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GENETIC VARIABILITY , HERITABILITY AND EXPECTED GENETIC ADVANCE FOR AGRONOMIC TRAITS AND WILT RESISTANCE IN SEGREGATING GENOTYPES OF CHICKPEA (*Cicer arietinum* L.)

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ABSTRACT

The F_3 , F_4 and F_5 genotypes of twenty chickpea crosses were made by the International Center for Agriculture Research in the Dry Areas (ICARDA) . Two local varieties (Giza 195 and giza 531) were used as checks in this study. Genetic variability , heritability in broad sense and genetic advance were estimated for genotypes in F_3 , F_4 and F_5 generations. Results revealed that genetic variance was existed and significant for most traits in F_3 , F_4 and F_5 generations. Environmental variation was notably high for yield and yield components (number of pods , seeds , seed weight per plant and seed index) as well as seed yield ton / fed. which resulted in relatively moderate to low heritability and genetic gain values estimated for most characters in F_3 , F_4 and F_5 generations. On the basis of the relatively high heritability , genetic coefficient of variation and expected genetic advance pronounced progress should be expected from selection for plant height , height of first pod , number of pods , seeds and , seed weight per plant and seed index , while moderate progress should be expected with number of branches / plant , number of seeds/pod , flowering , maturity date and wilt disease infection.

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is an important food legume crop in Egypt and all over the world. The development of high yielding and early maturity varieties of chickpea is a main objective in chickpea breeding programs.

In any breeding program effective selection is dependent on the existence of genetic variability . The existence of the genetic variability in a specific breeding population depends on germplasm included in it and its selection history (Hallauer 1981). Various authors have emphasized the utility of estimates of variance components as a basis for predicting the response of quantitative characters to selection in plant breeding . Selection in a given population is based on the phenotypic value of individuals, while only a portion of the phenotypic value is transmitted to the following generation. Thus it is of primary importance to know the relative magnitudes of the different components of the phenotypic value in investigations with chick pea accessions a wide range of variation for yield. Yield components and other characters chick pea was observed (Onkar – Singh *et al* (1994) ; Rao *et al.* (1994) ; Khorgade *et al.* (1985) ;Singh *et al.* (1985) ; Indu – Agrawal (1986) and Salimath *et al.* (1990).

Knowledge of the heritability of quantitatively inherited attributes has bean useful as a tool for improving selection efficiency. Progress under

selection depends on the magnitude of heritability for the trait under selection. In chickpea widely varying estimates of heritability and genetic advance for different characters have been reported (Agrawal and Indu Agrawal (1985) ; Indu (1986) ; Rao *et al*(1994); Salimath *et al.* (1990) and Rajesh *et al.* (1988).

The purpose of the present investigation was to estimate the genotypic , phenotypic and environmental variation , heritability and expected genetic gain from selection for certain agronomic characters of 20 crosses in F_3 , F_4 and F_5 generations.

MATERIALS AND METHODS

The present study, F_3, F_4 and F_5 genotypes of twenty Chickpea (*Cicer arietinum* L.) crosses made by the International Center for Agriculture Research in the Dry Areas (ICARDA) in addition to two commercial varieties (checks) Giza 531 and Giza 195, which are partially described in Table 1.

Table (1) : The pedigree of materials used in this study.

Entry No.	Cross No.	Pedigree	Origin
1	X 92 TH 10	Flip 84 – 92 c X Flip 90 – 126c	ICARDA/ ICRISAT
2	X 92 TH 73	Flip 84 – 92 c X Flip 88 – 39 c	ICARDA/ ICRISAT
3	X 92 TH 89	S 91167 X Flip 84 – 164 c	ICARDA/ ICRISAT
4	X 92 TH 86	S 89 TH 78998 X Flip 88c	ICARDA/ ICRISAT
5	ILC 3279	----------	Erst while USSR
6	X 92 TH 8	Flip 84 – 92 c X Flip 89 – 67 c	ICARDA/ ICRISAT
7	X 92 TH 22	Flip 90 – 103 c X Flip 84 – 15 c	ICARDA/ ICRISAT
8	X 92 TH 33	Flip 85 – 142 c X Flip 84 – 92 c	ICARDA/ ICRISAT
9	X 92 TH 72	ILC 72 X ILC 5364	ICARDA/ ICRISAT
10	X 92 TH 7	Flip 84 – 92 c X Flip 84 – 15 c	ICARDA/ ICRISAT
11	X 92 TH 11	Flip 85 – 86 c X Flip 86 – 5 c	ICARDA/ ICRISAT
12	X 92 TH 137	(Flip 88 – 71 c X Flip 83 – 72 c)X Flip 86 – 5 c	ICARDA/ ICRISAT
13	X 92 TH 34	Flip 85 – 142 c X Flip 83 – 115 c	ICARDA/ ICRISAT
14	X 92 TH 140	(Flip 89 – 124 c X Flip 84 – 79 c)X Flip 89-11c	ICARDA/ ICRISAT
15	X 92 TH 12	Flip 85 – 86 c X Flip 84 – 15 c	ICARDA/ ICRISAT
16	X 92 TH 28	Flip 85 – 18 c X Flip 84 – 92 c	ICARDA/ ICRISAT
17	X 92 TH 42	Flip 90 – 138 c X Flip 90 – 64 c	ICARDA/ ICRISAT
18	X 92 TH 23	Flip 90 – 103 c X Flip 89 – 67 c	ICARDA/ ICRISAT
19	X 92 TH 31	Flip 85 – 142 c X Flip 89 – 106 c	ICARDA/ ICRISAT
20	X 92 TH 80	Flip 84 – 33 c X Flip 89 – 67 c	ICARDA/ ICRISAT
21	Giza 531	Local check	Egypt
22	Giza 195	Local check	Egypt

This work was conducted at the Experimental Farm of Gemmiza Research Station, Gharbia Governorate , Egypt , during three successive growing seasons started in 1999 / 2000. F_3 seed of each cross were grown on Nov. 20 in three row plots replicated three times in a randomized complete block design. The plots were 30 plants per row spaced 10 cm. apart in the row with rows 60 cm. apart.

30 guarded plants were visually selected from each cross of F_3 population. Selection was based on growth vigor , erect , growth habit and diseases resistance. The following data were recorded, plant height cm. , height of first pod cm. , number of branches / plant , number of pods and

seeds/plant, seed weight / plant (gm.), Seed index (gm.) , number of seeds / pod, seed weight / fed. in ton , flowering date , maturity date and wilt disease infection %.

The best fifteen plants in seed yield were selected from each cross of F_3 population for the following planting in F_4 generation on Nov.25 2000 . F_4 seed of each cross were grown in five row plots replicated three times (each row represent one family) in a randomized complete block design and as followed in F_3 generation. At maturity 30 individual plants were selected from each cross for recording the same data taken as F_3 generation. The best fifteen plants in seed yield and other desirable traits were selected from each cross of F_4 population for the following planting in F_5 generation on Nov. 26 2001 as the same manner in F_4 generation. The same characters were recorded in F_5 generation as followed in both F_3 and F_4 generation.

Genetic variance (6^2 g) was derived from the mean squares for genotypes and error in the regular analysis of variance by separating out the variance components according to Burton 1952. Phenotypic (P. C. V.) and genotypic (G. C. V.) coefficient of variability and broad sense heritability (h^2) estimates were calculated according to the expressions of Anand and Torrie (1963).

The expected genetic advance Gs. Is K. H. 6^2 p. where K is the value for 5 % intensity of selection and P : is the estimate of the phenotype standard deviation among genotype means.

RESULTS AND DISCUSSION

Genotypes mean squares were significant in F_3 generation for all characters studied except maturity date and wilt disease infection % Table 2. Results presented in Tables 3 and 4 reveal significant variance among genotypes in F_4 and F_5 generation for different studied traits except number of seeds per pod in F_4 generation , number of branches per plant , number of seeds per pod and maturity date in F_5 generation.

Results in Tables 5 , 6 and 7 show that the genotypes numbers 5 , 7 , 8 and 16 gave the highest mean of plant height cm. and it were 93.7 , 90.0 , 96.7 and 88.0 cm. respectively in F_4 generation , while it were 101.7 , 95.0 , 90.0 and 95.0 cm. respectively in F_5 generation. Generally the overall mean of genotypes for this character was higher than the two checks(Giza 195 and Giza 531)in all three generations , however such tall genotypes might be used as useful plant material. In general , tall plants are preferred (unless it leads to lodging) since it may have more bud bearing nodes and hence higher seed yield. Our results are in general agreement with those of Rajesh-Mishra *et al.* (1988) and Rao *et al.* (1994).

The moderate and close estimates detected for P. C. V. and G. C. V. suggest the small effect of environment on the expression of this character Tables 8 , 9 and 10. Thus a selection for this character will provide a chance of genetic improvement. Similar finding regarding coefficients of variation in chickpea has bean reported by Arora and Jeena (1999); Rao *et al.*(1994) and Salimath *et al.* (1990) .

Table (2) : Mean squares values of agronomic characters studied in F_3 generation.

Source of Variation	d.f	Plant height cm.	Height of first pod cm.	No.of branch-es/plant	No.of pods/ plant	No.of seeds/ Plant	Seed weight/ Plant (gm.)	Seed yield ton/ fed.	Seed Index (gm.)	No.of seeds/ pod	50 % flowe-ring	Date of matu-rity	Wilt dise-ase infect-ion %
Replications	2	24.38	3.47	11.94**	625.5	940.9	24.2	0.001	19.3	0.006	38.5*	23.7**	6.79
Genotypes	21	147.4**	131.82**	16.47**	5412.7**	9254.1**	765.7**	0.276**	72.6**	0.05**	36.2**	8.33	17.4
Error	42	10.28	11.18	2.24	744.3	1011.4	76.95	0.026	9.78	0.008	12.42	5.05	19.8

Table (3): Mean squares values of agronomic characters studied in F_4 generation.

Source of Variation	d.f	Plant Height Cm.	Height of first pod cm.	No.of branch-es/ Plant	No.of pods/ plant	No.of seeds/ plant	Seed weight/ Plant (gm.)	Seed yield ton/ fed.	Seed Index (gm.)	No.of sees/ pod	50 % flowe-ring	Date of matu-rity	Wilt disea-Se Infect-ion %
Replications	2	18.1	0.59	5.7	450.3	249.7	32.5	0.004	8.09	0.037	7.19	12.68	0.288
Genotypes	21	220.4**	157.9**	15.5**	1613.3**	2007.7**	349.3**	0.354**	103.4**	0.072	31.1**	13.6**	23.0**
Error	42	44.4	19.73	5.04	564.3	73.7	101.9	0.023	9.54	0.043	7.17	2.19	10.62

Table (4) : Mean squares values of agronomic characters studied in F_5 generation

Source of Variation	d.f	Plant height cm.	Height of first pod cm.	No.of branches/ Plant	No.of pods/ Plant	No.of seeds/ plant	Seed weight/ Plant (gm.)	Seed yield Ton/ Fed.	Seed Index (gm.)	No.of seeds/ pod	50 % flower-ing	Date of matu-rity	Wilt dise-ase Infect ion %
Replications	2	231.7**	35.7	0.62	1408.9	671.2	32.7	0.008	3.11	0.001*	48.73	29.0**	1.19
Genotypes	21	123.6**	114.9**	0.72	8298.3**	10056.7**	700.2**	0.437**	94.3**	0.011	54.8**	8.82	17.5*
Error	42	43.14	38.9	0.62	1718.8	1482.0	65.9	0.044	16.84	0.012	16.76	4.73	8.96

Table (5) : Means of genotypes for different agronomic characters studied in F_3 generation.

Genotypes	Plant height cm.	Height of first pod cm.	No.of branches/ plant	No.of pods/ Plant	No.of seeds plant	Seed weight/plant (gm.)	Seed yield ton/fed.	Seed index (gm.)	No.of seeds/ pod	50 % flow-ering	Date of maturity	Wilt disease Infection %
1	77.3	38.7	8.9	143.3	151.1	52.14	1.713	27.43	1.100	89.3	166.3	10.0
2	68.0	33.3	7.8	91.8	91.7	33.53	1.850	35.01	1.02	89.7	167.0	3.33
3	66.3	27.0	12.6	132.0	138.4	39.05	1.573	30.95	1.04	92.3	167.7	9.33
4	65.7	20.3	9.5	70.2	68.9	21.39	1.620	36.08	0.99	93.7	168.0	9.0
5	63.7	32.3	11.0	89.6	80.5	24.09	1.083	29.83	0.89	97.0	168.7	4.33
6	66.3	25.7	14.5	207.6	251.8	67.51	2.017	26.97	1.21	89.3	166.0	6.67
7	61.0	20.3	11.6	180.4	212.8	60.59	1.550	30.30	1.19	95.3	168.0	8.33
8	61.0	23.7	11.5	108.0	99.3	18.13	2.367	33.20	0.89	93.7	169.0	5.0
9	61.0	33.3	8.2	96.5	107.2	32.16	2.183	31.77	1.10	97.7	168.0	7.33
10	60.7	27.7	7.2	98.1	109.2	33.41	1.650	35.99	1.10	91.3	169.3	7.33
11	81.0	43.7	14.8	157.1	162.0	64.65	1.617	37.69	1.03	92.	168.0	2.67
12	71.3	34.3	7.1	145.6	148.8	49.18	1.280	35.17	0.98	87.7	163.7	7.33
13	65.3	27.0	11.2	201.3	238.8	57.20	1.483	25.47	1.17	94.0	166.0	6.67
14	61.3	26.0	9.7	125.9	135.0	40.30	1.483	31.45	1.06	96.7	167.7	5.33
15	80.3	36.7	9.9	109.5	148.9	58.03	1.700	33.87	1.37	89.0	167.0	5.67
16	78.0	42.7	9.0	82.9	87.7	33.65	1.450	34.33	1.04	97.7	169.0	5.67
17	69.3	27.3	7.0	160.2	193.3	40.83	1.967	22.31	1.21	89.7	166.7	5.67
18	75.3	33.7	8.1	101.7	93.2	34.60	1.833	40.01	0.91	87.0	165.7	11.0
19	76.0	36.0	12.0	175.3	190.8	53.57	1.307	31.22	1.09	93.7	167.0	6.67
20	70.0	35.7	9.3	84.7	93.5	28.65	1.800	31.95	1.12	88.7	164.0	8.0
Mean	68.9	31.3	10.1	128.1	140.2	42.13	1.676	32.05	1.08	92.3	167.1	6.67
Range min	60.7	20.3	7.0	91.8	68.9	18.13	1.083	22.31	0.89	87.0	163.7	2.67
Max	81.0	42.7	14.8	207.6	251.8	67.51	2.367	40.01	1.37	97.7	169.3	11.0
Giza 531	61.0	25.0	8.2	68.5	59.9	17.32	1.483	25.70	0.88	91.0	164.0	10.33
Giza 195	60.3	25.3	6.8	79.4	70.4	15.57	1.967	20.59	0.89	86.7	165.0	11.67
L.S.D. 5%	5.28	5.51	2.46	44.96	52.40	14.75	0.266	5.15	0.15	0.26	5.81	3.70

Table (6) : Means of genotypes for different agronomic characters studied in F_4 generation.

Genotypes	Plant height cm.	Height of first pod cm.	No.of branch-es/plant	No.of pods/ Plant	No.of seeds/ plant	Seed weight/plant (gm.)	Seed yield ton /fed.	Seed index (gm.)	No.of seeds/ pod	50 % flow-ering	Date Of maturity	Wilt disease Infection %
1	77.0	35.7	7.3	78.5	84.8	26.07	1.597	24.40	1.08	87.3	165.7	6.0
2	81.7	41.3	9.1	74.7	74.9	28.53	1.733	31.52	1.0	85.3	164.7	3.0
3	77.7	49.3	7.5	53.1	61.9	23.87	1.560	37.42	1.19	84.3	163.3	10.0
4	93.3	46.0	7.7	58.2	72.3	46.67	1.670	41.06	1.24	90.0	164.3	5.33
5	93.7	45.3	7.5	73.3	68.7	23.60	0.990	27.42	0.92	89.3	163.7	4.33
6	70.0	35.7	5.9	47.6	36.4	16.53	2.100	30.92	0.78	85.3	165.0	6.0
7	90.0	46.7	11.9	92.4	98.7	43.33	1.450	41.04	1.05	85.7	163.3	6.0
8	96.7	53.7	12.7	94.5	97.3	39.07	2.547	33.85	1.03	86.3	168.3	4.67
9	94.0	48.7	9.1	67.5	54.2	27.2	2.117	39.58	0.77	91.3	166.3	8.33
10	93.3	50.3	11.9	67.6	77.5	35.67	1.570	40.99	1.14	88.7	168.3	5.33
11	82.3	34.7	10.3	142.3	146.0	54.80	1.613	33.0	1.03	87.3	166.7	3.0
12	81.7	32.3	5.8	81.0	84.3	26.67	1.230	29.77	1.02	87.0	163.0	9.67
13	92.7	44.0	14.5	94.0	95.8	42.73	1.420	38.71	1.01	83.7	164.0	7.33
14	81.0	30.3	7.9	87.2	92.5	26.13	1.407	25.05	1.23	96.7	170.0	5.0
15	82.3	32.3	7.7	41.4	48.7	14.07	1.667	24.18	1.20	90.3	162.0	5.67
16	88.0	39.7	6.9	52.7	47.5	21.0	1.363	31.41	0.88	90.3	167.3	4.0
17	77.0	38.7	8.3	95.7	83.1	23.53	1.953	29.0	0.88	91.0	165.3	5.67
18	75.7	33.7	8.4	79.1	77.9	29.47	1.750	36.12	1.04	86.0	165.0	11.0
19	78.7	36.3	8.4	47.1	59.3	21.2	1.207	30.03	1.29	86.0	166.3	6.33
20	74.7	32.3	8.7	89.0	116.0	40.0	1.700	32.16	1.27	90.3	165.0	10.67
Mean	84.1	40.4	8.9	75.9	78.9	30.5	1.632	32.88	1.06	88.1	165.4	6.37
Range min	70.0	30.3	5.8	41.4	48.7	14.07	0.990	24.18	0.77	83.7	162.0	3.0
Max	94.0	53.7	14.5	142.3	146.0	54.8	2.547	41.06	1.29	96.7	170.0	11.0
Giza 531	70.3	34.0	7.3	89.9	100.8	26.47	1.450	22.93	1.12	91.7	161.3	7.67
Giza 195	70.3	30.0	6.2	50.1	43.4	15.07	1.867	26.01	0.84	83.3	166.0	13.67
L.S.D. 5 %	10.98	7.32	3.70	39.14	44.54	16.63	0.247	5.09	N.S	4.41	2.44	5.37

Table (7) : Means of genotypes for different agronomic characters studied in F_5 generation.

Genotypes	Plant height cm.	Height of first pod cm.	No.of branches/ plant	No.of pods/ Plant	No.of seeds/ plant	Seed weight/ plant (gm.)	Seed yield ton /fed.	Seed index (gm.)	No.of seeds/ pod	50 % flowering	Date of maturity	Wilt disease Infection %
1	78.3	31.7	6.7	153.0	152.3	34.72	1.837	22.91	0.99	89.0	168.0	5.67
2	90.0	36.7	6.3	146.6	155.6	39.95	1.617	25.80	1.07	91.0	169.0	2.67
3	91.7	45.0	7.3	105.0	107.9	35.96	1.543	33.76	1.03	94.0	168.7	9.0
4	93.3	50.0	6.3	109.6	123.8	46.26	1.677	38.32	1.17	94.3	168.3	4.67
5	101.7	48.3	7.3	94.4	107.2	31.73	0.937	32.0	1.1	99.3	169.3	4.0
6	79.0	30.7	7.2	273.1	296.8	87.83	2.193	29.67	1.1	88.0	166.7	5.67
7	95.0	52.3	5.9	124.9	129.5	40.05	1.410	82.23	1.05	95.0	168.7	5.33
8	90.0	40.0	5.8	78.8	79.8	32.93	2.680	41.18	1.01	93.3	169.3	4.0
9	89.0	35.3	6.0	99.3	97.2	36.62	2.030	37.86	0.97	99.0	169.0	7.67
10	88.3	41.7	7.5	121.5	133.3	53.06	1.467	40.08	1.1	91.3	170.0	4.67
11	88.3	41.7	6.3	133.3	145.9	51.88	1.613	36.62	1.1	92.0	169.0	2.0
12	76.7	31.7	6.5	186.8	224.3	68.68	1.183	30.55	1.2	86.7	164.0	7.67
13	93.3	41.7	6.5	217.2	234.4	72.42	1.477	31.08	1.08	95.3	168.0	5.67
14	85.0	40.0	6.4	108.5	110.7	37.18	1.417	35.33	1.02	97.3	169.0	4.0
15	81.7	30.0	6.9	217.7	211.6	51.31	1.600	24.93	1.0	88.0	167.7	4.33
16	95.0	43.3	6.8	193.4	191.8	53.76	1.290	28.92	0.99	99.3	170.3	3.67
17	85.0	40.0	6.5	135.2	140.2	39.84	1.987	28.37	1.03	89.7	168.3	5.33
18	81.7	36.0	6.6	128.4	119.1	34.91	1.643	29.48	0.96	87.3	166.3	10.0
19	83.3	36.7	6.5	192.6	202.8	60.77	1.130	30.01	1.07	95.3	167.3	5.33
20	83.3	38.3	7.5	239.1	245.2	71.0	1.683	29.16	1.03	87.7	164.3	9.33
Mean	87.5	39.6	6.6	152.9	160.5	49.0	1.620	31.91	1.05	92.64	168.1	5.53
Range min	76.7	30.0	5.8	78.8	79.8	31.73	0.937	22.91	0.97	86.7	164.0	2.0
Max	101.7	52.3	7.5	273.1	296.8	87.83	2.680	41.18	1.08	99.3	170.3	10.0
Giza 531	81.7	33.3	6.9	174.6	180.7	38.72	1.343	21.80	1.06	91.3	165.7	6.33
Giza 195	81.7	35.0	6.5	206.6	235.5	51.18	1.790	22.10	1.13	85.7	166.0	11.33
L.S.D. 5%	10.82	10.28	N.S	68.31	63.43	13.37	0.345	6.76	N.S	6.75	3.58	4.93

The estimates of heritability was 82 , 57 and 38 % for F_3 , F_4 and F_5 generations respectively. The expected genetic gain observed was high for plant height 12.64 , 11.92 and 6.55 for F_3 , F_4 and F_5 generations respectively. Rajesh *et al* (1988) reported that a high heritability coupled with high genetic advance was observed for number of secondary branches/plant , plant height , number of pods/plant , seed yield/plant , biological yield/plant and harvest index.

Eight genotypes numbers 1 , 2 , 6 , 12 , 15 , 18 , 19 and 20 gave the low values of height of first pod and it were 31.7 , 36.7 , 30.7 , 31.7 , 30.0 , 36.0 , 36.7 and 38.3 (cm.) per plant for F_5 generation. Such low range of height of first pod might be useful in selecting genotypes characterized by high number of pods per plant in this material.

In tables 8 , 9 and 10 coefficients of variations at both phenotypic and genotypic levels were of high magnitude indicating wide variation in the material for height of first pod per plant cm. Heritability values estimated for height of first pod per plant in F_3 , F_4 and F_5 generations were 78 , 70and 40% respectively. The genotypes in F_3 and F_4 generations gave the highest values for expected genetic gain of 11.52 and 11.70 respectively, while in F_5 generation it was 6.61.These results agreement with that obtained by Jahagirdar *et al* (1994) and Rajesh *et al* (1988).

Data given in tables 5 , 6 and 7 reveal that genotypes mean for number of branches per plant in F3 generation ranged from 7.0 to 14.8 with an overall mean 10.1. In F_4 generation genotypes mean ranged from 5.8 to 14.5 with an overall mean of 8.9 branches per plant , whereas it ranged in F_5 generation from 5.8 to 7.5 with an overall mean of 6.6 branches per plant. Variation was more apparent among F_3 and F_4 than among F_5 genotypes.

The magnitude of environmental variation 6^2e (or E. C. V.) was generally , medium. This indicates that the genotypes vary in their sensitivity to environmental modulations which reflected on the values of heritability estimated for genotypes where , heritability was high in F_3 and F_4 generations 68 and 41 % respectively , low in F_5 generation 5%. Such as results suggest that improvement may be attained by increasing number of branches per plant when selection is practiced by Rao *et al*(1994) and Onkar *et al* (1994).

Expected genetic advance was high in F_3 and F_4 generations 3.70 and 2.47 respectively, while it was low in F_5 generation 0.08. Our results are in general agreement with those of Jahagirdar *et al* (1994) and Rao *et al* (1994).

As shown in tables 5 , 6 and 7 the genotypes in F_3 and F_5 generations gave the highest number of pods , seeds and seed weight per plant (gm.). The genotypes means for number of pods per plant in F_3 generation ranged from 91.8 to 207.6 with an overall mean 128.1 pods per plant , while it ranged from 78.8 to 273.1 with an overall mean 152.9 pods per plant in F_5 generation , whereas it ranged from 41.4 to 142.3 with an overall mean 75.9 in F_4 generation. Also number of seeds per plant ranged from 68.9 to 251.8 with an overall mean 140.2 in F_3 generation and it ranged from 79.8 to 296.8 with an overall mean 160.5 seeds per plant in F_5 generation. So it was low in F_4 generation and ranged from 48.7 to 146.0 with an overall mean 78.9 seeds per plant.

Seed weight per plant (gm.) was high in F_3 and F_5 generation more than F_4 generation . In F_3 generation seed weight per plant ranged from 18.13 to 67.5 grams with an overall mean 42.13 grams per plant and in F_5 generation ranged from 31.73 to 87.83 grams with an overall mean 49.0 grams per plant ,whereas it ranged from 14.07 to 54.8 grams with an overall mean 30.5 grams per plant in F_4 generation. Generally the genotypes in F_3, F_4 and F_5 generations gave the highest values of number of pods , seeds and seed weight in grams per plant comparing with two local checks Giza 531 and Giza 195. These results are in agreement with that obtained by Rao *et al* (1994).

Higher phenotypic coefficient variation compared with genotypic coefficient variation was observed for number of pods, seeds and seed weight in grams per plant in F_3, F_4 and F_5 generations, moderate to high values for environmental coefficient variation were also observed. This indicate that these characters is sensitive to environmental fluctuations. Heritability values were 68, 38 and 56 % for number of pods per plant in F_3 . F_4 and F_5 generations respectively. In F_3, F_4 and F_5 generations it was 59, 37 and 66 % for number of seeds per plant respectively, while it was 75, 45 and 76 % for seed weight per plant (gm.) in F_3 , F_4 and F_5 generation respectively.

The values of expected genetic advance were 67.19 , 23.67 and 72.15 for number of pods per plant , 82.96 , 25.92 and 89.57 for number of seeds per plant , 27.05 , 12.59 and 26.07 for seed weight in grams per plant in F_3 , F_4 and F_5 generations respectively. A high values of genetic advance, suggesting that improvement is quite possible by selecting the higher genotypes in number of pods , seeds and seed weight in grams per plant and these genotypes could be used in improving the trait in future programs. These results are in agreement with that obtained by Indu (1986) ; Jahagirdar *et al* (1994); Rao *et al* (1994) ; Salimath *et al* (1990) ; Moustafa (1993) ; Arun *et al* (1998) ; Rao and Jain (1998) ; Jagannath *et al* (1999) and Shiv *et al* (2001) .

In all the three generations F_3 , F_4 and F_5 as shown in tables 5 , 6 and 7 genotypes numbers 1, 2, 6, 8, 9, 17, 18 and 20 had the highest values for seed yield in ton per fed. , while those of genotypes numbers 12 , 16 and 20 had the lowest values . The overall mean was 1.676, 1.632 and 1.620 in ton per fed. in F_3 , F_4 and F_5 generations respectively. Seed yield of genotypes ranged from 1.083 to 2.367 , 0.990 to 2.547 and from 0.937 to 2.680 ton per fed. for F_3 , F_4 and F_5 generations respectively compared with two local checks Giza 531 (1.483 , 1.450 and 1.343 ton/ fed.) and Giza 195 (1.967 , 1.867 and 1.790 ton/ fed.) in F_3 , F_4 and F_5 generations respectively. In all three generations phenotypic and genotypic coefficient of variations were relatively moderate tables 8 , 9 and 10. Great differences were also observed between P. C. V. and G. C. V. in F_4 generation Table 9 revealing the large effect of environment on the expression of seed yield ton per fed. This character exhibited high heritability values which were 77, 83 and 75 % in F_3 , F_4 and F_5 generations respectively , suggesting that selection for improving this trait will be high effective.

Table (8) : Estimates of variability , heritability , and expected genetic advance for yield and its components and wilt disease infection % inF_3 generation.

Parameters	Plant height cm.	Height of first pod cm.	No.of branches/ plant	No.of pods/ Plant	No.of seeds/ Plant	Seed weight/ plant (gm.)	Seed yield ton / fed.	Seed index (gm.)	No.of seeds/ Pod	50 % flowering	Date Of maturty	Wilt disease InfectiOn%
Mean	68.9	31.3	10.1	128.1	140.2	42.13	1.676	32.05	1.08	92.28	167.13	6.67
Range min	60.7	20.3	7.0	91.8	68.9	18.13	1.083	22.31	0.89	87.0	163.7	2.67
max	81.0	42.7	14.8	207.6	251.8	67.51	2.367	40.01	1.37	97.7	169.3	11.0
$\sigma^2 ph$	56.01	51.39	6.99	2300.4	4658.7	306.54	0.108	30.72	0.0021	20.34	6.15	18.96
$\sigma^2 g$	45.7**	40.21**	4.74**	1556.1**	2747.6**	229.6**	0.083**	20.9**	0.13**	7.93**	1.094	-0.79
$\sigma^2 e$	10.28	11.19	2.24	744.3	1011.4	76.95	0.026	9.78	0.008	12.42	5.048	19.76
P C V	10.86	22.90	26.18	37.44	48.68	41.56	19.61	17.29	13.42	4.89	1.48	65.28
G. C V	9.81	20.26	21.56	9.74	37.39	35.96	17.18	14.27	10.56	3.05	0.63	-13.32
E. C. V	4.65	10.68	14.8	21.3	22.68	20.82	9.62	9.76	8.28	3.82	1.34	66.64
(h^2) %	82	78	68	68	59	75	77	68	62	39	18	-0.04
G.A.	12.64	11.52	3.70	67.19	82.96	27.05	0.52	7.76	0.19	3.62	0.92	8.89

Table (9) : Estimates of variability , heritability , and expected genetic advance for yield and its components and wilt disease infection % In F_4 generation.

Parameters	Plant height cm.	Height of first pod cm.	No.of branc-hes/ plant	No.of pods/ Plant	No.of seeds/ Plant	Seed weight/ Plant (gm.)	Seed yield ton / fed.	Seed index (gm.)	No.of seeds/ pod	50 % flowering	Date of maturity	Wilt disease Infection%
Mean	84.1	40.4	8.9	75.9	78.9	30.5	1.63	32.88	1.06	88.11	165.4	6.37
Range min	70.0	30.3	5.8	41.4	48.7	14.07	0.99	24.18	0.77	83.7	162.0	3.0
max	94.0	53.7	14.5	142.3	146.0	54.8	2.55	41.06	1.29	96.7	170.0	11.0
$\sigma^2 ph$	103.08	65.82	8.52	913.98	1156.38	184.35	0.132	40.83	0.0527	15.13	5.97	14.76
$\sigma^2 g$	58.7**	46.09**	3.49**	349.7**	425.7**	82.48**	0.110**	31.3**	31.28	7.97**	3.78**	4.13*
$\sigma^2 e$	44.42	19.73	5.039	564.31	730.72	101.86	0.023	9.54	0.043	7.165	2.19	10.62
P. C.V	12.07	20.08	32.80	39.83	43.10	44.52	22.29	19.43	21.66	4.42	1.48	60.31
G.C.V.	9.11	22.41	20.99	24.64	26.15	29.78	12.90	17.01	527.7	2.55	0.85	34.81
E.C.V.	7.93	14.66	25.22	31.30	34.26	33.09	9.29	9.39	19.56	3.04	0.90	51.16
(h^2) %	57	70	41	38	37	45	83	77	18	53	63	28
G A	11.92	11.70	2.47	23.67	25.92	12.59	0.62	10.14	0.085	4.25	3.17	2.22

Table (10) : Estimates of variability , heritability , and expected genetic advance for yield and its components and wilt disease infection % in F_5 generation.

Parameters	Plant height cm.	Height of first pod cm.	No.of branches/ plant	No.of pods/ Plant	No.of seeds/ Plant	Seed weight/ plant (gm.)	Seed yield ton / fed.	Seed index (gm.)	No.of seeds/ pod	50 % flowering	Date of maturity	Wilt disease Infection%
Mean	87.5	39.6	3.6	152.9	160.5	49.04	1.62	31.91	1.05	92.64	168.1	5.53
Range min	76.7	30.0	2.8	78.7	79.8	31.73	0.937	22.91	0.97	86.7	164.0	2.0
max	101.7	52.3	4.5	273.1	296.8	87.83	2.680	41.18	1.08	99.3	170.3	10.0
6^2ph	69.96	64.26	0.65	3911.97	4340.4	277.32	0.174	42.69	0.0116	29.43	6.09	11.79
6^2g	26.8**	25.36**	0.035	2193.2**	2858.2**	211.44**	0.131**	25.83	-0.0003	12.7**	1.36	2.83*
6^2e	43.14	38.90	0.615	1718.8	1482.04	65.87	0.044	16.84	0.012	16.76	4.73	8.96
P.C.V	9.56	20.24	22.40	40.91	41.05	33.96	25.75	20.49	10.26	5.86	1.47	62.09
G.C.V.	5.92	12.72	5.20	30.63	33.31	29.65	22.34	15.93	-1.65	3.84	0.69	35.39
E.C.V.	7.51	15.75	21.78	27.12	23.99	16.55	12.95	12.86	10.43	4.42	1.29	54.13
(h^2) %	38	40	5	56	66	76	75	61	- 2.59	43	22	24
G.A .	6.55	6.61	0.08	72.15	89.57	26.07	0.65	8.21	- 5.11	4.81	1.12	1.70

Also , values of expected genetic advance were low 0.52 , 0.62 and 0.65 for F_3, F_4 and F_5 generations respectively. Similar results were obtained by Khorgade *et al* (1985) ; Onkar *et al* (1994) ; Rao *et al* (1994) and Singh *et al* (1985).

Two genotypes numbers 1 and 15 gave the smallest seed index 24.40 and 24.18 (gm.) in F_4 generation , 22.91 and 24.93 (g) in F_5 generation. This character important to selecting the genotypes had small seeds because the consumers prefer smaller sizes varieties.

Parameters of variability phenotypic and genotypic coefficient or P. C. V., G. C. V. and E. C. V. are generally of high magnitude, showing a narrow variation in the genotypes. Also, the relatively high heritability values which were 68 % , 77 % and 61 % in F_3 , F_4 and F_5 generations respectively , indicate that the most phenotypic variation exists among genotypes are mainly caused by environmental factors and therefor , progress from selection will be less effective in improving this character. The expected genetic advance observed was high in F_3 , F_4 and F_5 generations 7.76 , 10.14 and 8.21 respectively. Similar results were obtained by Agrawal and Indu (1985) and Khorgade *et al* (1985).

For number of seeds per pod as shown in tables 5 , 6 and 7 the genotypes is approximately equal to the corresponding mean in F_4 and F_5 generations. In F_3 generation number of seeds per pod ranged from 0.89 to 1.37 with an overall mean 1.08 seeds/pod. The low magnitudes of the three parameters estimates of (6^2 ph , 6^2 g and 6^2 e), indicate that the variation exists among genotypes for number of seeds per pod is little and mainly attributed to environmental variation. The low estimates of heritability 18 % and - 2.59 % in F_4 and F_5 generations as well as the low estimates of expected genetic advance 0.085 and – 5.11 in F_4 and F_5 generations were detected., while the estimate of heritability was high in F_3 generation (62 %) and estimate of expected genetic advance was low (0.19).

In F_3 , F_4 and F_5 generations five genotypes numbers 1, 6, 12, 15 and 20 were early in flowering and maturing dates. The overall mean for days to flowering was 92.3 in F_3 generation comparing to 88.1 and 92.6 in F_4 and F_5 generations respectively.

The overall mean for number of days to maturity was 167.1 in F_3 generation compared to 165.4 and 168.1 in F_4 and F_5 generations respectively. Seven genotypes numbers 1, 6, 12, 15, 18, 19 and 20 were equal to two local checks (Giza 531 and Giza 195) in number of days from sowing to maturity in F_3, F_4 and F_5 generations. As shown in tables 8, 9 and 10 the three variability estimates (P. C. V., G. C. V. and E. C. V.) recorded for these two traits were of low magnitude. In spite of the two differences detected between the estimates of P. C. V. and G. C. V. in all generations that suggest the importance of genetic factors in the expression of these two traits, it seems that genetic differences are not sufficient in the material. These results are in agreement with those obtained by Agrawal and Indu (1985) and Rao *et al* (1994).

Estimates of heritability in broad sense were 39 , 53 and 43 % for number of days to 50 % flowering and it were 18 , 63 and 22 % for number of of days to maturity in F_3, F_4 and F_5 generations respectively. In facts the

magnitude of the expected genetic advance from selection depends on the value of heritability and the magnitude of selection differential in genotypes. The high heritability estimate coupled with high expected genetic advance recorded in F_3 generation previously mentioned in conformity with the findings of Agrawal and Indu (1985) who suggested that heritability in such cases may be attributed to additive gene effects.

In F_3, F_4 and F_5 generations five genotypes numbers 2, 5, 8, 11 and 14 were more tolerant to wilt disease infection % . These genotypes gave values of wilt disease infection % ranged between 4.0 – 5.3 % compared with 7.5 to 10.5 % for two local checks Giza 531 and Giza 195 . The overall mean were 6.67, 6.37 % and 5.53 % for F_3, F_4 and F_5 generations respectively. The highest amount of seed yield (ton/ fed.) was recorded in genotypes number 6, 8 and 9 that were moderate resistant for wilt disease. Similar results were obtained by Singh and Reddy (1994).

Higher phenotypic coefficient variation (65.28) compared with (– 13.32) for genotypic coefficient variation was observed for wilt disease infection % in F_3 generation. The phenotypic coefficient variation was higher than genotypic coefficient variation for this trait (60.31 to 34.81) in F_4 generation and (62.09 to 35.39) in F_5 generations . Heritability in broad sense was low in F_3 generation (- 0.04 %) and it was high in F_4 and F_5 generations (28 and 24 %) respectively. Expected genetic advance also relatively moderate to low. These character very important to selection the genotypes that most resistant to wilt disease and used it in breeding programs.

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التباين الوراثي وكفاءة التوريث للمحصول ومكوناته والمقاومة لمرض الذبول في الحمص

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أجرى هذا البحث بمحطة البحوث الزراعية بالجميزة غربية خلال ثلاث مواسم زراعية ابتداء من الموسم ٢٠٠٠حتى ٢٠٠٢/٢٠٠٣واستخدمت في هذه الدراسة عشائر الجيل الثالث والرابع والخامس لعشرين هجين من الحمص استقدمت من المركز الدولي للزراعة في المناطق الجافة (أيكا ردا) وتم تقدير التباين الوراثي ودرجة التوريث بمعناها الواسع والمكسب الوراثي للهجن المختلفة في الجيل الثالث والرابع والخامس مقارنة للصنفين التجاريين جيزة ١٩٥، ٥٣١ وتتلخص أهم النتائج فيما يلى :-

١- كان التباين الوراثي معنويا لمعظم الصفات تحت الدراسة في الجيل الثالث والرابع والخامس عدا صفة عدد البذور بالقرن في الجيل الرابع والخامس وصفة النضج في الجيل الثالث. في نفس الوقت كان التباين البيئي مرتفعا ويمثل الجزء الأكبر من التباين المظهري بالنسبة لصفات المحصول ومكوناته وأيضا طول النبات وارتفاع أول قرن على النبات وقد انعكس ذلك على قيم الكفاءة الوراثية والمكسب الوراثي من الأنتخاب والتي تراوحت بين المرتفع في صفات المحصول وبين المتوسط والمنخفض فيبعض الصفات الأخرى.

٢-بناء على نتائج معامل الاختلاف الوراثي ودرجة التوريث والمكسب الوراثي فانه يمكن إحراز تحسنا كبيرا عند الأنتخاب للصفات المحصولية والتبكير في النضج وطول النبات والمتاومة لأمراض الذبول وتحسن متوسط في الصفات الأخرى تحت الدراسة.