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INHERITANCE AND NATURE OF RESISTANCE TO TWO SPOTTED SPIDER MITE IN COMMON BEAN.

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ABSTRACT

Crosses were made between cultivars Emy, Sigme, Oxyra, paulista and Giza-6 to study the inheritance and nature of spider mite resistance and some component characters which may have direct or indirect effects on spider mite resistance. Such characters were recorded for the individual plants of the different populations of parents, F_1, F_2, Bc_1 and Bc_2. Spider mite resistance, fruit set percentage and total dry seed yield per plant were found to be inherited quantitatively. Partial dominance were observed for high resistance to spider mite, high fruit set percentage and high total dry seed yield/plant over the low levels of these characters. The broad sense heritability estimates for spider mite resistance ranged from intermediate (51.32%) to relatively high (86.43%), and that calculated for fruit set percentage ranged from below intermediate (43.40%) to high intermediate (65.26%), as well as that calculated for total dry seed yield/plant ranged from below intermediate (42.06%) to relatively high (74.22%) in the different crosses. On the other hand, the narrow sense heritability estimates for spider mite resistance ranged from low (27.48%) to below intermediate (46.21%); for fruit set percentage ranged from 35.61% to 56.03%and that calculated for total dry seed yield/plant ranged from low (25.08%) to below intermediate(48.63%)in all crosses. The number of gene pairs which control spider mite resistance, fruit set percentage and total dry seed yield/plant ranged from 1 to 4, 1 to 5 and 1 to 5, respectively. There were significant differences between parents, F_1, F_2, Bc_1 and Bc_2 populations of the cross Emy X Giza-6 in their leaf contents of nitrogen, potassium and total sugars. The cultivar Emy, which was found to be resistant to spider mite, contained the highest level of potassium and the lowest level of nitrogen and total sugars compared with the cultivar Giza-6, which showed susceptibility to spider mite. Spider mite resistance was positively correlated with each of number of branches/plant, number of pods/plant, fruit set percentage, number of seeds/pod, 100 seed weight and total dry seed yield/plant, but it was negatively correlated with number of days from planting date to the first flower bud anthesis. In addition, there was highly significant positive correlation between spider mite resistance and potassium content of plant leaves, but it was negatively correlated with total nitrogen and sugars. Furthermore, the resistance to spider mite was highly correlated with the combined effect of number of days from sowing date to the

first flower bud anthesis, number of pods/plant, fruit set percentage, 100 seed weight and total dry seed yield/plant.

INTRODUCTION

Phaseolus vulgaris (Common bean) is considered one of the most important crops for both local consumption and exportation. The two-spotted red spider mite (*Teranychus urticae*) is a very dangerous and widespread pest on many vegetable crops including common bean plants (Hill, 1987; Lee *et al.*, 1988 and Farrage *et al.*, 1998). This pest attach bean plants in the field causing serious damage (Lee *et al.*, 1988 and Farrage *et al.*, 1998). With heavy attacks, no chemical control will be effective. Moreover, at this stage the plant foliage becomes scarified, bronzed and the whole plant wilts and dies (Hill, 1987).

Genetic variations in degree of resistance to spider mite were observed among germplasm of common bean (Farrag *et al.*, 1980; Duzgunes and Cobanoglu, 1983; Wahba *et al.*, 1986; English-loeb, 1989; Faris *et al.*, 1991; Aydemir and Tores, 1992; Voicu *et al.*, 1992; Megali, 1997; Megali and Faris, 1997; Aggour *et al.*, 2001 and 2002). Moreover, Papaioannous and souliotis (1979) found that the reduction in seed weight of common bean plants due to infestation by spider mite was proportional with the population density of mites at the time of the initial infestation of the plants. In addition, Faris *et al.* (1997) reported that the yield of snap bean was decreased under sever infestation.

Henneberry and Schriver (1964) working on beans, reported that high leaf nitrogen content appeared to be a factor that could give mite population enough favorable host to become destructive and difficult to be controlled. Moreover, Farrag *et al.* (1980) found positive correlation between both nitrogen and phosphorus levels in soybean plants and mite increase. In addition, Mohamed(1982)found that the high level of leaf phosphorus content in sweet potato was positively correlated with number of eggs per female of the two-spotted spider mite, while the low level of potassium in plant leaves shortened the duration of immature stages and lengthened female longevity. Also, Aggour *et al* (2001) showed that the high levels of nitrogen, phosphorus, sugars and total protein in leaves of phaseolus germplasm were found to enhance preference of the individuals of the two-spotted red spider mite to live and reproduce on such leaves. On the other hand, the presence of potassium and sodium in leaves of phaseolus germplasm at high levels was found to have negative effect on the individuals of the two-spotted red spider mite reared on such leaves.

The objective of this research was to study the inheritance and nature of resistance to spider mite. Such information will be of great value in programs of bean breeding for resistance to the two-spotted red spider mite and improving the local cultivars for this character.

MATERIALS AND METHODS

This research was conducted during the period from 2000 to 2003 at the Experimental Farm of Horticulture Department, Faculty of Agriculture Moshtohor, Zagazig University, Benha Branch, Egypt.

Thirty common bean (*Phaseolus vulgaris*, L.) cultivars/lines were evaluated for resistant to two- spotted red spider mite (*Tetranychus urticae*, Koch) in naturally infested field on April, 2000, using randomized complete block design with three replicates. Seeds of these genotypes were obtained from Agricultural Technology Utilization and Transfer project, Agricultural research center, Dokki, Egypt. The highest cultivars concerning resistance to spider mite were selected under the conditions of natural infestations, *i.e.* Emy, Oxyra and Paulista . On the other hand, the highest susceptible cultivars to spider mite were selected under same conditions, *i.e.* Giza-6 and Sigme.

Seeds of the different selected common bean cultivars were planted in the field on March, 2001 to carry out the crosses between the individual plants of the different parental cultivars to obtain F_1 seeds of the crosses Emy X Giza-6, Emy X Sigme, Oxyra X Giza-6 and paulista X Giza-6.

On March, 2002, seeds of the parental cultivars and F_1 hybrids of the above mentioned crosses were planted in the field. Crosses between the individual plants of the parental cultivars were repeated to obtain enough seeds. In addition, F_1 plants of each cross were selfed to obtain F_2 seeds and crossed to the individual plants of their related parents to obtain seeds of Bc_1 and Bc_2.

On April, 26, 2003 seeds of the parents, F_1, F_2, Bc_1 and Bc_2 populations were planted in naturally infested field with spider mites on one side of ridges, which was 2.5 meters length, spaced 70 cm apart between centers and two seeds per hill 25 cm apart, using a randomized complete block design with three replicates. Each replicate contained one ridge for each of the parental genotypes and their F_1 plants, four ridges for each F_2 population and two ridges for each backcross population. All other agricultural practices; i.e. irrigation; fertilization; weed control…etc.; were done as followed in the district. However, no insecticides or acaricides were applied in the field.

Evaluation of spider mite resistance:-

After fifty-five days from the sowing date, individual plants of all populations in the naturally infested field were examined to calculate the percentage of healthy leaves on each plant. The percentage of symptomless healthy leaves, i. e. with no visible sign of spider mite symptoms, to total number of plant leaves was calculated after 55 days from sowing date. Infested leaves was assessed on the basis of field symptoms which showed white yellowish areas on the upper surface of one or more the leaflets.

Recorded Data:-

The following data were recorded on the individual plants for each population:

Number of days from seed sowing to first flower bud anthesis (earliness); number of branches/plant; number of pods/plant; fruit set percentage; number of seeds/pod; 100 seed weight (g.) and total dry seed yield/plant (g.). The total nitrogen was determined in plant leaves according to the method of Pregl (1945), while potassium was assayed as described by Brown and Lilleland (1946). Moreover, total sugars were assayed collorimetrically in plant leaves using the method described by Flood and Priesty (1973).

Genetic statistical analysis:-

Estimates of the mean and its standard deviation, total variance and type of inheritance of the studied characters 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 equation given by Smith (1952).

$$\text{Potence ratio (p)} = \frac{F1 - M.P.}{1/2(P2 - P1)}$$

Where:

$F_1 = F_1$ mean, P_1 = The smaller parent mean, P_2 = The larger parent mean and M. P. = Mid parent value = $1/2(P_2 + P_1)$.

Broad sense heritability (BSH) was estimated by the following method which was described by Allard (1960).

$$\text{BSH} = \frac{VF2 - (VF1 + VP1 + VP2)/3}{VF2} X100$$

Narrow sense heritability (NSH) was estimated after Mather and Jinkes (1971).

$$\text{NSH} = \frac{2VF2 - (VBc1 + VBc2)}{VF2} X100$$

Whereas:-

VF_1 = Variance of the first generation, VF_2 = Variance of the second generation, VP_1 = Variance of the first parent, VP_2 = Variance of the second parent, VBc_1 = Variance of the first backcross, and VBc_2 = Variance of the second backcross.

The minimum number of the gene pairs differentiating the two parents was estimated using the method given by Castle and Wright (1921).

$$N = \frac{D2}{8(VF2 - VF1)}$$

Where:

N = minimum number of gene pairs by which the parental differ,

D = Mean of larger parent – Mean of smaller parent, VF_2 = Variance of F_2population, and VF_1 = Variance of F_1population.

Coefficients of correlation between different characters in F_2 populations and multiple regression analyses were performed using the methods described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Spider mite resistance:-

The percentage of uninfected leaves number per plant of the parental germplasm presented in Table (1) show that the parental cultivar paulista had the highest percentage(88.73%)followed in ascending order by cv. Oxyra (84.90%), Emy (74.90%), Sigme (50.77%) and Giza-6 (36.13%). Such differences in this study between the parental common bean germplasm could be useful in breeding programs for resistance of common bean plants to spider mite. These results agree with those reported by Farrage *et al.*, 1980; Duzgunes and Cobanoglu, 1983; Wahba *et al.*, 1986; English-loeb, 1989; Faris *et al.*, 1991; Aydemir and Tores,1992; Voicu *et al.*, 1992; Megali, 1997; Megali and Faris, 1997 and Aggour *et al.*, 2001 and 2002, who observed genetic variations in degree of resistance to spider mite among germplasm of common bean.

Concerning the nature of dominance for this character, the potence ratio (p) calculated for different crosses (Table, 2) indicated partial dominance for high level of resistance over low level of resistance. In all the crosses, frequency distribution for percentage of symptomless leaves per plant in the P_1, P_2, F_1, F_2, $Bc_1$and Bc_2 populations indicated the quantitative inheritance pattern for this character (Table, 1).

Relatively high broad sense heritability estimates for the inheritance of this trait were found in all crosses (Table,2). The calculated BSH were 58.12%, 51.32%, 86.43% and 86.23% for the crosses Emy X Giza-6, Emy X Sigme, Oxyra X Giza-6 and paulista X Giza-6, respectively. Meanwhile, the narrow sense heritability ranged from low (27.48%) to intermediate (46.21%). This indicates that selection for this trait based on individual plant performance can be effective.

The number of the major effective genes controlling resistance to spider mite ranged from 1 to 4 gene pairs (Table, 2).

Fruit set percentage:

The parental cultivar paulista had a relatively very high percentage of fruit set (82.62%), while the parental cultivar Giza-6 had the lowest percentage of fruit set (47.22%), (Table, 3). On the other hand, the cultivars Emy and Oxyra had a relatively intermediate fruit set percentage (63.35% and 79.34%, respectively). These results indicated that the parental cultivar paulista was the best source for genes controlling the high percentage of fruit set.

Table (1): Frequency distribution and segregation for plant reaction to two-spotted spider mite in parents, F_1, F_2, Bc_1 and Bc_2 generations in some common bean crosses.

Generation	Frequency distribution and segregation for plant reaction (%).										Total No.of plants	Mean	SE	Variance
	10	20	30	40	50	60	70	80	90	100				
Emy (P_1)	-	-	-	-	-	-	-	21	9	-	30	74.90	1.91	58.80
Giza-6 (P_2)	-	-	7	23	-	-	-	-	-	-	30	36.13	1.91	30.91
F_1	-	-	-	-	-	-	14	16	-	-	30	70.77	1.91	97.89
F_2	-	2	5	13	15	16	28	25	10	6	120	72.18	0.95	149.33
$Bc_1(F_1XP_1)$	-	-	-	-	-	23	18	19	-	-	60	65.85	1.35	127.92
$Bc_2(F_1XP_2)$	-	-	-	9	31	20	-	-	-	-	60	57.80	1.35	129.70
LSD 0.05 0.01												14.77 22.38		
Emy (P_1)	-	-	-	-	-	-	-	21	9	-	30	74.90	1.79	58.80
Sigme (P_2)	-	-	-	-	13	17	-	-	-	-	30	50.77	1.79	65.21
F_1	-	-	-	-	-	-	24	6	-	-	30	68.60	1.79	4.37
F_2	-	-	1	3	20	30	28	29	9	-	120	71.83	0.90	87.61
$Bc_1(F_1XP_1)$	-	-	-	-	-	-	28	12	20	-	60	71.65	1.27	103.35
$Bc_2(F_1XP_2)$	-	-	-	-	-	9	38	13	-	-	60	67.37	1.27	36.36
LSD 0.05 0.01												13.87 21.02		
Oxyra (P_1)	-	-	-	-	-	-	-	6	24	-	30	84.90	1.75	21.16
Giza-6 (P_2)	-	-	7	23	-	-	-	-	-	-	30	36.13	1.75	30.91
F_1	-	-	-	-	-	-	16	14	-	-	30	69.83	1.75	24.11
F_2	1	2	3	13	18	20	31	15	10	7	120	70.35	0.87	187.14
$Bc_1(F_1XP_1)$	-	-	-	-	-	-	20	40	-	-	60	72.90	1.24	128.20
$Bc_2(F_1XP_2)$	-	-	-	-	7	27	26	-	-	-	60	59.70	1.24	159.60
LSD 0.05 0.01												13.52 20.48		
Paulista (P_1)	-	-	-	-	-	-	-	-	22	8	30	88.73	1.69	8.64
Giza-6 (P_2)	-	-	7	23	-	-	-	-	-	-	30	36.13	1.69	30.91
F_1	-	-	-	-	-	-	-	24	6	-	30	75.97	1.69	76.56
F_2	1	3	3	9	13	15	21	27	9	9	120	78.44	0.84	281.17
$Bc_1(F_1XP_1)$	-	-	-	-	-	-	-	39	21	-	60	79.37	1.19	213.40
$Bc_2(F_1XP_2)$	-	-	-	-	-	10	29	21	-	-	60	67.53	1.19	234.69
LSD 0.05 0.01												13.08 19.81		

Table (2): Potence ratio, broad (BSH) and narrow sense heritability(NSH) and minimum number of effective gene pairs estimates for some common bean crosses.

Crosses / Characters	Spider mites resistance			
	P. ratio	BSH	NSH	No.of gene pairs
Emy X Giza-6	0.79	58.12	27.48	4
Emy X Sigme	0.48	51.32	40.53	1
Oxyra X Giza-6	0.38	86.43	46.21	2
Paulista XGiza-6	0.51	86.23	40.63	2
Fruit set percentage				
Emy X Giza-6	0.65	43.40	35.61	1
Emy X Sigme	0.03	48.64	36.91	1
Oxyra X Giza-6	0.44	65.26	56.03	1
Paulista XGiza-6	0.57	53.71	43.47	5
Total yield/plant				
Emy X Giza-6	0.21	66.32	48.63	1
Emy X Sigme	0.90	42.06	25.08	1
Oxyra X Giza-6	0.82	72.76	31.60	5
Paulista XGiza-6	0.87	74.22	46.40	

Concerning nature of dominance, The data in Table, 2 indicate that there was partial dominance to the high fruit set percentage for all crosses under this study. Fruit set percentage values estimated for F_1 were intermediate between the two parental cultivars for each cross. Quantitative inheritance pattern for fruit set percentage of common bean was detected from the frequency distribution of this character in the F_2, Bc_1 and Bc2 populations of the crosses under this study (Table, 3).

The broad sense heritability estimates for fruit set percentage ranged from 43.40% to 65.26% (Table, 2), indicating the environmental effects on the expression of this character. On the other hand, narrow sense heritability ranged from 35.61% to 56.03%, indicating intermediate additive genetic variance for this character. Even though, the additive genetic variance, observed in the present study, was not high, it still could have an important role in the inheritance of fruit set percentage in common bean under the condition of infestation with spider mite.

The minimum number of gene pairs controlling fruit set percentage of common bean plants ranged from 1 to 5 gene pairs (Table, 2)

Total dry seed yield per plant:-

Highly significant differences were observed between the parental genotypes Emy, Giza-6, Sigme, Oxyra and paulista concerning total dry seed yield per plant under the condition of infestation with red spider mite (Table, 4). paulista gave the highest dry seed yield per plant (73.76 g.). However, the other

Table (3): Frequency distribution for fruit set percentage in different populations for some common bean crosses.

Generation	Upper limits (g.)										Total No.of plants	Mean±SE	Variance
	10	20	30	40	50	60	70	80	90	100			
Emy (P_1)	-	-	-	-	-	7	12	11	-	-	30	63.35±2.64	265.69
Giza-6 (P_2)	-	-	-	9	21	-	-	-	-	-	30	47.22±2.64	216.84
F_1	-	-	-	-	-	12	18	-	-	-	30	60.55±2.64	275.89
F_2	1	2	20	31	36	24	4	1	1	-	120	52.29±1.32	446.65
$Bc_1(F_1XP_1)$	-	-	-	-	26	12	22	-	-	-	60	55.04±1.87	320.82
$Bc_2(F_1XP_2)$	-	-	-	20	19	21	-	-	-	-	60	49.21±1.87	413.45
LSD 0.05												15.47	
0.01												23.44	
Emy (P_1)	-	-	-	-	-	7	12	11	-	-	30	63.35±2.58	265.69
Sigme (P_2)	-	-	-	-	-	-	7	23	-	-	30	71.83±2.58	237.16
F_1	-	-	-	-	-	-	9	21	-	-	30	67.70±2.58	162.82
F_2	-	5	5	11	30	37	21	9	1	1	120	54.22±1.29	132.02
$Bc_1(F_1XP_1)$	-	-	-	-	21	17	22	-	-	-	60	56.00±1.83	324.70
$Bc_2(F_1XP_2)$	-	-	-	-	-	-	28	32	-	-	60	68.20±1.83	279.89
LSD 0.05												9.98	
0.01												15.12	
Oxyra (P_1)	-	-	-	-	-	-	-	18	12	-	30	79.34±2.58	202.49
Giza-6 (P_2)	-	-	-	9	21	-	-	-	-	-	30	47.22±2.58	216.84
F_1	-	-	-	-	-	-	18	12	-	-	30	70.39±2.58	92.35
F_2	1	2	10	17	31	34	14	4	6	1	120	52.45±1.29	490.99
$Bc_1(F_1XP_1)$	-	-	-	-	-	36	24	-	-	-	60	61.47±1,82	394.28
$Bc_2(F_1XP_2)$	-	-	-	-	31	13	16	-	-	-	60	57.23±1.82	312.58
LSD 0.05												19.93	
0.01												30.19	
Paulista (P_1)	-	-	-	-	-	-	-	16	14	-	30	82.62±2.59	103.80
Giza-6 (P_2)	-	-	-	9	21	-	-	-	-	-	30	47.22±2.59	216.84
F_1	-	-	-	-	-	-	11	19	-	-	30	75.05±2.59	449.57
F_2	-	1	3	4	9	30	44	14	11	4	120	70.01±1.29	482.63
$Bc_1(F_1XP_1)$	-	-	-	-	-	-	17	23	20	-	60	78.93±1.83	363.74
$Bc_2(F_1XP_2)$	-	-	-	-	18	19	23	-	-	-	60	62.99±1.83	391.73
LSD 0.05												20.00	
0.01												30.30	

Table (4): Frequency distribution for total dry seed yield/plant in different populations for some common bean crosses.

Generation	Upper limits (g.)										Total	Mean±SE	Variance
	10	20	30	40	50	60	70	80	90	100	No.of plants		
Emy (P_1)	-	-	-	-	-	-	22	8	-	-	30	63.83±3.9	290.36
Giza-6 (P_2)	-	-	-	14	16	-	-	-	-	-	30	43.94±3.9	335.99
F_1	-	-	-	-	11	19	-	-	-	-	30	55.93±3.9	201.92
F_2	-	2	15	19	34	13	14	8	7	8	120	60.64±2.0	819.68
$Bc_1(F_1XP_1)$	-	-	-	-	23	16	21	-	-	-	60	59.89±2.8	639.94
$Bc_2(F_1XP_2)$	-	-	-	13	17	30	-	-	-	-	60	51.35±2.8	600.79
LSD 0.05 0.01												18.15 27.50	
Emy (P_1)	-	-	-	-	-	-	22	8	-	-	30	63.83±3.4	290.36
Sigme (P_2)	-	-	-	-	12	18	-	-	-	-	30	54.69±3.4	309.06
F_1	-	-	-	-	-	9	21	-	-	-	30	63.38±3.4	227.41
F_2	-	1	8	9	19	21	22	17	11	12	120	62.32±1.7	475.68
$Bc_1(F_1XP_1)$	-	-	-	-	17	14	29	-	-	-	60	59.55±2.4	370.27
$Bc_2(F_1XP_2)$	-	-	-	18	12	30	-	-	-	-	60	51.82±2.4	461.79
LSD 0.05 0.01												11.27 17.07	
Oxyra (P_1)	-	-	-	-	-	-	12	18	-	-	30	72.42±3.7	47.62
Giza-6 (P_2)	-	-	-	14	16	-	-	-	-	-	30	43.94±3.7	335.99
F_1	-	-	-	-	-	13	17	-	-	-	30	69.91±3.7	486.49
F_2	-	3	3	15	24	35	14	13	2	9	120	60.24±1.9	508.83
$Bc_1(F_1XP_1)$	-	-	-	-	-	-	32	28	-	-	60	67.15±2.6	411.30
$Bc_2(F_1XP_2)$	-	-	-	-	17	20	23	-	-	-	60	59.85±2.6	445.55
LSD 0.05 0.01												17.71 26.83	
Paulista (P_1)	-	-	-	-	-	-	15	15	-	-	30	73.76±4.4	179.83
Giza-6 (P_2)	-	-	-	14	16	-	-	-	-	-	30	43.94±4.4	335.99
F_1	-	-	-	-	-	-	19	11	-	-	30	71.76±4.4	330.88
F_2	-	5	7	13	13	15	16	33	10	8	120	69.00±2.2	1094.95
$Bc_1(F_1XP_1)$	-	-	-	-	-	-	32	28	-	-	60	70.89±3.1	872.13
$Bc_2(F_1XP_2)$	-	-	-	-	-	36	24	-	-	-	60	66.84±3.1	809.66
LSD 0.05 0.01												18.61 28.19	

parental genotypes E my, Giza-6, Sigme and Oxyra gave 63.83g., 43.94g., 54.69g. and 72.42g. per plant, respectively. These results indicated that the parental cultivar paulista was the most resistant genotype to spider mite as explained by its relatively high total dry seed yield per plant obtained under natural infestation conditions.

In the crosses, Emy X Giza-6, Emy X Sigme, Oxyra X Giza-6 and paulista X Giza-6, the values of relative potence of gene set (p) were 0.21, 0.90, 0.82 and 0.87, respectively (Table, 2). These results indicate that partial dominance for high yield/plant under natural infestation with spider mite. The plants of the cross paulista x giza-6 could posses, in addition to spider mite resistance, high dry seed yield per plant which may be not possessed by F_1 plants of the other crosses. In all the crosses, a quantitative inheritance pattern for total dry seed yield/plant under natural infestation conditions was observed in the F_2, Bc_1 and Bc_2 populations.

The values of the broad sense heritability (BSH) for total dry seed yield/plant were 66.32%, 42.06%, 72.76% and 74.22% for the crosses Emy X Giza-6, Emy X Sigme, Oxyra X Giza-6 and paulista X Giza-6, respectively (Table, 2). Meanwhile, the values of the narrow sense heritability (NSH) for total dry seed yield/plant were 48.63%, 25.08%, 31.60% and 46.40% for the same previously mentioned crosses. The observed intermediate to high estimates of the (BSH) indicated that dry seed yield/plant under natural infestation with spider mite conditions was less affected by the environmental conditions. Because of the relatively high BSH observed in most crosses, the additive part of the genetic variance for this character is expected to be high. Based on these results, selection for high dry seed yield/plant under natural infestation with spider mite conditions in the segregating generations should be based on individual plant basis and not on family mean basis.

Number of major genes controlling total dry seed yield/plant under natural infestation with spider mite conditions ranged from 1 to 5 gene pairs (Table, 2).

Leaf chemical content:-

Significant differences was observed between the cultivars Emy and Giza-6 in their nitrogen, potassium and sugars content of the plant leaves (Table, 5). The cultivar Giza-6 had relatively high total nitrogen and sugars content in leaves (4.56 and 58.67 mg/100g. dry weight, respectively), while leaves of the cultivar Emy had lower amount (3.36 and 29.09 mg/100g. d. w., respectively). On the other hand, the cultivar Emy had high potassium content of plant leaves (5623.20mg/100g.d.w.). Meanwhile, leaves of the cultivar Giza-6 had lower amount (4733.83mg /100g.d.w.). The F_1 values estimated for total nitrogen, potassium and sugars of plant leaves content were intermediate between the two parents. Bc_2 values for total nitrogen and sugars content were higher than Bc1 values. On the other hand, Bc_1 values were higher than Bc_2 values for potassium content. These results indicate the possibility of using total nitrogen, potassium and sugars content of plant leaves in selecting for spider mite resistance in segregating generations. Obtained results were supported by those of Henneberry and Schriver (1964) working on beans, who mentioned that high leaf nitrogen content appeared to be a factor that could give mite population enough favorable host to become destructive and difficult to be controlled. In addition, Aggour *et al.* (2001) showed that the high levels of nitrogen, phosphorus, sugars and total protein in leaves of Phaseolus germplasm enhanced preference of the individuals of the two-spotted red spider mite to live and reproduce on such leaves. On the other hand, the presence of potassium and sodium in leaves of Phaseolus germplasm at high levels was found to have negative effect of the individuals of the two-spotted red spider mite reared on such leaves.

Table (5): Leaf chemical composition of parents, F_1, F_2, Bc_1 and Bc_2 populations derived from the cross Emy X Giza-6 as affected by spider mites infection.

Characters Populations	Total nitrogen	Potassium	Total sugars
Emy (P_1)	3.36	5623.20	29.09
Giza-6 (P_2)	4.56	4733.83	58.67
F_1	3.57	5319.57	42.96
F_2	3.67	4914.71	38.22
Bc_1 (F_1X P_1)	3.44	5605.67	32.92
Bc_2(F_1 X P_2)	4.17	5079.63	51.20
LSD 0.05	0.53	538.69	11.10
0.01	0.80	816.06	16.82

Simple correlation:-

Highly significant positive correlations were observed between spider mite resistance and each of number of branches/plant, number of pods/pant, fruit set percentage, number of seeds/pod, 100seed weight and total dry seed yield/plant in the F_2 populations of all crosses under this study (Table, 6). On the other hand, there were highly significant negative correlations between spider mite resistance and number of days from sowing date to the first flower bud anthesis. Whereas, in the cross Emy X Giza-6 there were found that highly significant positive correlation between spider mite resistance and potassium content, while, negative correlation were found between spider mite resistance and each of total nitrogen and sugars content. These results indicated the importance of the above mentioned characters as a components of spider mite resistance. Based on these results, selection for spider mite resistance can be made when selected the plants contained the above mentioned characters. These results are in accordance with those reported by Farrag *et al.* (1980) who found positive correlation between both nitrogen and phosphorus levels in soybean plants and mite increase. Also, Mohamed (1982) showed that the high level of leaf phosphorus content in sweet potato was positively correlated with number of eggs per female of the two-spotted spider mite, while the low level of potassium in plant leaves shortened the duration of immature stages and lengthened female longevity.

Table (6): Coefficient of correlation values (r) of different characters for some common bean crosses.

Crosses	Characters	Earliness	No. of branches / plant	No. of pods / pant	Fruit set (%)	No. of seeds / pod	100 seed weight	Total yield / plant	Total nitrogen	Potassium	Total sugars
Emy X Giza-6	Spider mites resistance	-0.400**	0.705**	0.678**	0.641**	0.510**	0.897**	0.755**	-0.884**	0.929**	-0.926**
	Earliness		-0.184*	0.157	-0.223*	-0.252**	-0.379**	-0.319**	-0.360**	-0.381**	-0.393**
	No. of branches/plant			0.826*8	0.651**	0.741**	0.775**	0.856**	0.594**	0.687**	0.610**
	No. of pods/plant				0.796**	0.823**	0.716**	0.935**	0.500**	0.681**	0.596**
	Fruit set percentage					0.634**	0.643**	0.762**	0.458**	0.647**	0.561**
	No. of seeds/pod						0.552**	0.889**	0.428**	0.460**	0.507**
	100 seed weight							0.824**	0.780**	0.850**	0.816**
	Total yield/plant								-0.631**	0.706**	-0.719**
	Total nitrogen									0.790**	0.947**
	Potassium										0.808**
Emy X Sigme	Spider mites resistance	-0.476**	0.842**	0.390**	0.309**	0.468**	0.925**	0.646**			
	Earliness		-0.364**	-0.072	0.498**	-0.313**	-0.491**	-0.314**			
	No. of branches/plant			0.6937**	0.177	0.544*	0.854**	0.785**			
	No. of pods/plant				0.645**	0.548**	0.521**	0.796**			
	Fruit set percentage					0.271**	0.024	0.399**			
	No. of seeds/pod						0.624**	0.896**			
	100 seed weight							0.779**			
Oxyra X Giza-6	Spider mites resistance	-0.436**	0.659**	0.330**	0.244**	0.546**	0.812**	0.688**			
	Earliness		-0.125	0.055	0.355**	-0.179*	-0.444**	-0.183*			
	No. of branches/plant			0.809**	0.402**	0.511*	0.447**	0.808**			
	No. of pods/plant				0.441**	0.218*	0.174	0.655**			
	Fruit set percentage					0.212*	0.290**	0.436*			
	No. of seeds/pod						0.635**	0.776**			
	100 seed weight							0.754**			
Paulist X Giza-6	Spider mites resistance	-0.252**	0.617**	0.628**	0.388**	0.639**	0.663**	0.689**			
	Earliness		-0.412**	-0.296**	0.202*	-0.355**	-0.560**	-0.443**			
	No. of branches/plant			0.743**	0.146	0.801**	0.642**	0.844**			
	No. of pods/plant				0.473**	0.662**	0.611**	0.821**			
	Fruit set percentage					0.180*	0.160	0.231*			
	No. of seeds/pod						0.686**	0.909**			
	100 seed weight							0.842**			

*Significant at 0.05 level of significance **Significant at 0.01 level of significance

Fruit set percentage was positively correlated with each of number of seeds/pod and total dry seed yield/plant in the F_2 populations of all crosses under study. In addition, total dry seed yield/plant was positively correlated with each of spider mite resistance, number of branches/plant, number of pod/plant, fruit set percentage, number of seeds/pod, 100seed weight and potassium content in all crosses under study except potassium content in the cross Emy X Giza-6 only. On the opposite side, there were negative correlations between total dry seed yield/plant and each of number of days from sowing date to the first flower budan thesis, total nitrogen and sugars content in all crosses for earliness and in the cross Emy X Giza-6 for total nitrogen and sugars content. These results corroborate those of Papaioannous and Souliotis (1979) who found that the reduction in seed weight of common bean plants due to infestation by spider mite was proportional with the population density of mite at the time of the initial infestation of the plants. Also, Faris *et al.* (1997) reported that the yield of snap bean was decreased under sever infestation.

Multiple correlation:-

The combined effect of number of days from planting date to the first flower bud anthesis, number of pods/plant, fruit set percentage, 100 seed weight and total dry seed yield/plant was highly correlated with the resistant to spider mite (Table, 7). Relatively high multiple correlation coefficients were calculated whereas multiple R values were (0.937, 0.843 and 0.750) while R-square values were (0.879, 0.711 and 0.562) for the crosses Emy X Sigme, Oxyra X Giza-6 and Poliasta X Giza-6, respectively. These results indicated that 87.9%, 71.1%and 56.2%of the variation in spider mite resistance under natural infestation observed in the F_2 population of the previous mentioned crosses respectively is attributed to a real relationship between spider mite resistance and the combined effect of earliness, number of pods/plant, fruit set percentage, 100 seed weight and total dry seed yield/plant. Meanwhile, in the cross Emy X Giza-6, combined effect of earliness, number of pods/plant, fruit set percentage, 100 seed weight, total dry seed yield/plant, total nitrogen, potassium and total sugars was highly correlated with the resistance to spider mite. Relatively high multiple correlation coefficient was calculated where Multiple-R was (0.980), while R-square was (0.961). Based on these results, high earliness, high number of pods/plant, high fruit set percentage, high 100 seed weight, high yield/plant, low total nitrogen content, high potassium, and low sugars content should be considered when selecting under natural infestation with spider mite conditions to obtain plants with high resistance to spider mite.

Table (7): Multiple regression coefficients between resistant to spider mites and other component characters in some common bean crosses.

Crosses	Involved indepent variables	Multiple-R	R-Square	Significance
Emy X Giza-6	Earliness			
	No. of pods/plant			
	Fruit set percentage			
	100 seed weight			
	Total yield/plant	0.980	0.961	**
	Total nitrogen			
	Potassium			
	Total sugars			
Emy X Sigme	Earliness			
	No. of pods/plant			
	Fruit set percentage	0.937	0.879	**
	100 seed weight			
	Total yield/plant			
Oxyra X Giza-6	Earliness			
	No. of pods/plant			
	Fruit set percentage	0.843	0.711	**
	100 seed weight			
	Total yield/plant			
Paulista X Giza-6	Earliness			
	No. of pods/plant			
	Fruit set percentage	0.750	0.562	**
	100 seed weight			
	Total yield/pant			

** Significant at 0.01 level of significance

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توريث وطبيعة المقاومه للعنكبوت الاحمر ذو البقعتين فى الفاصوليا

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تم اجراء التهجين بين الاصناف امى وسجما واوجزيرا وبوليستا وجيزه-٦ وذلك لدراسة توريث وطبيعة المقاومه للعنكبوت الاحمر ذو البقعتين وبعض الصفات المكونه للمقاومه التى تؤثر بطريقه مباشره او غير مباشره على المقاومه للعنكبوت الاحمر ذو البقعتين. هذه الصفات تم تسجيلها على النباتات الفرديه للاجيال المختلفه من الاباء ونباتات الجيل الاول ونباتات الجيل الثانى والتهجين الرجعى لنباتات الجيل الاول مع الاب الاول ونباتات الجيل الاول مع الاب الثانى فى كل الهجن تحت الدراسه. ولقد وجد ان صفات المقاومه للعنكبوت الاحمر ذو البقعتين والنسبه المويه لعقد الثمار ومحصول النبات الكلى من البذور الجافه تورث كميا. وجد ان هناك سياده جزئيه للمقاومه العاليه للعنكبوت الاحمر ذو البقعتين والنسبه المويه العاليه لعقد الثمار والمحصول الكلى العالى من البذور الجافه للنبات على المستوى المنخفض من هذه الصفات. القدره على التوريث بمعناها الواسع لصفة المقاومه للعنكبوت الاحمر ذو البقعتين تراوحت بين المتوسط (٥١,٣٢ ٪) الى العالى نسبيا(٨٦,٤٣٪)-اما الذى تم حسابه لصفة النسبه المويه لعقد الثمار تراوح بين اقل من المتوسط (٤٣,٤٠٪) الى

اعلى من المتوسط (٦٥,٢٦٪)- وكذلك ايضا الذى تم حسابه لصفة محصول النبات الكلى من البذور الجافه تراوح بين اقل من المتوسط (٤٢,٠٦٪) الى العالى نسبيا(٢٢,٧٤٪) وذلك فى الهجن المختلفه• على العكس من ذلك-القدره على التوريث بمعناها الضيق الذى تم تقديرها لصفة المقاومه للعنكبوت الاحمر ذو البقعتين تراوحت بين المنخفض(٢٧,٤٨٪)الى اقل من المتوسط (٤٦,٢١٪)- بينما لصفة النسبه المؤيه لعقد الثمار تراوحت بين ٣٥,٦١٪ الى ٥٦,٠٣ ٪- والذى تم حسابه لصفة محصول النبات الكلى من البذور الجافه تراوح بين منخفض(٢٥,٠٨٪) الى اقل من المتوسط (٤٨,٦٣٪) فى كل الهجن تحت الدراسه• عدد ازواج الجينات التى تتحكم فى صفات المقاومه للعنكبوت الاحمر ذو البقعتين والنسبه المؤيه لعقد الثمار ومحصول النبات الكلى من البذور الجافه تراوح بين ١-٤& ١-٥ & ١-٥ بنفس الترتيب• وجد ان هناك اختلافات معنويه بين الاباء ونباتات الجيل الاول ونباتات الجيل الثانى ونباتات التهجين الرجعى لنباتات الجيل الاول مع الاب الاول ونباتات التهجين الرجعى لنباتات الجيل الاول مع الاب الثانى وذلك فى الهجين امى X جيزه ٦ وذلك بالنسبه لمحتوى الاوراق من النتروجين والبوتاسيوم والسكريات الكليه• الصنف امى (الذى وجد انه مقاوم للعنكبوت الاحمر ذو البقعتين) كان يحتوى على اعلى مستوى من البوتاسيوم واقل مستوى من النيتروجين والسكريات الكليه بالمقارنه بالصنف جيزه ٦ الذى وجد انه حساس للاصابه بالعنكبوت الاحمر ذو البقعتين • المقاومه للعنكبوت الاحمر ذو البقعتين كانت ترتبط ارتباط موجب مع كل من عدد افرع النبات وعدد قرون النبات والنسبه المؤيه لعقد القرون وعدد البذور بالقرن ووزن ١٠٠بذره ومحصول النبات الكلى من البذور الجافه- ولكن هذه العلاقه كانت سالبه مع عدد الايام من تاريخ الزراعه حتى تفتح اول برعم زهرى • بالاضافه الى ذلك- وجد ان هناك علاقه موجبه عالية المعنويه بين المقاومه للعنكبوت الاحمر ذو البقعتين ومحتوى اوراق النبات من البوتاسيوم- ولكن هذه العلاقه كانت سالبه مع محتوى اوراق النبات من النيتروجين والسكريات الكليه• علاوه على ذلك – وجد ان المقاومه للعنكبوت الاحمر ذو البقعتين كانت ترتبط ارتباطعالى مع التاثير المشترك لكل من عدد الايام من تاريخ الزراعه حتى تفتح اول برعم زهرى وعدد قرون النبات والنسبه المؤيه لعقد القرون ووزن ١٠٠بذره ومحصول النبات الكلى من البذور الجافهز.