The remaining F_2 plants (4.86% and 5.56%, respectively) for the two crosses covered the range exhibited the recessive parents (Eskandrani).

The minimum number of genes was estimated as 1.94 and 2.63 according to Castle & Wright, formulae in the two crosss (M1 x Eskandrani) and (M1 x Eskandrani), respectively. The heritability (h_b^2) was estimated as 51.99 % and 74.52 %, in the two crosses respectively. The (h_b^2) indicates that length is relatively affected by environmental conditions because it controlled by many genes (Table 2).

It appears from the examination of data presented that the stem length is controlled by more about two pairs of genes with mostly dominance for the high stem length. The present results confirms previous findings of Cohen, *et al.* (2003).

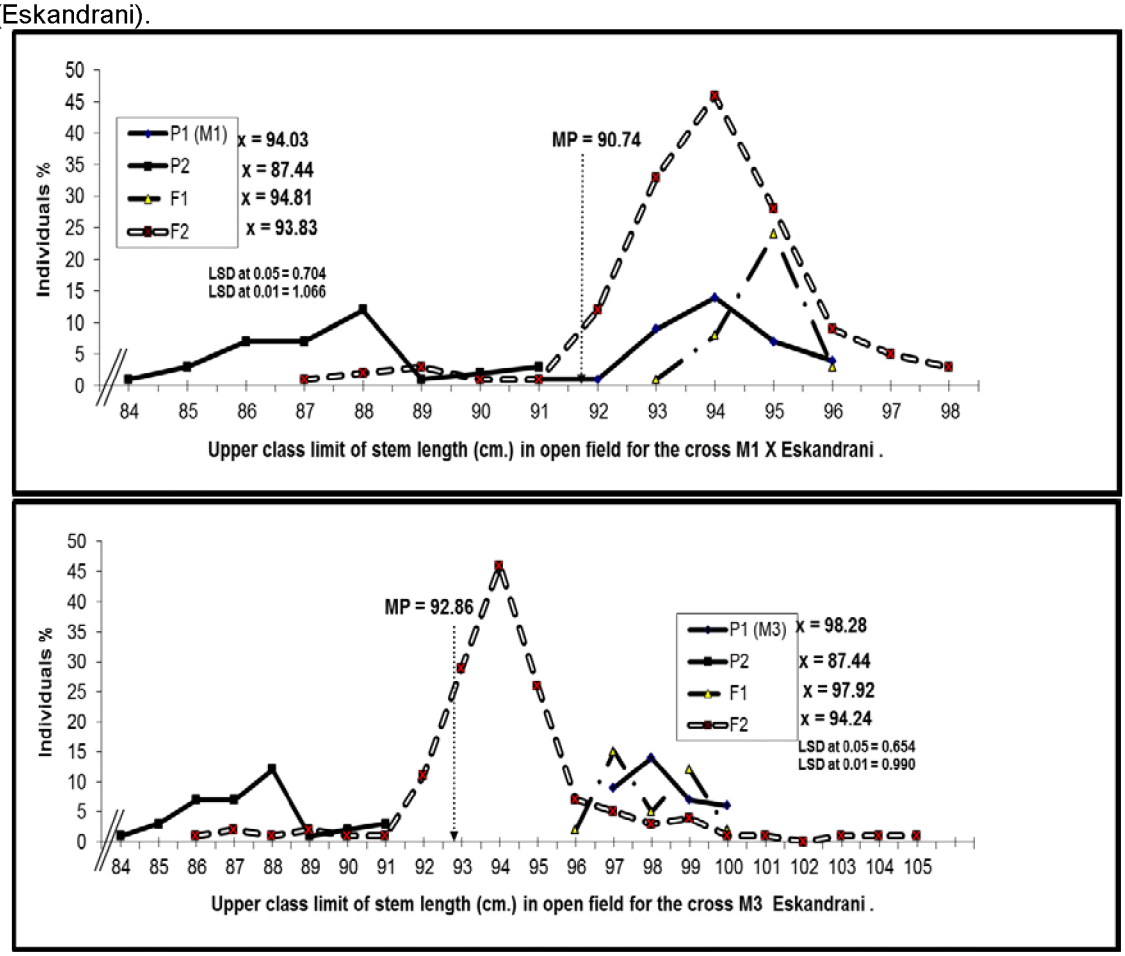


Fig. (3): Distribution of stem length (cm.) in parental lines, F_1 and F_2 plants for the crosses (M1 x Eskandrani) and (M3x Eskandrani) in open field.

Table (2) : Estimates of genetic parameters for studied characters.

Genetic parameters.	F_1 crosses.	ADH%		Potence ratio(PR).	Heritability in broad sense (h_b^2)%.	Minimum number of genes.
		Based on MP.	Based on HP.			
Stem length	M1 × Eskandrani	4.49	0.83	1.24	51.99	1.94
	M3 × Eskandrani	5.44	-0.37	0.93	74.52	2.63
No. of leaves	M1 × Eskandrani	10.28	1.09	1.13	62.55	2.90
	M3 × Eskandrani	11.74	1.01	1.00	75.93	3.51
Average fruit weight	M1 × Eskandrani	-7.08	-15.88	-0.68	60.33	3.56
	M3 × Eskandrani	-6.09	-14.63	-0.61	45.52	2.02
Total fruit number/ plant	M1 × Eskandrani	25.37	7.69	1.54	78.16	2.33
	M3 × Eskandrani	28.18	6.73	1.40	78.29	2.21
Total fruit weight/ plant	M1 × Eskandrani	14.52	-9.41	0.55	73.86	3.39
	M3 × Eskandrani	18.02	-8.84	0.61	72.29	3.99

[3] Number of leaves / plant in open field

Data presented in Fig. (4) revealed significant difference between the two parental lines for each cross in this trait. The parents M1 and M3 significantly exceeded the parent Eskandrani by about 5.50 and 9.25 leaves /plant, respectively. The two parents for each cross had distinctly non-overlapping ranges.

Significant differences were observed between obtained (33.36 and 34.78 leave / plant) and expected (30.25 and 31.13 leave / plant) of the F_1's populations in the two studied crosses. The ADH%, based on the MP values was estimated as 10.28% in the cross "M1 x Eskandrani" and 11.74% in the cross "M3 x Eskandrani ", indicating dominance towards the high parents. Complete dominance for the high number of leaves was detected in these crosses, since it showed non-significant ADH values in relation to high parents. These values were (1.09% and 1.01%, respectively) in the two crosses. The estimated potence values (1.13 in the first cross and 1.00 in the second cross were supported the suggested dominance hypothesis (Table 2). Similar results were obtained by Cohen, *et al.* (2003). The F_1's distribution was skewed towards the high parents, due to the dominance of the high parents. Significant difference between the means of the F_1 and F_2 supporting the complete dominance of the high number of leaves (Table 2).

The distribution of the F_2 plants for the two crosses stretched over a wide range as number of leaves / plant. About 80.65% of the F_2 plants for the cross M1 x Eskandrani and 72.92% for the cross M3 x Eskandrani were covered the range exhibited by the high parents M1 and M3) in the two crosses, and F_1 populations. The remaining F_2 plants (19.35% and 27.08%, respectively) in the two crosses covered the range exhibited the recessive parents (Eskandrani). The BSH (h_b^2 %) was estimated as 62.55% in the cross "M1 x Eskandrani " and 75.93% in the cross M3 x Eskandrani. The relatively low BSH (h_b^2 %) obtained indicates that number of leaves is controlled affected by

environmental conditions.

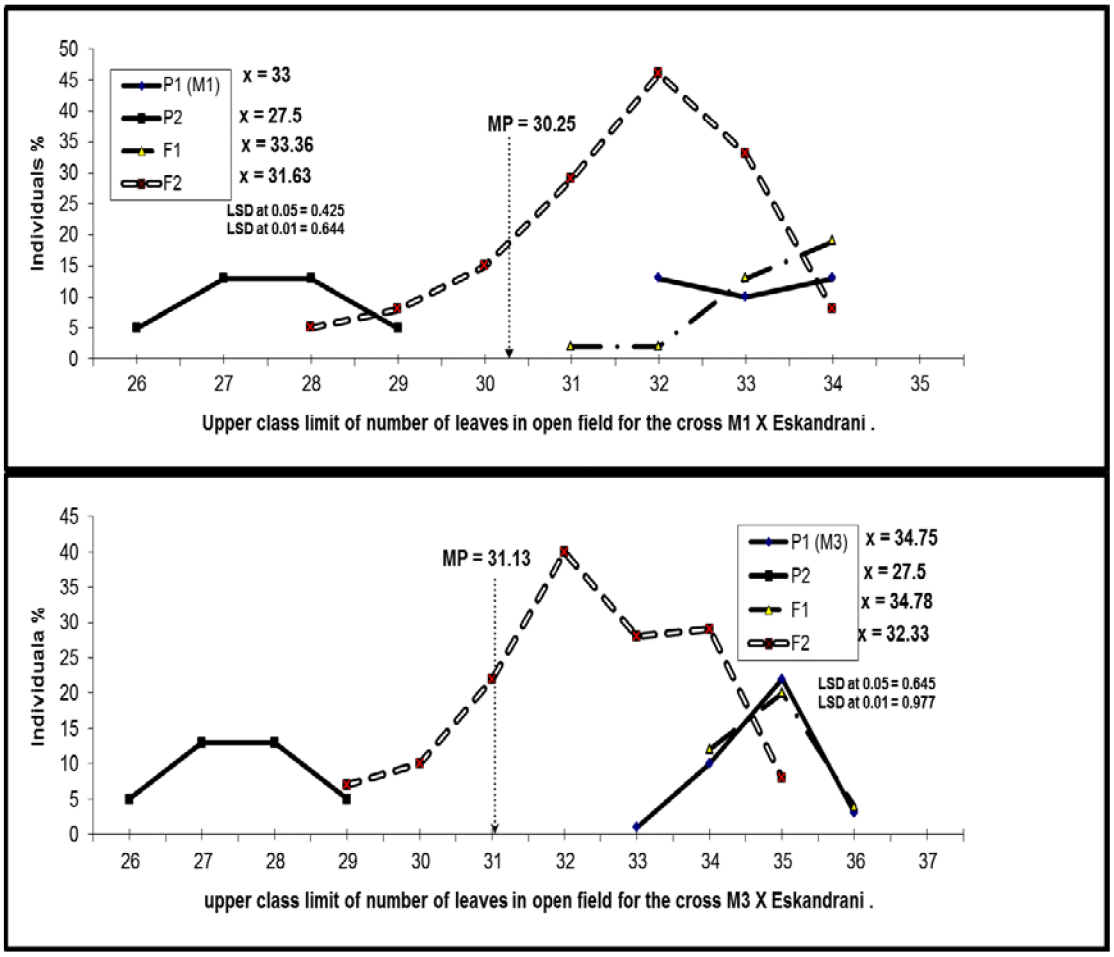


Fig. (4): Distribution of number of leaves in parental lines, F_1 and F_2 plants for the crosses (M1 x Eskandrani) and (M3x Eskandrani) in open field.

[4] Average of fruit weight:

Data presented in Fig. (5) revealed significant difference between the two parental lines for each cross in this trait. The two parents for each cross had distinctly non-overlapping ranges.

Significant differences were observed between obtained (87.72 and 88.19 gm.) and expected (94.41 and 93.92 gm.) arithmetic means of the F_1's populations for the two studied crosses. It is noticed that, the obtained mean was lower than the theoretical one. It could be explained by the strong partial dominance of the small fruits. The ADH%, based on the MP values was estimated as -7.08% in the cross "M1 x Eskandrani" and -6.09% in the cross "M3 x Eskandrani ", indicating dominance towards the small fruit parent. Partial dominance for the small fruit for average fruit weight was detected in these crosses, since it showed significant negative ADH values in relation to high parents. These values were (-15.88% and -14.63%, respectively) for the two crosses. The estimated potence values (-0.68 in the cross M1 x Eskandrani and -0.61in the cross M3 x Eskandrani) was in accordance with the suggested negative partial dominance and additive effects hypothesis (Table 2). Similar results were obtained by Paris and Cohen (2002).

The F_1's frequency distribution was skewed towards the low parents, due to the

partial dominance of the small fruit. Significant difference between the actual means of the F_1 and F_2 supporting the partial dominance of the low fruit weight. (Table 2).

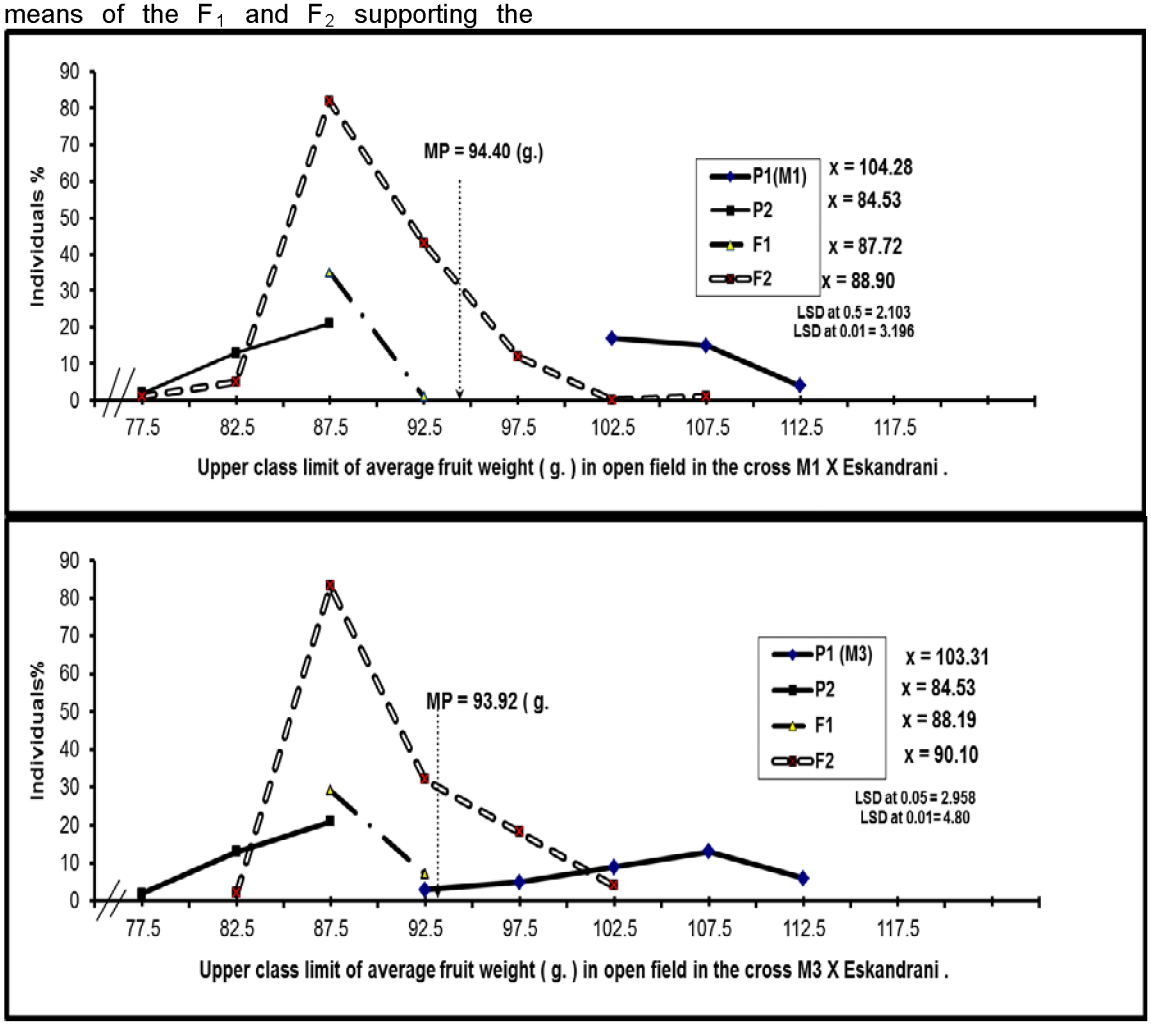


Fig. (5): Distribution of average fruit weight in parental lines , F_1 and F_2 plants for the crosses (M1 x Eskandrani) and (M3x Eskandrani) in open field .

The distribution of the F_2 plants for the two crosses stretched over a wide range as weight of fruit. About 90.97% of the F_2 plants for the cross M1 x Eskandrani and 81.25% for the cross M3 x Eskandrani were covered the range exhibited by the high parents M1 and M3) for the two crosses, and F_1 populations. The remaining F_2 plants (9.03% and 18.75%, respectively) for the two crosses covered the range exhibited the recessive parents (Eskandrani). This distribution fit a 3 : 1 ratio using x^2 test with probability of 0.50 – 0.95.

The minimum number of genes was estimated as 3.56and 4.38 according to Castle & Wright and Burton formulae, respectively, for the cross "M1 x Eskandrani", and 2.02 and 2.39, respectively for the cross "M1 x Eskandrani ". The BSH (h_b^2) was estimated as 60.33% in the cross "M1 x Eskandrani" and 45.50% in the cross M3 x Eskandrani. The relatively low BSH obtained indicates that average fruit weight is controlled by many genes and accordingly affected by environmental factors. Shalaby , (1975) found that broad sense heritability in squash was 83.6 % for average fruit.

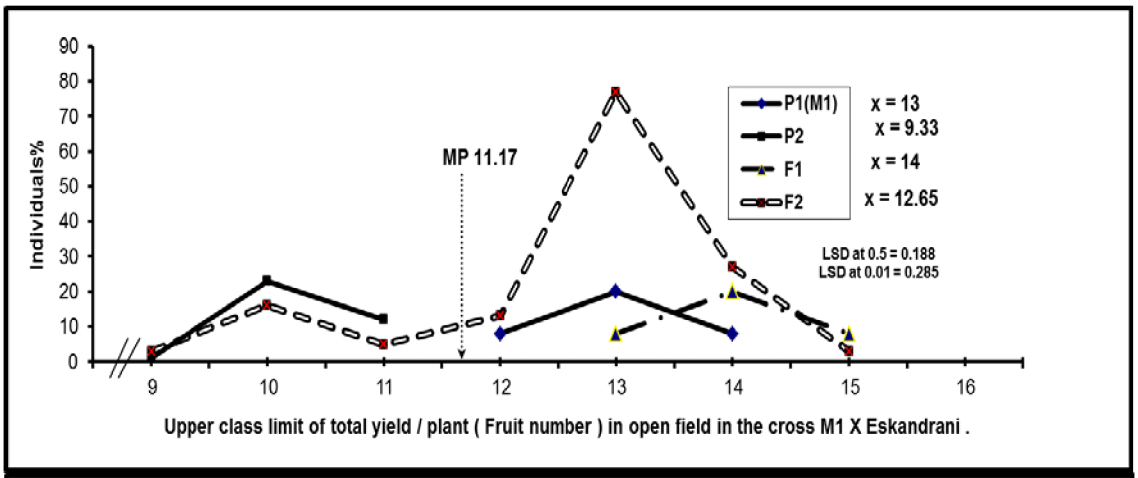
It could be concluded that the average fruit weight is controlled by more than two pairs of genes with mostly additive gene actions and partial dominance for the low weight.

[4] Total yield fruit number/ plant

Data presented in Fig. (6) showed highly significant difference between the two parental lines in each studied cross in total yield fruit number/ plant. The parent "M1" exceeded "Eskandrani" by about 3.67 fruits, but the parent "M3" exceeded "Eskandrani" by about 4.7 fruits.

Significant difference was observed between both obtained (14 Fruits) and expected (11.17 Fruits) arithmetic means of the F_1 population (M1 x Eskandrani), but observed between both obtained (14.97 Fruits) and expected (11.68 Fruits) arithmetic means of F_1 population for the cross (M1 x Eskandrani). McGrath and Staniszewska, 1996, found that the number of fruits and yields of the experimental powdery mildew-resistant hybrids exceeded those of their susceptible commercial counterparts. Thus, the difficulty in obtaining adequate yields from powdery mildew-resistant stocks.

The ADH% was estimated as 25.37% and 28.18% based on MP for the crosses "M1 x Eskandrani " and " M3 x Eskandrani ", respectively. These values 7.69% and 6.73% based on HP for the two crosses, respectively, suggesting over dominance for the large fruit number, with additive gene action. The high potence values (1.54 and 1.40, respectively for the two crosses) is in accordance with the suggested over dominance and additive effects hypothesis (Table 2).



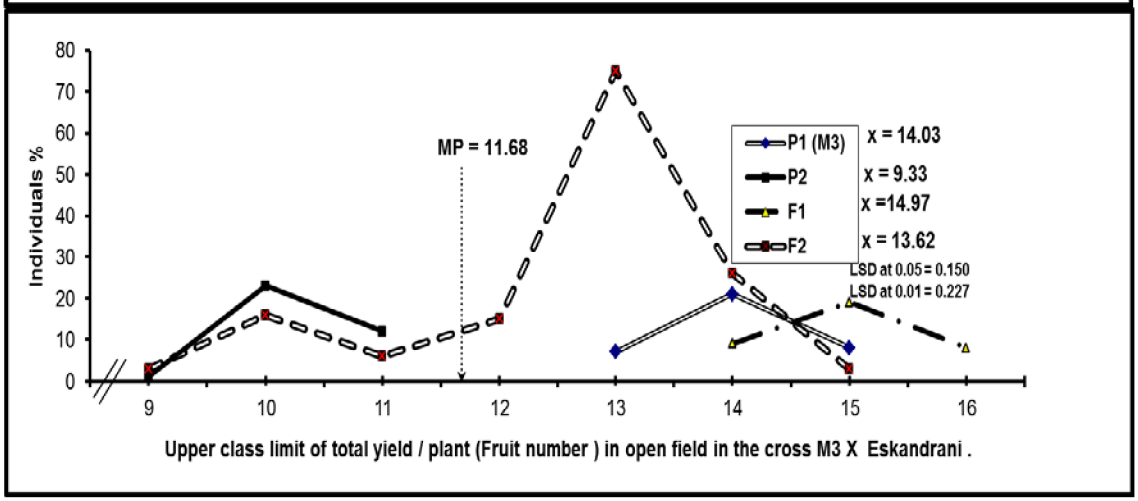


Fig. (6): Distribution of total yield fruit number/ plant in parental lines , F_1 and F_2 plants for the crosses (M1 x Eskandrani) and (M3x Eskandrani) in open field .

The F1's frequency distribution was skewed towards the high parents, supporting the over dominance of the large fruit number.

The distribution of the F_2 plants in the two crosses were stretched over a wide range of the total yield fruit number/ plant scale without distinct classes, indicating that the character may be controlled by many genes. The minimum number of genes for the crosses " M1 x Eskandrani " and " M3 x Eskandrani " was estimated as 2.33 and 2.91 according to Castle-Wright and Burton formulae, respectively, for the first cross " M1 x Eskandrani " and 2.21 and 3.37, respectively, for the second cross " M1 x Eskandrani " . The heritability (h_b^2) was estimated as 78.16% for the first cross and 78.29% for the second cross, respectively. The relatively low (h_b^2) obtained is in accordance with the continuity distribution of F2 plants and the estimated minimum number of genes. Shalaby , (1975) found that broad sense heritability in squash was 48.7 for total number of fruits / plant.

[5] Total yield fruit weight

Showed highly significant difference between the two parental lines in each studied cross in total yield fruit weight / plant. The parent "M1" exceeded "Eskandrani" by about 566.33 gm., but the parent "M3" exceeded "Eskandrani" by about 659.28. (Fig. 7). Harry S. Paris & Ron Cohen (2002)found that the number of fruits and yields of the experimental powdery mildew-resistant hybrids exceeded those of their susceptible commercial counterparts, and found that both problems associated with powdery mildew resistance in *C. pepo* until now – reduced yield and reduced fruit length – can be overcome, at least in some heterozygous, partially resistant, hybrid combinations. Moreover, the horticultural quality of the fruits did not seem to be reduced in any way compared with existing cultivars, but rather seemed to be improved in some characteristics, such as less ribbiness and smaller stylar-end scar.

The ADH% was estimated as 14.52% and 18.02%, respectively, based on MP and as -9.41% and -8.84%, respectively, based on high parents content, in the two crosses. These results suggesting partial dominance for the high total yield for the first and the second cross. The estimated potence values (0.42 and 0.83, respectively) for the two crosses are in accordance with this suggestion (Table 5). Paris and Cohen (2002) who found powdery mildew-resistant summer squash hybrids having higher yields than their susceptible, commercial counterparts. The resistant hybrids were similar to their respective commercially available susceptible hybrids in fruit appearance and other horticulturally important traits. The resistant hybrids yielded at least as well as the commercial hybrids early in the season and outyielded them later in the season.

The F1's distribution for the two crosses was skewed towards the high parental lines, supporting the partial dominance of the high total yield fruit weight / plant (Fig. 7).

Heritability in broad-sense (BSH) in the studied crosses (M1 x Eskandrani and M3 x Eskandrani) were 73.86% and 72.29%, respectively. These high values suggested that progress could be made in total yield fruit weight of squash by selection within segregating progenies. The minimum number of genes was estimated as 3.39 and 3.90 according to Castl-Wright and Burton formulae, respectively for the cross M1 x Eskandrani, and as 3.99 and 4.70 according to Castl-Wright and Burton formulae, respectively for the cross M3 x Eskandrani .

It appears from the examination of data presented that this trait. It is controlled by many pair of genes with partial dominance for the high total yield as fruit yield fruit weight.

[6] Activities of peroxidase and polyphenol-oxidase

A. Peroxidase (PRO) activity

The Peroxidase was estimated as 1.84, 1.75 and 1.83 mg./g./fresh weight in the M1, Eskandrani cv. and F1, respectively, in the cross"M1 x Eskandrani" while in the cross "M3 x Eskandrani" was estimated as 1.83, 1.75 and 1.82 mg./g./fresh weight in the M3, Eskandrani cv. and F_1, respectively, in

greenhouse experiment. These values of peroxidase amount suggest that high content of peroxidase amount is dominant over the low amount. The F_1 plants are equals to the resistant parent.

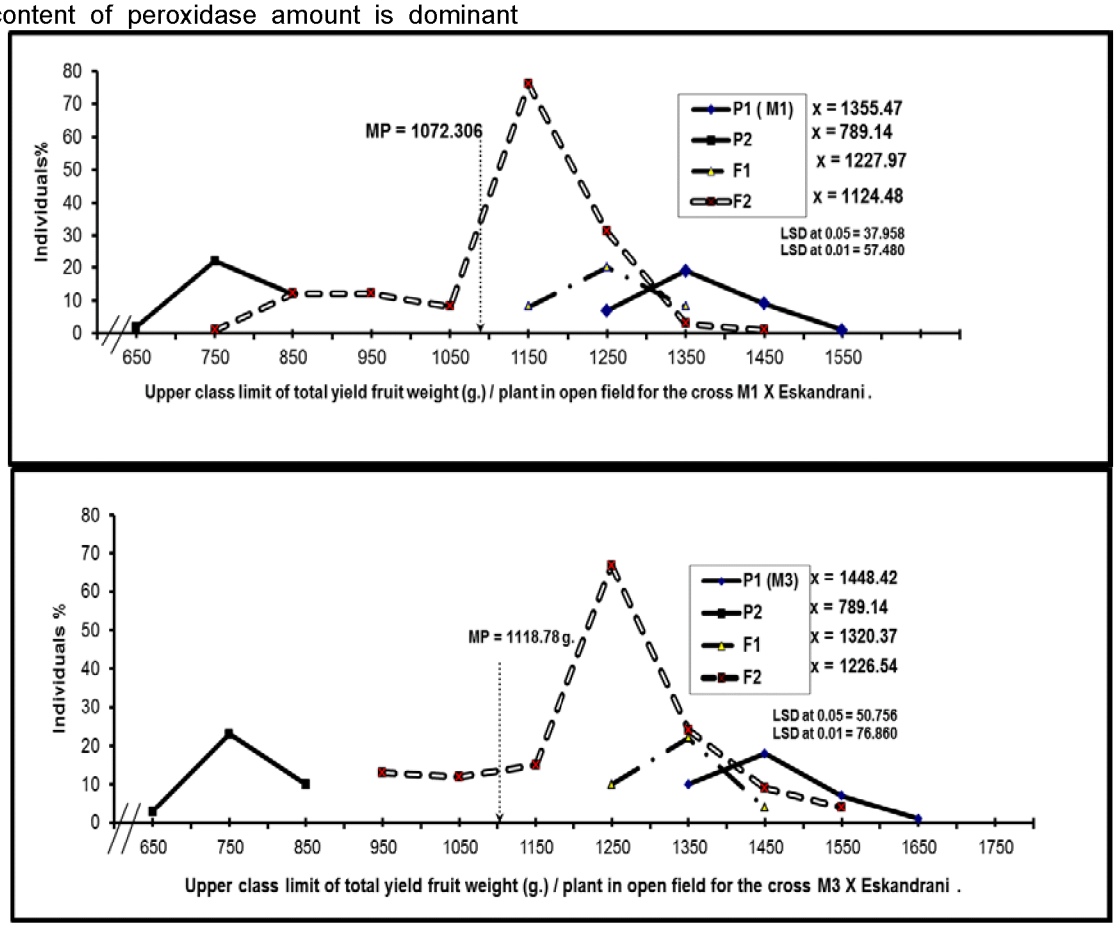


Fig. (7): Distribution of total yield fruit weight/ plant in parental lines , F_1 and F_2 plants for the crosses (M1 x Eskandrani) and (M3x Eskandrani) in open field .

B. Polyphenoloxidase (PPO) activity:

The Polyphenoloxidase was estimated as 1.25, 0.74and 1.23 mg./g./fresh weight in the M1, Eskandrani cv. and F_1, respectively, in the cross"M1 x Eskandrani" while in the cross "M3 x Eskandrani" was estimated as 1.32, 0.74 and 1.18 mg./g./fresh weight in the M3, Eskandrani cv. and F_1, respectively, in greenhouse experiment. Increase in the activities of peroxidase and polyphenoloxidase in the resistant genotypes. Similar results were obtained by Avdiushko *et al*. (1993); Gamil (1995); Mosa (1997) ; Orober *et al*. (1998) and Ahmed (2005) .

[7] Correlation between the studied traits:

The correlation between the different traits in squash is an important aspect which should be utilized for better planning of selection program. This relationship is expressed by the correlation coefficient. A positive or negative direction correlation between the characters may be due to either a peleiotropic effect of gene on different parts of the plant or to linkage. Significant negative correlations were found between disease severities of all studied traits. Significant negative correlations were found between the following pairs of traits: disease severities in crosses "M1 x Eskandrani" and "M3 x Eskandrani", respectively for each, Polyphyniloxidase (r = -0.999 and -0.974), Preoxidase (r = -0.994 and -0.995), stem

length (r = -0.996 and -0.999), number of leaves (r = -0.999 and -0.963), average fruit weight (r = -0.616 and -0.660), Total yield fruit number/ plant (r = -0.981 and -0.986), and total yield as fruit weight (r = -0.974 and -0.985), (Tables 3 and 4).

Table (3): Correlation coefficient between polyphenoloxidase and peroxidase with disease severity% .

Characters	Disease severity%	
	M1 x Eskandrani	M3 x Eskandrani
Polyphenoloxidase	-0.999**	-0.974**
Peroxidase	-0.994**	-0.995**

* Significant at 0.05 level.
** Significant at 0.01 level.

Table (4): Correlation coefficient between disease severity% and the studied character in the two crosses in open field.

Characters	Disease severity%	
	M1 x Eskandrani	M3 x Eskandrani
Stem length	-0.996**	-0.999**
Number of leaves / plant	-0.999**	-0.963**
Average fruit weight	-0.616*	-0.660*
Total fruit number / plant	-0.981**	-0.986**
Total yield fruit weight / plant	-0.974**	-0.985**

* Significant at 0.05 level.
** Significant at 0.01 level.

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وراثة بعض الصِفات الهَامَّة والمُقاومة لمَرض البياض الدقيقى فى الكوسَة

مَحمُود قُطب حَاتِم [١] ، سِهَام سَمير مُحمد رَجَب [٢]

[١] بحوث الخُضَر . معهد بحوث البساتين . مركز البحوث الزراعية .

[٢] معهد بحوث أمراض النبات – مركز البحوث الزراعية .

المُلَخَّص العرَبى

أُجريت هَذهِ الدراسَة بمَزرَعة مَحطة بحُوث البَسَاتين بالقَناطِر الخَيرية خِلال المَواسِم الصَيفية لأعْوام ٢٠٠٩ ، ٢٠١٠ ، ٢٠١١ بهدف الحُصول على المزيد من المَعلومات الخاصَّة بوراثة صِفة المُقاومَة لِمرض البياض الدقيقى في الكوسَة حيث تفيد هذه المَعلومات المُربى في وَضع وتَنفيذ بَرامج التربية لِتَحسين هذا المَحصُول . واستُخدِمت في هذه الدِراسَة أربعة سُلالات أبَوية مِن الكوسة وهى M1 ، M3 ، والأسكندرانى (صنف حسَّاس للإصَابة بالبيَاض الدقيقى) ، و Saturn (كَصَنف مُقاوِم للمُقارنة) . وقد أُجريت لِهذه السُلالات التربية الداخلية لعِدة أجيال لِتَنقيتُها وُراثِياً . وقد أُجرِى التَهجين في مُوسم ٢٠٠٩ لإنتاج الجيل الأول . وفى مُوسم ٢٠١٠ زُرعت بُذور الأباء الأربَعة والهَجِينَين وتم إنتاج الجيل الأول بين الأباء والجيل الثانى من التلقيح الذاتى لنباتات الجيل الأول .

وفى مُوسِم ٢٠١١ زُرعت الأبـاء والهُجُن والجيل الثـانى فـي تجـرُبَتين مُصـمَّمَتين بِطَريقـة القِطاعَـات الكامِلـةُ العَشوائِية في ثلاث مُكررات بالحَقل المَكشوف وتُرِكَت للعَدوى الطبيعِية , وأربعة مُكرَّرَات فى تجرُبة الأصُص وتم فيها العَدوى الصناعية بجراثيم الفِطر . والصِفات التي تناوَلتها هذه الدراسة هى:- نِسبة وشِدة الإصَابة بمرض البياض الدقيقى فى تجرُبة الأُصُص وتجربة الحَقل المَفتوح، ونشَاط اِنزيمَىْ البيرُكسيديز والبولى فينيول أوكسِيديز فى تجرُبة الأُصُص، وطول السَاق وعَدد الأوراق ومُتوسط وزن الثَمَرة والمَحصُول الكُلى (عَدَد وَوَزن الثِمار) فى الحَقل المَفتوح.

وكانت أهم النتائِج المُتَحصِّل عَليّها هى :

[١] كانت صِفة وراثة المُقاومة لِمرض البياض الدقيقى صِفة بسيطة التَوريث مع وُجُود سِيادة تامة لِصفة المُقاومة . وأن كل مِن إنزيمى البيروكسيديز والبولى فينول أُكسيديز يَزيدان فى التراكيب الوراثية المُقاوِمَة عَن الحَسَّاسَة.

[٢] أظهرت النتائج أن كلاً من صِفة طول السَاق وعَدد الأوراق يتَحَكَّم فيها أكثر من ثلاثِ أزواجٍ من الجيناتِ مع وجود السِيادة في كل من هذه الصِفات .

[٣] كانت صِفة مُتوسط وزن الثمرة والمَحصُول الكُلى (عَدَد وَوَزن) صِفة كَمية التوريث مع وُجُود سِيادة جُزئيه لِوزن الثمرة الأقَل والمَحصُول العالى (عَدَد وَوَزن) .