IV - EXPERIMENTAL RESULTS

Inheritance of some characters :

Plant height, head length, head width, head index, head weight and seed weight per plant were studied in nine crosses to determine their inheritance.

1- Inheritance of plant height

Plant height was studied in nine crosses, the parents were chosen to represent three types of plant height; short, medium and long.

Short type: Mean plant height ranged from (80 to 140 cm) it was represented by the two varieties NES 324 and NES 645

Medium type : Mean plant height varies from (141 to 250 cm) as it was in the variety TAM 428.

Tall type: Mean plant height ranged from (251 to 376 cm) including the two varieties G.15 and G.114.

I- Short X Short category : this group included the cross NES 324 X NES 645. Plant height of the variety NES 324 ranged from 89 to 158 cm with a mean value (118.3 ± 0.99 cm) and a coefficient of variation 2.64 % . The other parent, NES 645 ranged from 112 to 158 cm having a mean value of (138.40 ± 2.28 cm) and a coefficient of variation of 4.25 %. The F_1 plants ranged from 112 to 158 cm giving a mean valve of (138.50 ± 3.17 cm) and a coefficient of variation of 7.23 %. Plant height of the F_2 population had range from 112 to 227 cm and covering the limits of the two parents. Its mean was (174.16 ± 3.51 cm)

with a coefficient of variation of 20.16%which was higher than those of parents and F_1 populations. The continuous distribution of the F_2 population indicated that plant height behaved as a quantitative character, Table (2)

Nature of dominance : The observed F_1 meon (138.50 cm) was higher than the arithmetic mean (128.35 cm) indicating nearly complete dominance of the taller parent. However, the observed F_2 mean (174.16 cm) was higher than the arithmetic mean (133 • 42 cm) showing overdominance of the taller parent.

The estimations of heterosis over the mid-parents and the better parent were (7.91 %) and (0.07 %) respectively. The inbreeding depression was (- 25. 75 %), Table (3).

Nature of gene action : The observed F_1 mean (138.50 cm) was higher than both the arithmetic mean (128.35 cm) and the geometric mean (127.95 cm). Moreover, the observed F_2 mean (174.16 cm) was higher than both the arithmetic mean (133.42 cm) and the geometric mean (133.33 cm) which are equal indicating that both gene actions are acting with the same amount, Table (3)

The estimates of the different kinds of the gene effects showed that additive x additive (19.98) was the most important part affecting plant height in this cross, while additive, dominance, additive x dominance and dominance X dominance gave estimates of (-10.93), (-9.83), (-0.88) and (-122.98) respectively, Table (4).

Number of genes involved : The Castle - Wright and Wright's formula resulted in the estimation of (0.044 and 0.067) pair of genes respectively, indicating that the minimum number of genes responsible for the parental difference in plant height in this cross was one pair of genes, Table (4). However, the Mendelian principles could not be used precisely due to similarity of the ranges of the two parents.

Heritability: in broad sense was 91.87 % . On the other hand, heritability in narrow sense could not be calculated which may be due to heterosis effect Table (4).

II- Short X Medium Category: This group was represented by the two crosses : NES 324 X TAM 428 and NES 645 X TAM 428

1- NES 324 X TAM 428 : The data for plant height of the variety NES 324 was previously discussed. The other parent TAM 428 ranged from (135 to 158 cm) with a mean value of(141.70 ± 1.80 cm) and a coefficient of variation of 1.98 %,plant height of the F_1 showed a range from (158 to 227 cm) with a mean value of (197.10 ± 5.50 cm) and a coefficient of variation of 8.82 %. Besides, the distribution of plant height in the F_2 generation ranged from (112 to 204 cm) and showed transgressive segregation over the taller parent. Its mean value was (159.28 ± 2.88 cm) with a coefficient of variation of 18.07 %, Table (2).

Nature of dominance : The observed F_1 mean (197. 10 cm) was higher than the arithmetic mean (130.00 cm), indicating over-dominance of tallness. Moreover, the observed F_2 mean (159.27 cm) was insignificantly lower than the arithmetic mean

(163.55 cm) showing inbreeding depression.

Heterosis estimates percentage were (51. 61 %) and (39.10 %) over the mid-parents and the better parent respectively. The inbreeding depression was 19.19 %, Table (3).

Nature of gene action : The observed F_1 mean (197.10 cm) was higher than the arithmetic mean (130.00 cm) and the geometric mean (129.47 cm) which are nearly equal. At the same time, the observed F_2 mean (159.27 cm) was lower than the arithmetic mean (163.55 cm) and the geometric mean (160.07 cm) which are insignificantly different indicating that nature of gene action could not be determined, Table (3).

The estimates of the different kinds of the gene effects showed that dominance (92.50) and additive x additive effect (25.40) were important parts in this cross. While additive, additive xdominance and dominance x dominance geve effects gave values of (-3.62), (-15.32) and (-33.72) respectively, Table (4).

Number of genes involved: The Castle Wright and Wright's formulae gave 0.130 and 2.270 pair of genes respectively indicating that the two parents differ in (1-2) pair of genes. The Mendelian principles could not be applied due to similarity between the two parents, Table (4).

Heritability : Heritability in broad sense was 63.57 % . Meanwhile, the heritability estimate in narrow sense could not be calculated due to the heterotic effect, Table (4).

2- NES 645 X TAM 428 : The data of plant height of the varieties NES 645 and TAM 428 were previously discussed. Plant height of the F_1 showed range from (158 to 181 cm) with a mean of (162.50 ± 2.27 cm) and a coefficient of variation of 4.41 %.Besides, the distribution of plant height in the F_2 generation ranged from (89 to 227 cm) with a mean of (129.60 ± 3.45 cm) and a coefficient of variation of 26.61 %, Table (2).

Nature of dominance : The observed F_1 mean (162.50 cm) was higher than the arithmetic mean (140.05 cm) showing overdominance of the taller parent. Meanwhile , the observed F_2 mean (129.60 cm) was lower than the arithmethic mean (166.27 cm) indicating inbreeding depression.

Heterosis estimates percentage were (16.03 %) and (14.68%) over the mid - parents and the better parent respectively. The inbreeding depression was (20.25 %), Table (3).

Nature of gene action : The observed F_1 mean (162.50 cm.) was higher than both the arithmetic mean (140.05 cm) and the geometric mean (140.04) which are equal. Moreover, the observed F_2 mean (129.60 cm) was lower than both the arithmetic mean (166.27 cm) and the geometric mean (150.86 cm), but closer to the geometric mean probably indicating multiplicative gene action, Table (3).

The estimates of the different kinds of the gene effects showed that dominance (140.93) and additive x additive effect (118.48) were important than additive (-62.76), additive x dominance (- 61.11) and dominance x dominance effect (-150.26) in the inheritance of plant height in this cross, Table (4).

Number of genes involved : The Castle-Wright and Wright's formula gave estimates of 0.001 and 0.112 pair of genes, respectively, suggesting that the parents were different in one pair of genes, Table (4). The parental varieties were nearly similar in their destribution, and it was therefore, impossible to use the Mendelian principles for estimating genes number.

Heritability : Heritability value reached 95.68 % using the F_1 variance, Meanwhile , the heritability estimate in narrow sense could not be calculated because of the heterosis effect, Table (4).

III- Short X tall category: This group was represented by the three crosses NES 324 X G.114, NES 645 X G.15 and NES 645 x G.114.

1- NES 324 x G. 114. The data of the parent NES 324 were previously discussed. The other parent, G. 114 ranged from 296 to 365 cm, with a mean value of (340.10 ± 3.52 cm) and a coefficient of variation reaching 3.29 %. The F_1 plants ranged from 296 to 342 cm, with a mean value of (318.50 ± 5.07 cm) and a coefficient of variation of 5.03 % . The F_2

Heterosis estimates over the mid-parents and the better parent were (29.08 %) and (- 11.70 %) respectively. The inbreeding depression was (9.79 %), Table (3).

Nature of gene action : The observed F_1 mean (332.00 cm) was higher than both the arithmetic mean (257.20 cm) and the geometric mean (228.12 cm). Meanwhile, the observed F_2 mean (299.50 cm) was insignificantly higher than the arithmetic mean (294.60 cm) but significantly lower than the geometric mean (312.74 cm) showing that nature of gene action could not be determined Table (3).

The estimates of the different kinds of the gene effects showed that dominance x dominance (54.20), additive x dominance (38.85) and dominance (37.90) were the important parts in this cross. While additive x additive and additive gene effect gave estimates of (23.20) and (-79.95) respectively Table (4).

Number of genes involved : The Castle-Wright and Wright's formulae gave (5.933) and (7.122) pairs of genes respectively, Table (4).

The Mendelian principles could not be applied here because none of the F_2 plants were within the range of the recessive parent which may be due to the small number of F_2 plants

Heritability : A heritability value of 93.78 % was reached by using the F_1 variance as an estimate for environmental variance. On the other hand, the heritability in narrow sense could not be calculated ~~because of the high variance of the F_1 which explain the heterotic effect~~, Table (4).

3- NES 645 X G.114. The data for plant height of the varieties NES 645 and G.114 were previously discussed. The F_1 plants ranged from 273 to 342 cm with a mean value of (310.00 ± 7.85 cm) and a coefficient of variation of 8.01 %. Plant height in the F_2 population ranged from 158 to 342 cm with a mean value of (296.90 ± 3.82 cm) and a coefficient of variation of 14.54 % which is higher than those of parents and F_1 population. These observations showed transgressive segregation exceeding the limits of the two parents and the continuous F_2 distribution indicated that plant height behaved as a quantitative character, Table (2),

Nature of dominance : The observed F_1 mean (310.00 cm) was higher than the arithmetic mean (239.25 cm). This indicated the presence of partial dominance of the taller parent.However, the observed F_2 mean (262.90 cm) was lower than the arithmetic mean (274.62 cm) showing inbreeding depression.

The estimates of heterosis percentage were (29.57 %) and (-8.85 %) over the mid-parents and the better parent respectively. The inbreeding depression was (15.19 %), Table (3).

Nature of gene action: The observed F_1 mean (310.00 cm) was higher than both the arithmetic mean (239.25 cm)and the geometric mean (216.95 cm). The observed F_2 mean (262.90 cm) was higher than both the arithmetic mean (274.62 cm) and the geometric mean (272.34) which are nearly equal indicating

that both gene actions are acting with the same amount, Table (3). The estimates of the different kinds of the gene effects showed that dominance (94.25) and additive x additive (23.20) were the important parts in this cross. On the other hand additive, additive x dominance and dominance x dominance gene effects gave estimates of (-58.25),(-15.65) and (-0.10) respectively, Table (4).

Number of genes involved : The Castle-Wright and Wright's formulae resulted in the estimates of (6.023 and 7.517) pair of genes respectively indicating that the minimum number of genes responsible for the parental difference in plant height were 6-8 pair of genes, Table (4).

The Mendelian principles showed that two plants out of 100 F_2 plants studied were within the range of the recessive parent NES 645, giving a ratio of (1-50) which indicates that those parents differ in 2 to 3 pair of genes.

Heritability : A heritability value of 57.78 % was obtained by using the F_1 variance as the environmental variance. On the other hand,the heritability estimates in narrow sense could not be calculated ~~which may be due to the heterosis effect~~, Table (4).

IV- Medium X Tall category : This group involved the two crosses TAM 428 X G.15 and TAM 428 X G.114.

1- TAM 428 X G.15 : Data for the plant height of the two parents TAM 428 and G.15 were discussed previously. The F_1

plants ranged from 319 to 388 cm, its mean value was (354.50 ± 6.73 cm), with a coefficient of variation of 6.00 % which is higher than those of parents. The F_2 population showed a range from 204 to 388 cm covering the ranges of the two parents. The F_2 mean value was (300.35 ± 5.09 cm) with a coefficient of variation of 16.93 % which is higher than those of parents and F_1 population. The continuous range of the F_2 population indicated that plant height in this cross behaved as a quantitative character, Table (2).

Nature of dominance : The observed F_1 mean (354.50 cm) was higher than the arithmetic mean (258.85 cm) showing partial dominance of the taller parent. Meanwhile, the observed F_2 mean (300.35 cm) was insignificantly lower than the arithmetic mean (306.67 cm) indicating inbreeding depression, Table (3)

Heterosis values in F_1 over the mid-parents and the better parent (36.95 %) and (-5.72 %) respectively. The i breeding depression was 15.28 %, Table (3).

Nature of gene action : The obseved F_1 mean (354.50 cm) was higher than both the arithmetic mean (258.85 cm) and the geometric mean (230.82 cm), but closer to the arithmetic mean. Moreover, the observed F_2 mean (300.35 cm) was insignificantly lower than both the arithmetic mean (306.67 cm) and the geometric mean (302.92 cm) indicating that nature of gene action could not be determined, Table (3). The estimates of the different kinds of the gene effects showed that dominance

(130.25), additive x dominance (43.60)and additive x additive gene effect (35 .10) were more important than additive (-73.55) and dominance x dominance gene effects (-44.90) in the inheritance of plant height, Table (4).

Number of genes involved : The Castle-Wright and Wright's formula gave (3.217) and (4.259) pair of genes, respectively. The Mendelian principles could not be applied here because none of the F_2 plants were within the range of the recessive parent which may be due to smallness of number of F_2 plants.

Heritability : A heritability value of (82.50 %) was obtained by using the F_1 variance. Meanwhile, heritability value in narrow sense was (45.84 %), Table (4).

2- TAM 428 X G.114 : The data for plant height of the varieties TAM 428 and G.114 were previously discussed. The F_1 plants ranged from 342 to 388 cm, with a mean value of (368.50 $\pm$ 7.07 cm) and a coefficient of variation of 6.07 % which is higher than those of parents. Plant height in the F_2 population ranged from 158 to 388 cm with a mean value of (294.75 $\pm$ 4.44 cm) and a coefficient of variation of 15.05% which is higher than those of parents and F_1 population. These observations showed transgressive segregation over the taller parent and the continuous F_2 distribution indicated that plant height behaved as a quantitative character, Table (2).

Nature of dominance : The observed F_1 mean (368.50 cm.) was higher than the arithmetic mean (240.90 cm) indicating over-dominance of the taller parent. On the other hand, the observed F_2 mean (294.75 cm) was lower than the arithmetic mean (304.45 cm) showing inbreeding depression.

The estimates of heterosis percentage were (52.97 %) and (8.38%) over the mid-parents and the better parent respectively. The inbreeding depression was (20.01 %), Table(3).

Nature of gene action : The observed F_1 mean (368.50 cm) was higher than both the arithmetic mean (240.90 cm) and the geometric mean (219.53 cm), but closer to the arithmetic mean. At the some time, the observed F_2 mean (294.75 cm). was lower than the arithmetic mean (304.45 cm) but insignificantly lower than the geometric mean (297.94 cm) indicating that nature of gene action could not be determined, Table (3).

The estimates of the different kinds of the gene effects showed that dominance (115.14), dominance x dominance (64.72) and additive x dominance gene effects (28.27) were more important than additive (-70.93) and additive x additive gene effects (-12.46) in the inheritance of plant height in this cross, Table (4).

Number of genes involved : The Castle-Wright and Wright's formula resulted in the estimates of (3.350 - 6.144) pair of genes respectively, indicating that the minimum number of genes responsible for the parental difference in plant height

were 3-6 pair of genes, Table (4).

The Mendelian principles showed that one plant out of 100 F_2 plants studied were within the range of the recessive parent TAM 428, giving a ratio of (1:100) which indicates that those parents differ in more than three pair of genes.

Heritability : A heritability in broad sense was estimated as 74.59 %. In the same time, heritability value in narrow sense was 11.72 %, Table (4).

V- Tall X Tall category : This group included the cross G.15 X G.114. The data of plant height of the two varieties G.15 and G.114 were previously mentioned concerning its. range, mean and coefficient of variation. The mean of the F_1 plants was (361.00 $\pm$ 1.25 cm) having a range from 342 to 365 cm and a coefficient of variation of 1.09 % which is lower than both parents indicating homogeneity of the F_1 plants. The F_2 plants having a range from 296 to 388 cm covering the ranges of both parents and the F_1 population. The mean of F_2 plants was (377.55 $\pm$ 2.81 cm) and its coefficient of variation was 7.45 % which is more higher than those of parents and F_1 populations. The cantinuity of the F_2 distribution indicated that this character was quantitatively inherited, Table (2).

Nature of dominance : The observed F_1 mean (361.00 cm) was higher than the arithmetic mean (358.08 cm) indicating partial dominance of the taller parent. Meanwhile, the observed F_2 mean (377.55 cm) was higher than the arithmetic mean

(359.52 cm) showing nearly complete dominance of the taller parent.

Heterosis estimates over the mid-parents and the better parent were (0.81%) and (-3.99%) respectively. The inbreeding depression value was (-4.58 %), Table (3).

Nature of gene action : The observed F_1 mean (361.00 cm) was higher than both the arithmetic mean (358.08 cm) and the geometric mean (357.60 cm) which are nearly equal. Meanwhile, the observed F_2 mean (377.55 cm) was higher than both the arithmetic mean (359.52 cm) and the geometric mean(359.54 cm) which are identical, indicating that both gene actions are acting with the same amount, Table (3).

The estimates of different kinds of gene effects showed that additive (- 19.09) and dominance x dominance (-9.26) were the important parts in this cross. While, dominance, additive x additive, additive x dominance gene effects gave estimates of (-28.47), (-31.42) and (-37.04) respectively, Table (4).

Number of genes involved : The Castle- Wright and Wright's formula gave 0.208 and 0.211 pair of genes respectively. These values showed that the two parental varieties differ in one pair of genes, Table (4).

The Mendelian principles could not be used as the two parents were nearly similar in their distribution.

Heritability : A heritability value of 98.03 % was calculated using the F_1 variance. However, the heritability in narrow sense could not be determined, due to the F_1 variance which was higher than the variance of P_2, Table (4).

Table (2) Frequency distribution of plant height in centimeters in the nine crosses studied

Crosses	Class centers													Number of plants	$\bar{X}$ ± S.E	C.V%
	89	112	135	158	181	204	227	250	273	296	319	342	365	388		
I Short x Short Category																
NEs 324 x NES 645																
R	1	21	7	1											30	118.30±0.99	2.64
B_{c1}	4	14	25	13	20	11	7	3	2	1					100	163.70±4.29	26.20
F_1		1	8	1											10	138.50±3.17	7.23
F_2		18	12	24	34	11	1								100	174.16±3.51	20.16
B_{c2}		7	18	16	24	19	15	1							100	174.63±3.40	19.48
P_2		16	10	14											40	138.40±2.28	4.25
II Short X Medium category																
1- NES 324 x TAM 428																
P_1	1	21	7	1											30	118.30±0.99	2.64
B_{c1}	4	9	19	21	21	13	10	3							100	167.44±3.71	22.16
F_1				1	2	6	1								10	197.10±5.50	8.82
F_2		18	12	24	34	12									100	159.28±2.88	18.07
B_{c2}		12	21	19	27	21									100	163.82±3.05	18.64
P_2			29	11											40	141.70±1.80	1.98

Table (2) Cont .

Crosses	Class centers													Number of plants	$\bar{X}$	± S.E	C.V %
	89	112	135	158	181	204	227	250	273	296	319	342	365	388				
2- NES 645 xTAM428																		
P_1		16	10	14											40	133.40	2.28	4.25
Bc_1	3	45	40	12											100	127.48	1.43	11.18
F_1				8	2										10	162.50	2.27	4.41
F_2	15	36	32	14	1	1	1								10	129.60	3.45	26.61
Bc_2	1	3	24	16	13	19	5	6	5	3	5				100	190.60	5.67	29.75
P_2			29	11											40	141.70	1.80	1.98
III- Short x Tall category																		
1- NES 324 x G.114																		
P_1	1	21	7	1											30	118.30	0.99	2.64
Bc_1			2	1	6	14	10	15	8	9	18	13	1	3	100	269.05	6.00	22.30
F_1										2	6	2			10	318.50	5.07	5 .03
F_2					5	6	5	10	10	13	26	11	13	1	100	295.53	5.21	17.63
Bc_2						1	3	5	4	9	28	25	20	5	100	327.17	4.07	12.44
P_2										1	13	17	9		40	340.10	3.52	3 .29

Table (2) Cont .

Crosses	Class centers													Number of plants	$\bar{X}$	±	S.E	C.V%
	89	112	135	158	181	204	227	250	273	296	319	342	365	388					
2- NES 645 x G.15																			
P_1		16	10	14											40	138.40	±	2.28	4.25
Bc_1			1	4	5	13	15	21	18	11	11	1			100	250.30	±	4.59	18.32
F_1											6	4			10	332.00	±	2.81	2.68
F_2						2	5	10	16	18	31	15	3		100	299.50	±	3.56	11.89
Bc_2						1	1	4	7	10	31	22	11	13	100	330.25	±	3.77	11.43
P_2												3	11	16	30	385.00	±	2.68	2.24
3- NES 645 x G.114																			
P_1		16	10	14											40	138.40	±	2.28	4.25
Bc_1		1	6	7	5	13	9	27	10	10	8	4			100	239.65	±	5.56	23.21
F_1									2	3	5	1			10	310.00	±	7.85	8.01
F_2				2	1	6	13	31	18	15	13	1			100	262.90	±	3.82	14.54
Bc_2				1	2	4	1	13	12	15	32	16	1	3	100	297.90	±	4.62	15.51
P_2										1	13	17	9		40	340.10	±	3.52	3.29

Table (2) cont.

Crosses	Class centers														Number of plants	X ± S.E.	C.V%
	89	112	135	158	181	204	227	250	273	296	319	342	365	388			
IV- Medium x Tall category																	
1- TAM 428 x G.15																	
P_1			29	11											40	141.70 ± 1.80	1.98
Bc_1			1	3	5	5	10								100	272.35 ± 5.11	18.7
F_1											1	4	3	2	10	354.50 ± 6.73	6.0
F_2						9	4	11	8	22	20	12	9	5	100	300.35 ± 5.09	16.9
Bc_2							3	3	5	21	28	19	19	21	100	345.90 ± 3.71	10.74
P_2												3	11	16	30	376.00 ± 2.68	2.24
2- TAM 428 x G.114																	
P_1			29	11											40	141.70 ± 1.80	1.98
Bc_1			2	2	3	15	14	19	13	15	14	1	1	1	100	256.17 ± 5.01	19.54
F_1												3	4	3	10	368.50 ± 7.07	6.07
F_2				1	2	5	2	16	14	20	19	14	5	2	100	294.75 ± 4.44	15.05
Bc_2								6	6	12	33	23	13	7	100	327.10 ± 3.38	10.34
P_2										1	13	17	9		40	340.10 ± 3.52	3.29

Table (2) Cont.

Crosses	Class centers													Number of plant	X + S.E	C.V%
	89	112	135	158	181	204	227	250	273	296	319	342	365	388			
V- Tall x Tall category																	
G.15 x G.114																	
P_1											3	11	16		30	376.00 ± 2.68	2.24
Bc_1									2	2	8	21	41	26	100	360.15 + 2.67	7.41
F_1												1	9		10	361.00 + 1.25	1.09
F_2										1	7	12	18	62	100	377.55 ± 2.81	7.45
Bc_2											5	14	21	60	100	379.24 ± 2.99	7.89
P_2										1	13	17	9		40	340.10 ± 3.52	3.29

Table (3): Estimates of nature of gene action, heterosis percentage (H %) over mid-parants and better parent and inbreeding depression percentage (I.D %) with respect to plant height

Crosses	F_1 population			F_2 population			Heterosis (H%)		inbreeding depression (I. D. %)
	Obser. mean	Calc. Arith.	Calc. Geom.	Obser. mean	Calc. Arith	Calc. Geom.	M.P.	B.P.	
I- Short x Short category									
NES 324 x NES 645	138.50	128.35	127.95	174.16	133.42	133.33	7.91	0.07	-25.75
II-Short x Medium category									
1- NES 324 x TAM 428	197.10	130.00	129.47	159.27	163.55	160.07	51.61	39.10	19.19
2- NES 645 x TAM 428	162.50	140.05	140.04	129.60	166.27	150.86	16.03	14.68	20.25
III-Short x Tall category									
1- NES 324 x G.114	318.50	229.20	200.58	295.53	273.85	270.18	38.96	- 6.35	7.21
2- NES 645 x G.15	332.00	257.20	228.12	299.50	294.60	312.74	29.08	-11.70	9.79
3- NES 645 x G.114	310.00	239.25	216.95	262.90	274.62	272.34	29.57	- 8.85	15.19
IV- Medium x Tall category									
1- TAM 428 x G.15	354.50	258.85	230.82	300.35	306.67	302.92	36.95	- 5.72	15.28
2- TAM 428 x G.114	368.50	240.90	219.53	294.75	304.45	297.94	52.97	8.35	20.01
V - Tall x Tall category									
G.15 x G.114	361.00	358.08	357.60	377.55	359.52	359.54	0.81	- 3.99	- 4.58

Table (4): Estimates of parameters of gene action; number of genes and heritability (h^2%) in broad and narrow sense with respect to plant height.

Crosses	Gene action						Number of genes		Heritability %	
	m	a	d	aa	ad	dd	Castle Wright	Wright formula	B.S.	N.S.
I- Short x Short category										
NES 324 x NES 645	174.16	-10.93	- 9.83	19.98	- 0.88	-122.98	0.044	0.067	91.87	--
II- Short x Medium category										
1- NES 324 x TAM 428	159.28	- 3.62	92.50	25.40	-15.23	- 33.72	0.130	2.270	63.57	--
2- NES 645 x TAM 428	129.60	-62.76	140.93	118.48	-61.11	-150.26	0.001	0.112	95.68	--
III- Short x Tall category										
1- NES 324 x G.114	295.33	-28.12	100.84	10.32	52.78	-107.36	2.451	3.246	90.54	6.93
2- NES 645 x G.15	299.50	-79.95	37.90	23.20	38.85	54.20	5.933	7.122	93.78	--
3- NES 645 x G.114	262.90	-58.25	94.25	23.20	-15.65	- 0.10	6.023	7.517	57.78	--
IV- Medium x Tall category										
1- TAM 428 x G.15	300.35	-73.55	130.25	35.10	43.60	- 44.90	3.217	4.259	82.50	45.84
2- TAM 428 x G.114	294.75	-70.93	115.14	-12.46	28.27	64.72	3.350	6.144	74.59	11.72
V- Tall x Tall category										
G.15 x G.114	377.55	-19.09	-28.47	-31.42	-37.04	- 9.26	0.208	0.211	98.03	--

m = F_2
a = additive effect
d = dominance effect
aa = additive x additive type of epistasis
ad = additive x dominance type of epistasis
dd = dominance x dominance type of epistasis

2- Inheritance of head length :

Head length was measured to the nearest centimeter in nine crosses. The parents were chosen to represent three types of head length, short, medium and long.

Short type. Mean head length varies from (20 to 21.5 cm) and it was represented by the varieties G.114 and G.15.

Medium type. Mean head lenght varies from (21.6 to 23 cm). as it was in the variety TAM 428.

Long type. Mean head length ranged from (23.1 to 26 cm) including the parents NES 324 and NES 645

1- Short x short head : This group included the cross G.15 x G.114.Head length of the variety G.15 had a mean value of (21.40 ±0.37 cm) and a coefficient of variation of 5.93 %.The other parent, G.114, had a mean of (20.20 ± 0.29 cm) with a coefficient of variation of 4.00 %. The F_1 plants gave a mean of (22.30 ± 0.21 cm) and a coefficient of variation of 3.03 % which is lower than those of both parents indicating homogeneity of the F_1 plants. Head length of the F_2 population had a mean value (19.06 ± 0.20 cm) and a coefficient of variation of 10.62 %, which was higher than those of parents and F_1 populations, Table (5).

Nature of dominance : The observed F_1 mean (22.30 cm) was higher than the arithmetic mean (20.80 cm) showing overdominance of the taller head. On the other hand the observed

F_2 mean (19.06 cm) was lower than the arithmetic mean (21.55 cm) indicating inbreeding depression.

Heterosis over mid-parents and better parent gave estimates of (7.21 %) and (4.21 %) respectively. The inbreeding depression was (14.53 %), Table (6).

Nature of gene action : The observed F_1 mean (22.30 cm) was higher than both the arithmetic mean (20.80 cm) and the geometric mean (20.79 cm) . Moreover,the observed F_2 mean (19.06 cm) was lowerthan both the arithmetic mean (21.55 cm) and the geometric mean (21.54 cm) which are nearly equal indicating that the two types of gene action may act with the same amount, Table (6).

The estimates of different kinds of gene effects showed that dominance x dominance (8.12) and dominance effect (2.42) were more important than additive x additive (0.92), additive (0.48) and additive x dominance effect (-0.12), Table (7)

Number of genes involved : The Castle-Wright and Wright's formulae gave estimates of (0.049) and (0.204), Pair of genes respectively indicating that the parental varieties differd in one pair of genes, Table (7).

Heritability : A heritability value in broad sense was 88.78 %, but the norrow sense heritability could not be calcalated because the variance of the F_1 was higher than

the F_2 variance, Table (7).

II- Medium x Short head : This group was represented by the two crosses TAM 428 X G.15 and TAM 428 X G.114.

1- TAM 428 X G.15 : The data for head length of the variety G.15 were previously discussed. The other parent TAM 428 had a mean value of (22.50 ± 0.27 cm) with a coefficient of variation of 3.30 %. The mean value of the F_1 population was (25.30 ± 0.40 cm) with a coefficient of variation of 6.19 % which is higher than those of both parents. Head length of the F_2 population had a mean value of (21.50 ± 0.36 cm) and a coefficient of variation of 16.81 which is higher than those of the two parents and F_1 populations, Table (5).

Nature of dominance : The observed F_1 mean (25.30 cm) was higher than the arithmetic mean (21.35 cm), indicating over-dominance of the taller head. On the other hand the observed F_2 mean (21.50 cm) was lower than the arithmetic mean (23.33 cm) showing inbreeding depression.

Heterosis estimates percentage were (17.51 %) and (12.44%) over the mid-parents and the better parent respectively. The inbreeding depression value was 15.02 %, Table (6)

Nature of gene action : The observed F_1 mean (25.30 cm) was higher than both the arithmetic mean (21.35 cm) and the geometric mean (21.94 cm). At the sametime , the observed

F_2 mean (21.50 cm) was lower than both the arithmetic mean (23.33 cm) and the geometric mean (23.24 cm), which are nearly equal. Therefore, both types of gene action may be found with the same amount, Table (6).

The estimates of the different kinds of gene effects for head length showing that dominance (7.55), additive x additive effect (4.20) and additive effect (1.26) were more important than additive x dominance (0.71) and dominance x dominance effect (0.10) in the inheritance of this character, Table (7).

Number of genes involved : The Castle-Wright and Wright's formulae gave (0.058) and (0.397) pair of genes respectively. This indicates that the two parents differ by one pair of genes, Table (7).

Heritability : Heritability values in broad and narrow sense were 88.00 % and 44.00 % respectively, Table (7).

2- TAM 428 x G.114 : The data for head length of the varieties TAM 428 and G.114 were previously discussed. F_1 population had a mean value of (29.60 ± 0.40 cm) and a coefficient of variation of 4.27% which is higher than both of the two parents. Besides, the mean value of the F_2 plants was (21.89 ± 0.34 cm) with a coefficient of variation of 15.69%, being higher than that of parents and F_1, Table (5).

Nature of dominance : The observed F_1 mean (29.60 cm) was higher than the arithmetic mean (21.35 cm) indicating the presence of overdominance of the taller head. Moreover, the observed F_2 mean (21.89 cm) was lower than the arithmetic mean (25.22cm) showing inbreeding depression.

The data showed positive values of heterosis estimated over the mid-parents and over the better parent which were (38.64 %) and (31.56 %) respectively.

The inbreeding depression was 26.05 %, Table (6).

Nature of gene action : The observed F_1 mean (29.60 cm) was higher than both the arithmetic mean (21.35 cm) and the geometric mean (21.32 cm). Furthermore, the observed F_2 mean (25.22 cm) was lower than both the arithmetic mean (25.22 cm) and the geometric mean (25.14 cm) which are nearly equal, indicating that genes may affect this character either additively or cummulatively, Table (6).

The different kinds of gene effects indicated that dominance effect (14.15), additive x additive effect (5.90), dominance x dominance effect (2.54) were most important than additive effect (2.31) and additive x dominance effect (0.95) in the inheritance of head length, Table (7).

Number of genes involved : The Castle-Wright and Wright's formulae gave estimates of (0.065) and (1.34), respectively indicating that these two parents differ by (1-2) pair of genes, Table (7).

Heritability : Heritability value in broad sense gave estimates of 86.44 % by using the F_1 variance as an environmental variance. Heritability in narrow sense could not be calculated since the variance of the F_1 was higher than the F_2 variance, Table (7)

III- Long x Short head: This group involved the crosses, NES 324 x G.114; NES 645 x G.15 and NES 645 x G.114.

1- NES 324 x G.114 : The data for head length of the variety G.114 was previously discussed. head length in the other parent NES 324 had a mean value of (26.00 ± 0.54 cm) and a coefficient of variation of 7.58 %. The mean value of F_1 plants was (28.40 ± 0.54 cm) with a coefficient of variation of 6.63 % which is intermediate between the two parents.

Head length in the F_2 population had a mean value of (21.66 ± 0.37 cm) with a coefficient of variation of 17.28% which is higher than those of parents and F_1 populations, Table (5).

Nature of dominance : The observed F_1 mean (28.40 cm) was higher than the arithmetic mean (23.10 cm), showing overdominance of the taller head. Moreover, the observed F_2 mean (21.66 cm) was lower than the arithmetic mean (25.75 cm)

showing inbreeding depression.

The estimates of heterosis percentage were (22.94 %) and (9.23 %) over the mid - parents and the better parent respectively. The inbreeding depression was 23.73 %, Table (6)

Nature of gene action: The observed F_1 mean (28.40 cm) was higher than both the arithmetic mean (23.10 cm) and the geometric mean (22.92 %).

The observed F_2 mean (21.66 cm) was lower than both the arithmetic mean (25.75 cm) and the geometric mean(25.61 cm) which are nearly equal, indicating that both gene actions are acting with the same amount, Table (6)

The different kinds of gene effects of head length showed that the dominance gene effect (9.28), dominancex dominance gene effect (8.90) and additive x additive gene effect (3.98) were more important than additive affect (1.81) and additive x dominance effect (-1.09) with respect to inheritance of head length in this cross, Table (7)

Number of genes involved : The Castle- Wright and Wright's formulae gave estimates of (0.380) and (1.014) pair of genes respectively indicating that the two parental varieties differed by one pair of genes, Table (7).

Heritability : Heritability in broad and narrow sense gave estimates of (79.01 %) and (62.00 %) , respectively,Table (7).

2- NES 645 x G.15 : The data for head length for the parent G.15 was previously discussed. The mean value of the other parent, NES 645, was (23.15 ± 0.49 cm) with a coefficient of variation of 6.71 % . The mean value of the F_1 plants was (27.40 ± 0.31 cm) and a coefficient of variation of 3.53% which is lower than those of both parents, showing homogeneity of F_1 plants. The F_2 population had a mean value (21.28 ± 0.32 cm) with a coefficient of variation of 14.83 % which is higher than those of parents and F_1 populations,Table(5).

Nature of dominance : The observed F_1 mean (27.40 cm) was higher than the arithmetic mean (22.28 cm) , indicating the presence of overdominance of the taller parent. Besides,the observed F_2 mean (21.28 cm) was lower than the arithmetic mean (24.84 cm), showing inbreeding depression.

Heterosis estimates over the mid-parents and the better parent were (22.98 %) and (18.36 %) respectively. The inbreeding depression was 22.34 %, Table (6).

Nature of gene action : The observed F_1 mean (27.40 cm) was higher than both the arithmetic mean (22.28 cm) and the geometric mean (22.26 cm).

Moreover, the observed F_2 mean (21.28 cm) was lower than both the arithmetic mean (24.84 cm) and the geometric mean (24.71 cm) whichare nearly equal indicating that both gene actions may act with the same amount, Table (6).

The values of the different kinds of gene effects for head length showed that the dominance (9.21) and dominance x dominance gene effect (6.07) were more important than additive x additive (40.08), additive (3.14) and additive x dominance effects (2.27) in the inheritance of head length, Table (7) .

Number of genes involved : The Castle-Wright and Wright's formulae gave (0.042) and (0.770) pair of genes respectively. This indicates that the parental varieties may differ by one pair of genes, Table (7).

Heritability : Heritability value of 95.63% was obtained by using the F_1 variance. However, the heritability estimates in narrow sense was 17.00 % by using the formula of Warner (1952), Table (7).

3- NES 645 x G.114 : The data for head length of the parents NES 645 and G.114 were previously discussed. The mean value of the F_1 plants was (23.30 $\pm$ 0.67 cm) with a coefficient of variation of 9.06 which is higher than that of both parents. The F_2 plants had a mean value of (20.79 $\pm$ 0.31 cm) and a coefficient of variation of 15.00 % which is higher than

those of parents and F_1 populations, Table (5).

Nature of dominance : The observed F_1 mean (23.30 cm) was higher than the arithmetic mean (21.68 cm) indicating nearly partial dominance of the taller parent. Moreover, the observed F_2 mean (20.79 cm) was lower than the arithmetic mean (22.49 cm) indicating inbreeding depression.

Estimates of heterosis reached (7.47 %) and (0.65 %) over the mid-parents and the better parent respectively. The inbreeding depression was 10.77 %, Table (6).

Nature of gene action : The observed F_1 mean (23.30 cm) was higher than both the arithmetic mean (21.68 cm) and the geometric mean (21.62 cm). Besides, the observed F_2 mean (20.79 cm) was lower than both the arithmetic mean (22.49 cm) and the geometric mean (22.48 cm) which are nearly identical, suggesting that the two types of gene action may act with the same amount, Table (6).

The estimates of different kinds of gene effects showed that dominance effect (7.09), additive x additive effect (5.46) and additive effect (1.43) were important than dominance x dominance effect (-4.13) and additive x dominance effect (-0.05) in the inheritance of head length, Table (7).

Table (5): Statistics relative to head length for different populations in the nine crosses studied.

Populations	N	$\bar{X}$	±	S.E.	C.V.%
I- Short x Short head					
G.15 x G.114					
P_1	30	21.40	±	0.37	5.93
Bc_1	100	19.53	±	0.22	11.07
F_1	10	22.30	±	0.21	3.03
F_2	100	19.06	±	0.20	10.62
Bc_2	100	19.05	±	0.20	10.38
P_2	40	20.20	±	0.29	4.00
II- Medium x Short head					
1- TAM 428 x G.15					
P_1	40	22.50	±	0.27	3.30
Bc_1	100	23.18	±	0.33	14.28
F_1	10	25.30	±	0.40	6.19
F_2	100	21.50	±	0.36	16.81
Bc_2	100	21.92	±	0.31	14.02
P_2	30	21.40	±	0.37	5.93
2- TAM 428 x G.114					
P_1	40	22.50	±	0.27	3.30
Bc_1	100	24.43	±	0.38	15.49
F_1	10	29.60	±	0.40	4.27
F_2	100	21.89	±	0.34	15.69
Bc_2	100	22.30	±	0.33	14.70
P_2	40	20.20	±	0.29	4.00

Table (5) : Cont.

Populations	N	$\bar{X}$ ±	S.E.	C.V.%
III- Long x Short head				
1- NES 324 x G.114				
P_1	30	26.00 ±	0.54	7.58
Bc_1	100	23.65 ±	0.30	12.66
F_1	10	28.40 ±	0.54	6.63
F_2	100	21.66 ±	0.37	17.28
Bc_2	100	21.75 ±	0.32	14.85
P_2	40	20.20 ±	0.29	4.00
2- NES 645 x G.15				
P_1	40	23.15 ±	0.49	6.71
Bc_1	100	23.87 ±	0.34	14.21
F_1	10	27.40 ±	0.31	3.53
F_2	100	21.28 ±	0.32	14.83
Bc_2	100	20.73 ±	0.26	12.51
P_2	30	21.40 ±	0.37	5.93
3- NES 645 x G.114				
P_1	40	23.15 ±	0.49	6.71
Bc_1	100	22.87 ±	0.33	14.21
F_1	10	23.30 ±	0.67	9.06
F_2	100	20.79 ±	0.31	15.00
Bc_2	100	21.44 ±	0.26	12.32
P_2	40	20.20 ±	0.29	4.00

Table (5) : Cont.

Populations	N	$\bar{X}$	±	S.E.	C.V.%
III- Long x Short head					
1- NES 324 x G.114					
P_1	30	26.00	±	0.54	7.58
Bc_1	100	23.65	±	0.30	12.66
F_1	10	28.40	±	0.54	6.63
F_2	100	21.66	±	0.37	17.28
Bc_2	100	21.75	±	0.32	14.85
P_2	40	20.20	±	0.29	4.00
2- NES 645 x G.15					
P_1	40	23.15	±	0.49	6.71
Bc_1	100	23.87	±	0.34	14.21
F_1	10	27.40	±	0.31	3.53
F_2	100	21.28	±	0.32	14.83
Bc_2	100	20.73	±	0.26	12.51
P_2	30	21.40	±	0.37	5.93
3- NES 645 x G.114					
P_1	40	23.15	±	0.49	6.71
Bc_1	100	22.87	±	0.33	14.21
F_1	10	23.30	±	0.67	9.06
F_2	100	20.79	±	0.31	15.00
Bc_2	100	21.44	±	0.26	12.32
P_2	40	20.20	±	0.29	4.00

Table (5) : Cont.

Populations	N	$\bar{X}$	+	S.E.	C.V.%
IV- Long x Medium head:					
1-NES 324 x TAM 428					
P_1	30	26.00	±	0.54	7.58
Bc_1	100	26.39	±	0.31	11.77
F_1	10	29.20	±	0.39	4.21
F_2	100	26.21	±	0.33	12.44
Bc_2	100	24.19	±	0.36	14.75
P_2	40	22.50	±	0.27	3.30
2- NES 645 x TAM 428					
P_1	40	23.15	±	0.49	6.71
Bc_1	100	24.85	±	0.34	13.64
F_1	10	29.60	±	0.22	2.36
F_2	10	23.74	±	0.33	13.93
Bc_2	100	25.10	±	0.39	15.43
P_2	40	22.50	±	0.29	3.30
V- Long x Long head					
NES 324 x NES 645					
P_1	30	26.00	±	0.54	7.58
Bc_1	100	24.33	±	0.36	14.79
F_1	10	26.00	±	0.47	5.74
F_2	100	25.77	±	0.57	22.21
Bc_2	100	26.94	±	0.34	12.49
P_2	40	23.15	±	0.49	6.71

Table (6): Estimates of nature of gene action; heterosis percentage (H %) over mid-parents and better parent and inbreeding depression percentage (I. D %) with respect to head length.

Crosses	F_1 Population			F_2 population			Heterosis (H %)		inbreeding depression (I.D . %)
	Obser. mean	Calc. Arith.	Calc. Geom.	Obser mean	Calc. Arith	Calc. Geom.	M.P.	B.P.	
I- Short x Short head									
G.15 x G.114	22.30	20.80	20.79	19.06	21.55	21.54	7.21	4.21	14.53
II-Medium x Short head									
1- TAM 428 x G.15	25.30	21.35	21.94	21.50	23.33	23.24	17.51	12.44	15.02
2- TAM 428 x G.114	29.60	21.35	21.32	21.89	25.22	25.14	38.64	31.56	26.05
III-Long x Short head									
1- NES 324 x G.114	28.40	23.10	22.92	21.66	25.75	25.61	22.94	9.23	23.73
2- NES 645 x G.15	27.40	22.28	22.26	21.28	24.84	24.71	22.98	18.36	22.34
3- NES 645 x G.114	23.30	21.68	21.62	20.79	22.49	22.48	7.47	0.65	10.77
IV- Long x Medium head									
1- NES 324 x TAM 428	29.20	24.25	24.19	26.21	26.73	26.61	20.41	12.31	10.24
2- NES 645 x TAM 428	29.60	22.83	22.82	23.74	26.31	26.CO	29.65	27.86	19.80
V- Long x Long head									
NES 324 x NES 645	26.00	24.57	24.53	25.77	25.29	25.27	5.82	0.0	0.88

Table (7): Estimates of parameters of gene action ; number of genes and heritability (h^2%) in broad and narrow sense with respect to head length.

Crosses	Gene action						Number og genes		Heritability %	
	m	a	d	aa	ad	dd	Castle Wright	Wrights formula	B.S.	N.S.
I- Short x Short head										
G.15 x G.114	19.06	0.48	2.42	0.92	- 0.12	3.12	0.049	0.204	88.78	--
II- Medium x Short head										
1- TAM 428 x G.15	21.50	1.26	7.55	4.20	0.71	0.10	0.058	0.397	88.00	44.00
2- TAM 428 x G.114	21.89	2.31	14.15	5.90	0.95	2.54	0.065	1.734	86.44	--
III-Long x Short head										
1- NES 324 x G.114	21.66	1.81	9.28	3.98	- 1.09	8.90	0.380	1.014	79.01	62.00
2- NES 645 x G.15	21.28	3.14	9.21	4.08	2.27	6.07	0.042	0.770	95.63	17.00
3- NES 645 x G.114	20.79	1.43	7.09	5.46	- 0.05	- 4.13	0.207	0.332	54.18	19.65
IV- Long x Medium head										
1- NES 324 x TAM 428	26.21	2.20	1.27	-3.68	0.45	13.31	0.168	0.839	90.49	--
2- NES 645 x TAM 428	23.74	-0.25	11.72	4.92	- 0.58	0.01	0.005	1.102	95.53	--
V - Long x Long head										
NES 324 x NES 645	25.77	-2.61	0.89	-0.54	- 4.04	- 0.85	0.033	0.050	93.23	12.59

m = F_2
a = additive effect
d = dominance effect
aa = additive x additive type of epistasis
ad = additive x dominance type of epistasis
dd = dominance x dominance type of epistasis

3-Inheritance of head width :

Head width was measured in cintemeters in nine crosses. The parents were chosen to represent three types of head width, thin, nedium and wide.

Thin type. Mean head width ranged from (6 to 6.50 cm) and it was represented by the variety NES 645.

Medium type. Mean head width varies from (6.51 to 7.0 cm), as it was in the varieties NES 324 and TAM 428

Wide type. Mean head length ranged from (7.1 to 8.0 cm) including the two parents G.114 and G.15.

1- Thin x Medium head : This group included the cross NES 645 x TAM 428. The parent NES 645 had a mean value of(6.50 ± 0.15 cm) with a coefficient of variation of 7.37 %, The mean value of the other parent TAM 428 was (6.70 ± 0.17 cm) with a coefficient of variation of 6.67 %. The F_1 plants had a mean value of (7.15 ± 0.11 cm) and a coefficient of variation of 4.71 %, which is lower than that of both parents showing homogeneity of the F_1 plants. The mean value of the F_2 population was (5.51 ± 0.08 cm) with a coefficient of ariation of 15.99 % , which is higher than those of parents and F_1 populations, Table (8)

Nature of dominance : The observed F_1 mean (7.15 cm) was higher than the arithmetic mean (6.6 cm) indicating overdominance of the wider head Moreover the observed F_2 mean

(5.51 cm) was lower than the arithmetic mean (6.68 cm) showing inbreeding depression.

The degree of heterosis over the mid-parents and the better parent were (8.33 %) and (6.72 %) respectively.

The inbreeding depression was 22.94 %, Table (9).

Nature of gene action : The observed F_1 mean (7.15 cm) was higher than both the arithmetic mean (6.60 cm) and the geometric mean (6.60 cm) which are identical. On the other hand the observed F_2 mean (5.51 cm) was lower than both the arithmetic mean (6.68 cm) and the geometric mean (6.87 cm) indicating that the two types of gene action may act with the same amount, Table (9).

The different kinds of gene effects showing that the dominance effect (3.43) and additive x additive effect (2.89) were more important than additive effect (-0.77), additive x dominance effect (-0.66) and dominance x dominance effect (-0.30) with respect to inheritance of head width, Table (10) .

Number of genes involved : The Castle-Wright and Wright's formulae gave (0.0076) and (0.1219) pair of genes respectively, indicating that the two parents differed by one pair of genes, Table (10).

Heritability : Broad sense heritability was found to be 85.29 %, However, the heritability in narrow sense could not be determined due to the variance of F_1 was higher than the F_2 variance, Table (10).

II- Thin x Wide head : This group was represented by the two crosses NES 645 x G.15 and NES 645 x G.114.

1- NES 645 x G.15: The data for head width of the parent NES 645 were previously discussed. The other parent G.15 had a mean value of (7.75 ± 0.14 cm) with a coefficient of variation of 5.29 %. The mean value of the F_1 plants was (7.75 ± 0.00 cm) with a coefficient of variation of 8.19 % which is higher than those of both parents. The F_2 plants had a mean value of (7.37 ± 0.11 cm) and a coefficient of variation of 14.67 % which is higher than those of parents. and F_1 populations, Table (8).

Nature of dominance : The observed F_1 mean (7.75 cm) was higher than the arithmetic mean (7.12 cm) indicating complete dominance of the wider head. On the other hand the observed F_2 mean (7.37 cm) was lower than the arithmetic mean (7.74 cm) showing inbreeding depression.

The estimates of heterosis percentage gave (8.85 %) and (Zero) over the mid-parents and the better parent, respectively. The inbreeding depression was 4.90 % Table (9).

Nature of gene action : The observed F_1 mean (7.75 cm) was higher than both the arithmetic mean (7.12 cm) and the geometric mean (7.10). The observed F_2 mean (7.37 cm) was insignificantly lower than the geometric mean (7.43 cm) but significantly lower than the arithmetic mean (7.74 cm), indicating that nature of gene action was more additive than multipicative, Table (9).

The different kinds of gene effects showed that dominance x dominance (2.99) and additive x dominance effect (0.19) were important than additive (-0.44), dominance (-0.74) and additive x additive effect (-1.37) in the inheritance of head width in this cross, Table (10).

Number of genes involved: The Castle- Wright and Wright's formulae gave (0.2549) and (0.3823) pair of genes respectively, suggesting that the two parents differ by one pair of genes, Table (10).

Heritability: Heritability value of 65.53 % using the F_1 variance was obtained. Meanwhile, the narrow sense heritability was 7.10 % , Table (10).

2- NES 645 x G.114 : The data for head width of the parent NES 645 were previously discussed. The other parent G. 114 had a mean value of (7.69 $\pm$ 0.17 cm) with a coefficient of variation of 6.78 % . The mean value of the F_1 population was (8.40 $\pm$ 0.33 cm) with a coefficient of variation of 12.49 % which is higher than those of both parents. The F_2 plants had a mean value of (6.38 $\pm$ 0.11cm) and a coefficient of variation of 16.96 % which is higher than those of parents and F_1 populations Table (8).

Nature of dominance : The observed F_1 mean (8.40 cm) was higher than the arithmetic mean (7.10 cm) indicating the presence of overdominance of the wider head. Moreover, the observed F_2 mean (6.38 cm) was lower than the arithmetic mean (7.75 cm) showing inbreeding depression.

The degrees of heterosis over the mid-parents and the better parent were (18.31 %) and (9.23 %) respectively. The inbreeding depression was found to be 24.05 % , Table (9).

Nature of gene action : The observed F_1 mean (8.40 cm) was higher than both the arithmetic mean (7.10 cm) and the geometric mean (7.07 cm) which are nearly equal. Besides the observed F_2 mean (6.38 cm) was lower than both the arithmetic mean (7.75 cm) and the geometric mean (7.72 cm) which are nearly equal, indicating that both gene actions may act with the same amount, Table (9)

The different kinds of gene effects showing that dominance x dominance (2.71), dominance (2.69) and additive x additive (1.40) were important than additive (-0.65) and additive x dominance gene effect (-0.06) in the inheritance of this character, Table (10).

Number of genes involved: The Castle-Wright and Wright's formulae resulted in the estimations of (2.5653) and(8.7320)

pair of genes respectively. These values indicated that this character may be controlled with (3- 9) pair of genes, Table (10).

Heritability : Heritability in broad and narrow sense were found to be (5.90 %) and (45.60 %) respectively, Table(10).

III- Medium X Thin head : This group was represented by the cross NES 324 X NES 645. The data for head width for the variety NES 645 were previously discussed. The other parent NES 324 had a mean value of (6.65 ± 0.17 cm) with a coefficient of variation of 8.06 % . The mean value of the F_1 populations was (6.85 ± 0.27 cm) and a coefficient of variation of 12.42 % which is higher than those of both parents. Head width in the F_2 plants had a mean value of (8.81 ± 0.52 cm) and a coefficient of variation of 58.18 % which is higher than those of the two parents and the F_1 populations, Table (8).

Nature of dominance : The observed F_1 mean (6.85 cm) was insignificantly higher than the arithmetic mean (6.58 cm) indicating absence of dominance. On the other hand the observed F_2 mean (8.81 cm) was higher than the arithmetic mean (6.71 cm) showing overdominance of the wider head.

The degree percentage of heterosis over the mid-parents and the better parent were (4.10 %) and (3.01 %) respectively

The inbreeding depression was (-28.61 %), Table (9).

Nature of gene action : The observed F_1 mean (6.85 cm) was insignificantly higher than both the arithmetic mean(6.58 cm) and the geometric mean (6.57 cm) . On the other hand the observed F_2 mean (8.81 cm) was higher than both the arithmetic mean (6.71 cm) and the geometric mean (6.71 cm) which are identical, suggesting that both types of gene action are acting with the same amount, Table (9)

The different kinds of gene action indicated that dominance x dominance gene effect (2.59) was the most important part. Meanwhile additive , dominance , additive x additive and additive x dominance effects gave estimates of (-0.05), (-5.39), (-5.65) and (-0.13) respectively, Table (10).

Number of genes involved : The estimated number of genes determined by using Castle-Wright and Wright's formulae gave (0.0001) and (0.0008) pair of genes respectively, suggesting that the parental varieties differ in one pair of genes, Table (10).

Heritability : Broad sense heritability was found to be 97.29 % by using the F_1 variance while the narrow sense heritability gave a value of 18.40 % using Warner formula (1952), Table (10)

IV- Medium X Medium head : This group was represented by the cross NES 324 x TAM 428. The data for head width for the two varieties NES 324 and TAM 428 were previously discussed. The F_1 population gave a mean value of (8.75 ± 0.35 cm) and a coefficient of variation of 12.71 %. The mean value of the F_2 plants was (6.76 ± 0.10 cm) with a coefficient of variation of 15.40 % which is higher than those of parents and F_1 populations, Table (8).

Nature of dominance: The observed F_1 mean (8.75 cm) was higher than the arithmetic mean (6.68 cm), showing overdominance of the wider head. Moreover the observed F_2 mean (6.76 cm) was lower than the arithmetic mean (7.21 %) showing inbreeding depression.

The estimates of heterosis over the mid-parents and the better parent were (30.99 %) and (30.60 %) respectively. The inbreeding depression was 22.74 %, Table (9).

Nature of gene action: The observed F_1 mean (8.75 cm) was higher than both the arithmetic mean (6.68 cm) and the geometric mean (6.67 cm). On the other hand the observed F_2 mean (6.76 cm) was lower than both the arithmetic mean (7.21 cm) and the geometric mean (7.74cm), but closer to the arithmetic mean, indicating that nature of gene action seemes to be more additive than multiplicative, Table (9)

The different kinds of gene effects showed that dominance x dominance (5.53) and dominance (1.22) were more important than additive (0.53), additive x additive (0.86) and additive x dominance effects (0.56) in the inheritance of head width Table (10).

Number of genes involved : Number of genes involved could not be calculated because of the presence of the heterotic effect, Table (10).

Heritability : Heritability value in broad sense could not be calculated due to the high variance of the F_1. The heritability in narrow sense was 8.77 % , Table (10).

V- Medium x Wide head : This group included the three crosses NES 324 x G.114, TAM 428 x G.15 and TAM 428 x G.114.

1- NES 324 x G.114 : The data for head width in the two parents NES 324 and G.114 were previously discussed. The mean value of F_1 population was (8.56 $\pm$ 0.36 cm) with a coefficient of variation of 13.22 which is higher than those of both parents. The F_2 populations had a mean value of (6.47 $\pm$ 0.09 cm) and a coefficient of variation of 15.36 % which is higher than that of both parents and F_1 populations, Table (8).

Nature of dominance: The observed F_1 mean (8.56 cm) was higher than the arithmetic mean (6.68 cm) indicating the presence of overdominance of the wider head. Besides the

observed F_2 mean (6.47 cm) was lower than the arithmetic mean (7.62 cm) showing inbreeding depression.

Heterosis estimates over the mid-parents and the better parent were (28.14 %) and (11.31 %) respectively. The inbreeding depression was found to be 32.30 % Table (9).

Nature of gene action : The observed F_1 mean (8.56 cm) was higher than both the arithmetic mean (6.68 cm) and the geometric mean (7.15 cm). however the observed F_2 mean (6.47 cm) was lower than both the arithmetic mean (7.62 cm) and the geometric mean (7.56 cm) which are nearly equal, indicating that the two types of gene action may act with the same amount, Table (9).

The different kindes of gene effects showing that dominance effect (3.11), dominance x dominance effect (2.14) and additive x additive effect (1.71) were more important than additive x dominance effect (0.44) and additive effect in the inheritance of head width in this cross, Table (10).

Number of genes involved : Number of genes involved could not be calculated because of the high variance of the F_1 Table (10).

Heritability : Heritability in broad sense could not be calculated since the variance of the F_1 was higher than the

variance of the F_2, but heritability in narrow sense was as low as 26.49 %, Table (10).

2- TAM 428 x G.15 : The data for the two parents TAM 428 and G.15 was previously discussed with respect to mean and coefficient of variation. The F_1 plants had a mean value of (9.20 ± 0.08 cm) with a coefficient of variation of 2.80 %, which is lower than those of both parents indicating homogeneity of the F_1 population. The F_2 populations had a mean value of (6.33 ± 0.12 cm) and a coefficient of variation of 18.51% which is higher than those of parents and F_1 populations, Table (8).

Nature of dominance : The observed F_1 mean (9.20 cm) was higher than the arithmetic mean (7.23 cm) indicating overdominance of the wider head. On the other hand the observed F_2 mean (6.33 cm) was lower than the arithmetic mean (8.22 cm) showing inbreeding depression.

The data for the F_1 plants showed positive estimates of heterosis over the mid- parents and the better parent reaching (27.25 %) and (18.71 %), respectively. The inbreeding depression was 31.20 %, Table (9).

Nature of gene action : The observed F_1 mean (9.20 cm) was higher than both the arithmetic mean (7.23 cm) and the geometric mean (7.21 cm) which are nearly equal. On the other hand the observed F_2 mean (6.33 cm) was lower than both the

arithmetic mean (8.22 cm) and the geometric mean (8.16 cm) which are nearly equal, suggesting that, both gene actions may be acting with the same anount, Table (9).

The different kinds of gene effect indicated that the dominance x dominance (5.85) and dominance effect (2.82) were more important than additive x additive (0.84), additive (-0.54) and additive x dominance effect (-0.02) in the inheritance of head width in this cross, Table (10).

Number of genes involved : The Castle-Wright and Wright's formulae gave estimates of (0.2114) and (0.8535) pair of genes respectively, indicating that the two parental varieties are different in one pair of genes, Table (10).

Heritability : A heritability value of 95.11 % was obtained by using the F_1 variance as an estimate for invironmental variance. The narrow sense heritability reached to be 50.00% Table (10).

3- TAM 428 x G. 114 : The data for head width of the varieties TAM 428 and G.114 were previously discussed. The mean value of F_1 population was (8.55 ± 0.41 cm) with a coefficient of variation of 7.52 %. The F_2 population had a mean value of (6.08 ± 0.12 cm) and a coefficient of variation of 19.79 %, which is higher than that of both parents and F_1 populations, Table (8)

Nature of dominance : The observed F_1 mean (8.55 cm) was higher than the arithmetic mean (7.20 cm) indicating over-dominance of the wider head. however the observed F_2 mean (6.08 cm) was lower than the arithmetic mean (7.87 cm) showing inbreeding depression.

The degree of heterosis over the mid-parents and the better parent were (18.75 %) and (11.18 %) respectively. The inbreeding depression was 28.89 %, Table (9)

Nature of gene action : The observed F_1 mean (8.55 cm) was higher than both the arithmetic mean (7.20 cm) and the geometric mean (7.18 cm). Moreover the observed F_2 mean (6.08 cm) was lower than both the arithmetic mean (7.87 cm) and the geometric mean(7.85 cm) which are nearly equal, indicating that genes may affect this character either additively or cummulatively, Table (9).

The different kinds of gene effects showing that the dominance (3.94), additive x additive gene (2.57) and dominance (2.01) were more important than additive x dominance (0.25) and additive gene effects (-0.26) in the inheritance of head width in this cross, Table (10).

Number of genes involved : The Castle-Wright and Wright's formulae resulted in the estimation of (0.1185) and (0.6149) pair of genes, indicating that parental difference in head width was due to one pair of genes Table (10).

Heritability : A heritability value of 71.41 % was obtained by using the F_1 variance. The narrow sense heritability was 43.70 % , Table (10).

VI- Wide X Wide head : This group included only the cross G.15 x G.114. The data for head width of the varieties G.15 and G.114 were previously discussed. The F_1 plants had a mean value of (9.15 ± 0.13 cm) and a coefficient of variotion of 4.50 % which is lower than those of both parents showing homogeneity of the F_1 population. The mean value of F_2 plants was (8.08 ± 0.11 cm) with a coefficient of variation of 13.92 which is higher than those of parents and F_1 plants Table (8).

Nature of dominance : The observed F_1 mean (9.15 cm) was higher than the arithmetic mean (7.72 cm) indicating the presence of overdominance of the wider head. Meanwhile the observed F_2 mean (8.08 cm) was lower than the arithmetic mean (8.44 cm) showing inbreeding depression.

The estimates of heterosis over the mid-parents and the better parent were (18.52 %) and (18.06 %), respectively . The inbreeding depression was 11.69 %, Table (9).

Nature of gene action : The observed F_1 mean (9.15 cm) was higher than both the arithmetic mean (7.72 cm) and the geometric mean (7.72 cm) which are identical. Moreover the observed F_2 mean (8.08 cm) was higher than both the arithmetic mean (8.44 cm) and the geometric mean (8.40 cm) which

are nearly equal, indicating that the two types of gene action may act with the same amount, Table (9).

The different kinds of gene effects showed that dominance x dominance (2.02) and dominance (1.11) were more important than additive (-0.24), additive x additive (-0.30) and additive x dominance gene effect (-0.24) in the inheritance of head width, Table (10) .

Number of genes involved : The Castle-Wright and Wright's formulae gave estimates of (0.0004) and (0.4664) suggesting that the minimum number of genes affecting head width was one pair of genes, Table (10).

Heritability: A heritability in broad sense was 86.65 % Mean while the narrow sense heritability could not be calculated ~~due to heterotic effect,~~ Table (10).

Table (8): Statistics relative to head width for different populations in the nine crosses studied

Populations	N	$\bar{X}$	±	S.E.	C.V %
I-Thin x Medium head					
NES 645 x TAM 428					
P_1	40	6.50	±	0.15	7.37
Bo_1	100	5.85	±	0.10	16.66
F_1	10	7.15	±	0.11	4.71
F_2	100	5.51	±	0.08	15.99
Bo_2	100	6.61	±	0.13	20.08
P_2	40	6.70	±	0.17	6.67
II- Thin x Wide head					
1- NES 645 x G.15					
P_1	40	6.50	±	0.15	7.37
Bo_1	100	6.81	±	0.12	17.92
F_1	10	7.75	±	0.20	8.19
F_2	100	7.37	±	0.11	14.67
Bo_2	100	7.25	±	0.28	12.08
P_2	30	7.75	±	0.14	5.29
2- NES 645 x G.114					
P_1	40	6.50	±	0.15	7.37
Bo_1	100	6.40	±	0.09	13.28
F_1	10	8.40	±	0.33	12.49
F_2	100	6.38	±	0.11	16.96
Bo_2	100	6.40	±	0.09	13.28
P_2	40	7.69	±	0.17	6.78

Table (8): Cont.

Populations	N	$\bar{X}$ ±	S.E	C.V.%
III- Medium x Thin head				
NES 324 x NES 645				
P_1	30	6.65 ±	0.17	8.06
Bc_1	100	7.37 ±	0.15	19.73
F_1	10	6.85 ±	0.27	12.42
F_2	100	8.81 ±	0.52	58.18
Bc_2	100	7.42 ±	0.15	20.05
P_2	40	6.50 ±	0.15	7.37
IV- Medium x Medium head				
NES 324 x TAM 428				
P_1	30	6.65 ±	0.17	8.06
Bc_1	100	6.81 ±	0.11	16.30
F_1	10	8.75 ±	0.35	12.71
F_2	100	6.76 ±	0.10	15.40
Bc_2	100	6.28 ±	0.09	14.60
P_2	40	6.70 ±	0.17	6.67
V- Medium x Wide head				
I - NES 324 x G.114				
P_1	30	6.65 ±	0.17	8.06
Bc_1	100	6.86 ±	0.10	14.63
F_1	10	8.56 ±	0.36	13.22
F_2	100	6.47 ±	0.09	15.36
Bc_2	100	6.94 ±	0.09	12.80
P_2	40	7.69 ±	0.17	6.78

Table (8) : Cont.

Populations	N	$\bar{X}$	±	S.E	C.V %
2- TAM 428 x G.15					
P_1	40	6.70	±	0.17	6.67
Bc_1	100	6.27	±	0.10	16.38
F_1	10	9.20	±	0.08	2.80
F_2	100	6.33	±	0.12	18.51
Bc_2	100	6.81	±	0.10	14.65
P_2	30	7.75	±	0.14	5.29
3- TAM 428 x G.114					
P_1	40	6.70	±	0.17	6.67
Bc_1	100	6.60	±	0.11	17.33
F_1	10	8.55	±	0.41	7.52
F_2	100	6.08	±	0.12	19.79
Bc_2	100	6.85	±	0.10	14.28
P_2	40	7.69	±	0.17	6.78
IV- Wide x Wide head					
G.15 x G.114					
P_1	30	7.75	±	0.14	5.29
Bc_1	100	7.90	±	0.12	15.51
F_1	10	9.15	±	0.13	4.50
F_2	100	8.08	±	0.11	13.92
Bc_2	100	8.11	±	0.12	14.49
P_2	40	7.69	±	0.17	6.78

Table (9): Estimates of nature of gene action; heterosis percentage (H%) over mid-parents and better parent and inbreeding depression percentage (I.D %) with respect to head width

Crosses	F_1 Population			F_2 population			Heterosis (H%)		inbreeding depression (I. D %)
	Obser. mean	Calc. Arith.	Calc. Geom	Obser mean	Calc. Arith	Calc. Geom.	M.P.	B.P.	
I- Thin x Medium head									
NES 645 x TAM 428	7.15	6.60	6.60	5.51	6.68	6.87	8.33	6.72	22.94
II-Thin x Wide head									
1- NES 645 x G.15	7.75	7,12	7.10	7.37	7.74	7.43	8.85	0.0	4.90
2- NES 645 x G.114	8.40	7.10	7.07	6.38	7.75	7.72	18.31	9.23	24.05
III- Medium x Thin head									
NES 324 x NES 645	6.85	6.58	6.57	8.81	6.71	6.71	4.10	3.01	-28.61
IV- Medium x Medium head									
NES 324 x TAM 428	8.75	6.68	6.67	6.76	7.21	7.74	30.99	30.60	22.74
V- Medium x Wide head									
1- NES 324 x G.114	8.56	6.68	7.15	6.47	7.62	7.56	28.14	11.31	32.30
2- TAM 428 x G.15	9.20	7.23	7.21	6.33	8.22	8.16	27.25	18.71	31.20
3- TAM 428 x G.114	8.55	7.20	7.18	6.08	7.87	7.85	18.75	11.18	28.89
IV- Wide x Wide head									
G.15 x G.114	9.15	7.72	7.72	8.08	8.44	8.40	18.52	18.06	11.69

Table (10): Estimates of parameters of gene action; number of genes and heritability (h^2 %) in broad and narrow sense with respect to head width.

Crosses	Gene action						Number of genes		Heritability %	
	m	a	d	aa	ad	dd	Castle Wright	Wrights formula	B. S	N.S
I- Thin x Modium head										
NES 645 x TAM 428	5.51	-0.77	3.43	2.89	- 0.66	- 0.30	0.0076	0.1219	85.29	--
II- Thin x Wide head										
1- NES 645 x G.15	7.37	-0.44	-0.74	-1.37	0.19	2.99	0.2549	0.3823	65.53	7.10
2- NES 645 x G.114	6.38	-0.65	2.69	1.40	- 0.06	2.71	2.5653	8.7320	5.90	45.59
III- Medium x Thin head										
NES 324 x NES 645	8.81	-0.05	-5.39	-5.65	- 0.13	2.59	0.0001	0.0008	97.29	18.40
IV- Medium x Medium head										
NES 324 x TAM 428	6.76	0.53	1.22	0.86	0.56	5.53	--	--	--	8.77
V- Medium x Wide head										
1- NES 324 x G.114	6.47	-0.09	3.11	1.71	0.44	2.14	--	--	--	26.49
2- TAM 428 x G.15	6.33	-0.54	2.82	0.84	- 0.62	5.85	0.2114	0.8535	95.11	50.00
3- TAM 428 x G.114	6.08	-0.26	3.94	2. 57	0.25	2.01	0.1185	0.6149	71.41	43.70
VI- Wide x Wide head										
G. 15 x G.114	8.08	-0.24	1.11	-0.30	- 0.24	2.02	0.0004	0.4664	86.65	--

m = F_2
a = additive effect
d = dominance effect
aa = additive x additive type of epistasis
ad = additive x dominance type of epistasis
dd = dominance x dominance type of epistasis

4-Inheritance of head index :

Head index was extracted from dividing head width by head length and it was studied in nine crosses. The parents wereclassified according their head index into the following three types :

Small type: Mean head index ranged from (0.260 to 0.320 cm) and it was represented by the two varieties NES 324 and NES 645.

Medium type: Mean head index varied from (0.321 to 0.380 cm) as it was in the variety TAM 428.

Large type : Mean head index ranged from (0.381 to 0.440 cm) including the two varieties G.114 and G.15.

I- Small x Small head index : This group included the cross NES 324 x NES 645. The variety NES 324 had a mean value of (0.26 ± 0.007 cm) with a coefficient of variation of 8.83 %. The other parent NES 645 had a mean value of (0.28 ± 0.005 cm) and a coefficient of variation of 5.21 % . The mean value of the F_1 plants was (0.27 ± 0.009 cm) with a coefficient of variation of 11.28 % which is higher than those of the two parents. The mean value of the F_2 population was found to be (0.28 ± 0.005 cm) with a coefficient of variation of 18.21%which is higher than those of both parents and F_1 population,Table (11).

Nature of dominance : The observed F_1 mean (0.266 cm) was insignificantly lower than the arithmetic mean (0.269 cm) indicating absence of dominance. Moreover, the observed F_2 mean (0.280 cm) was higher than the arithmetic mean (0.268 cm) showing nearly complete dominance of the larger head parent.

The estimations of heterosis over the mid-parents and the better parent were (-1.12 %) and (-3.27 %), respectively. The inbreeding depression was (-3.70) %, Table (12).

Nature of gene action : The observed F_1 mean (0.266 cm) was insignificantly lower than both the arithmetic mean (0.269 cm) and the geometric mean (0.269 cm). Moreover the observed F_2 mean (0.280 cm) was higher than both the arithmetic mean (0.268 cm) and the geometric mean (0.267 cm) suggesting that the two types of gene action may act with the same amount, Table (12).

The different kinds of gene effects indicated that the dominance (0.037), additive x additive (0.040) and additive x dominance gene effect (0.034 were more important than additive (0.030) and dominance x dominance gene effect (-0.130) in the inheritance of head index in this cross, Table (13).

Number of genes involved : The Castle Wright and Wright's formulae gave estimates of (0.015) and (0.012) pair of genes respectively, suggesting that the two parents differed

The inbreeding depression was found to be 13.38 %, Table (12).

Nature of gene action: The observed F_1 mean (0.299 cm) was higher than both the arithmetic mean (0.279 cm) and the geometric mean (0.278 cm). However, the observed F_2 mean (0.259 cm) was lower than both the arithmetic mean (0.279 cm) and the geometric mean (0.288 cm), but closer to the arittmetic indicating that nature of gene action was more additive than multiplicative, Table (12).

The data of gene effects for head index indicated that the dominance x dominance gene effect (0.11) and dominance effect (0.027) were more important than additive x dominance gene effect (0.012), additive x additive gene effect (0.010) and additive gene effect (-0.010) in the inheritance of head index in this cross, Table (13).

Number of genes involved: Estimates of number of genes by Castle - Wright and Wright's formulae were (1.201) and (2.108) pair of gene respectively. These values indicated that the two parents differ in (1-2) pair of genes, Table (13).

Heritability : Heritability in broad and narrow senese gave estimates of (10.00 %) and (20.00 %) respectively, Table (13).

2- NES 645 x TAM 428 : The data for head index of the two parents NES 645 and TAM 428 were previously discussed. The

F_1 population had a mean value of (0.24 ± 0.004 cm) with a coefficient of variation of 4.96 % which is lower than those of both parents indicating homogeneity in the F_1 plants. Besides,the mean value of the F_2 population was (0.23 ± 0.004 cm) having a coefficient of variation of 18.10 % which is higher than that of parents and F_1 populations, Table (11).

Nature of dominance : The observed F_1 mean (0.242 cm) was lower than the arithmetic mean (0.285 cm) suggesting overdominance of the smaller in head index.Meanwhile , the observed F_2 mean (0.232 cm) was lower than the arithmetic mean (0.263 cm) indicating also overdominance of the smaller head and low inbreeding depression.

Heterosis estimates were (- 15.09 %) and (- 17.69 %) over the mid-parents and the better parent, respectively.

The inbreeding depression was as low as 4.13 %,Table (12).

Nature of gene action : The observed F_1 mean (0.242 cm) was lower than both the arithmetic mean (0.285 cm) and the geometric mean (0.284 cm). Meanwhile , the observed F_2 mean (0.232 cm) was lower than both the arithmetic mean(0.263 cm) and the geometric mean (0.263 cm) which are identical suggesting that genes may affect this character either additively or cummulatively, Table (12).

Data of gene effects for head index in this cross showed that additive x additive (0.080) and dominance gene effect (0.036) were the most important kinds of gene effects while the additive effect (-0.030), additive x dominance (0.020) and dominance x dominance gene effect (- 0.031) were less important in the inheritance of head index, Table(13)

Number of genes involved : The Castle-Wright and Wright's farmulae gave (0.025) and (0.610) pair of genes respectively, suggesting that the porental varieties differed in one pair of genes, Table (13).

Heritability : Broad sense heritability gave estimates of 90.00 % by using the F_1 voriance as the environmental variance. Besides, the narrow sense heritability was found to be 50.00 % by using the equation of Warner (1952), Table (13).

III- Small x Large head index: This group involved the three crosses : NES 324 x G.114; NES 645 x G.15 and NES 645 x G. 114.

1- NES 324 x G.114 : The data for head index of the variety NES 324 were previously discussed. The other parent G. 114 had a mean value of (0.38 $\pm$ 0.007 cm) and a coefficient of variation of 5.82 %. The mean value of F_1 population was (0.30 $\pm$ 0.008 cm) having a coefficient of variation of 8.55 %. The F_2 population had a mean value of (0.30 $\pm$ 0.004 cm) with a coefficient of variation of 13.53 % which is higher than those of parents and F_1 plants Table,(11).

Nature of dominance : The observed F_1 mean (0.304 cm) was higher than the arithmetic mean (0.323 cm) indicating overdoninance of the smaller head. Besides,the observed F_2 mean (0.303) was lower than the arithmetic mean (0.313 cm) indicating also overdoninance of the smaller parent and low inbreeding depression.

The data for the F_1 plants showed negative estimates of heterosis over the mid-parents and the better parent reaching (- 5.88 %) and (- 20.42 %) respectively. The inbreeding depression gave a value as low as 0.33 %, Table (12).

Nature of gene action : The observed F_1 mean (0.304 cm) was lower than both the arithmetic mean (0.323 cm) and the geametric mean (0.317). Besides,the observed F_2 mean (0.303 cm) was lower than both the arithmetic mean (0.313 cm) and the geometric mean (0.313 cm) which are identical indicating that the two types of gene action may act with the same amount, Table (12).

The different kinds of gene effects showed that additive x dominance (0.032), additive x additive (0.020) and dominance x dominance gene effect (0.009) were more important than additive (-0.030) and dominance gene effect (0.003) in the inheritance of head index in this cross, Table (13).

Number of genes involved: The Castle-Wright and Wright's formulae gave estimates of (1.362) and (1.434) respectively, indicating that the minimum number of genes affecting

this character was one pair of genes, Table (13).

Heritability : Heritability in broad and narrow sense gave estimates of (65.00 %) and (50.00 %) respectively, Table (13).

2- NES 645 x G.15 : The data for head index of the variety NES 645 were previously discussed. The other parent G.15 had a mean value of (0.41 ± 0.008 cm) and a coefficient of variation of 6.82 %. The mean value of the F_1 plants was (0.28 ± 0.005 cm) with a coefficient of variation of 6.01 % which is intermediate between those of both parents. Mean value of the F_2 population was found to be (0.35 ± 0.004 cm) with a coefficient of variation of 13.71 % which is higher than that of both parents and the F_1 populations, Table (11).

Nature of dominance : The observed F_1 mean (0.283 cm) was higher than the arithmetic mean (0.342 cm) indicating complete dominance of the smaller in head index. Moreover, the observed F_2 mean (0.350 cm) was higher than the arithmetic mean (0.312 cm) suggesting partial dominance of the larger head .

Heterosis over the mid -parents and the better parent gave the negative values: (-19.59 %) and (- 32.60 %) respectively. The inbreeding depression was (- 25.00 %), Table (12).

Nature of gene action : The observed F_1 mean (0.283 cm) was lower than both the arithmetic mean (0.342 cm) and the geometric mean (0.335 cm). On the other hand, the observed F_2 mean (0.350 cm) was higher than both the arithmetic mean (0.312 cm) and the geometric mean (0.311 cm) which are nearly equal suggesting that the two types of gene action may act with the same amount, Table (12).

The different kinds of gene action showed that dominance x dominance gene effect (0.101) was the most important part in the inheritance of head index while the additive, dominance, additive x additive and additive x dominance gene effects gave negative value of (-0.070), (-0.185), (-0.130) and (- 0.003) respectively, Table (13).

Number of genes involved : The Castle - Wright and Wright's formulae gave estimates of (1.228) and (1.844) pair of genes respectively, suggesting that the parental varieties differed in (1-2) pair of genes, Table (13).

Heritability : Heritability in broad sense gave estimates of 90.00 % by using the F_1 variance as the environmental variance while the narrow sense heritability was found to be 50.00 %, Table (13).

3- NES 645 x G.114 : The data for head index of the two parental varieties NES 645 and G.114 were previously discussed. The F_1 plants had a mean value of (0.36 $\pm$ 0.010 cm) and a coefficient of variation of 11.60 % which is higher

than those of both parents. While the F_2 mean was (0.31 ± 0.005 cm) with a coefficient of variation of 15.64 % which is higher than those of the two parents and F_1 populations, Table (11).

Nature of dominance : The observed F_1 mean (0.362 cm) was higher than the arithmetic mean (0.329 cm) incicating rather partial dominance of the larger head index. In the same time F_2 mean (0.307 cm) was lower than the arithmetic mean (0.345 cm) indicating inbreeding depression.

The estimates of heterosis over the mid-parents and the better parent were (10.03 %) and (-5.24 %) respectively. The inbreeding depression was 15.19 %., Table (12).

Nature of gene action : The observed F_1 mean (0.362 cm) was higher than both the arithmetic mean (0.329 cm) and the geometric mean (0.324 cm). Moreover, the observed F_2 mean (0.307 cm) was lower than both the arithmetic mean(0.345 cm) and the geometric mean (0.345 cm) which are identical, suggesting that the two types of gene action may act with the same amount, Table (12).

The different kinds of gene action indicated that dominance x dominance (0.205), dominance (0.028) and additive gene effect (0.050) were more important than additive x additive (0.010) and additive x dominance gene effect (0.009) in the inheritance of head index, Table (13).

Number of genes involved : The Castle-Wright and Wright's formulae gave estimates of (1.431) and (1.704) pair of genes respectively, suggesting that the two parental varieties differed in (1-2) pair of genes, Table (13).

Heritability : Heritability value in broad sense was found to be (33.33 %), while the narrow sense heritability gave also the same result (33.33 %), Table (13).

IV-Medium x Large head index : This group included the two crosses TAM 428 x G.15 and TAM 428 x G.114.

1- TAM 428 x G.15 : The data for head index of the two varieties TAM 428 and G.15 were previously discussed. The F_1 population had a mean value of (0.31 ± 0.004 cm) with a coefficient of variation of 4.24 % which is lower than those of both parents indicating homogeneity of the F_1 plants. The mean value of the F_2 plants was (0.30 ± 0.016 cm) with a coefficient of variation of 21.38 % which is higher than those of both parents and F_1 populations, Table (11).

Nature of dominance : The observed F_1 mean (0.307 cm) was lower than the arithmetic mean (0.351 cm) indicating rather partial dominance of the smaller in head index. Moreover, the observed F_2 mean (0.304 cm) was lower than the arithmetic mean (0.354 cm) indicating also partial dominance of the smaller head, and low inbreeding depression.

Heterosis over the mid-parents and the better parent gave estimates of (-12.54 %) and (-24.76 %) respectively. The inbreeding depression was 0.98 %, Table (12).

Nature of gene action : The observed F_1 mean (0.307 cm) was lower than both the arithmetic mean (0.351 cm) and the geometric mean (0.346 cm). Meanwhile,The observed F_2 mean(0.304 cm) was lower than both the arithmetic mean (0.354 cm) and the geometric mean (0.328 cm) indicating that the two types of gene action may act with the same amount, Table (12).

The different kinds of gene effects showed that dominance x dominance (0.236) and additive x dominance effect (0.025) were more important than additive (-0.030), dominance (-0.112) and additive x additive effect (-0.70) in the inheritance of head index in this cross, Table (13).

Number of genes involved : The Castle-Wright and Wright's formulae gave estimates of (0.060) and (0.078) pair of genes respectively indicating that the two parental varieties differ by one pair of genes, Table (13).

Heritability : Broad and narrow sense heritability gave estimates of 99.26 % and 74.07 respectively, Table (13)

2- TAM 428 x G.114 : The data for head index of the varieties TAM 428 and G.114 were previously discussed. The F_1 plants had a mean value of (0.29 ± C.009 cm) with a coefficient of variation of 9.66 % which is higher than those of the two parents. The mean value of the F_2 population was (0.28 ± 0.00 5 cm) with a coefficient of variation of 16.07 % which is higher than those of the two parents and the F_1 population,Table (11).

Nature of dominance : The observed F_1 mean (0.290 cm) was lower than the arithmetic mean (0.338 cm) suggesting nearly complete dominance of the smaller head. Meanwhile, the observed F_2 mean (0.280 cm) was lower than the arithmetic mean (0.314 cm) indicating nearly partial dominance of the smaller head and low inbreeding depression.

The data for the F_1 plants showed negative estimates of heterosis over the mid-parents and the better parent as low as (-14.20 %) and (-24.08 %) respectively. The inbreeding depression was 3.45 %, Table (12).

Nature of gene action : The observed F_1 mean (0.290 cm) was lower than both the arithmetic mean (0.338 cm) and the geometric mean (0.335 cm). Meanwhile, the observed F_2 mean (0.280 cm) was lower than both the arithmetic mean (0.314 cm) and the geometric mean (0.313 cm) whichhare nearly equal indicating that the two types of gene action may act with the same amount, Table (12).

The different kinds of gene effects showed that dominance x dominance (0.052), additive x additive (0.040 cm) and additive x dominance gene effect (0.003) were more important than additive (-0.040) and dominance effect (-0.006) in the inheritance of head index, Table (13).

Number of genes involved : Estimated number of genes by Castle-Wright and Wright's formulae were (0.807) and (1336)

pair of genes respectively, suggesting that the parents differed in one pair of genes, Table (13).

Heritability : A heritability value of 60.00 % was obtained by using the F_1 variance as the environmental variance. Besides, the narrow sense heritability was found to be 50.00%, Table (13).

V- Large X Large head index: This group was represented by the cross G.15 x G.114. The data for head index of the varieties G.15 and G.114 were previously discussed. The F_1 population had a mean value of (0.41 ± 0.006 cm) and a coefficient of variation of 4.39 % which is lower than those of the two parents indicating homogeneity of the F_1 plants. The mean value of the F_2 population was (0.42 ± 0.005 cm) with a coefficient of variation of 10.61 % which is higher than that of both parents and F_1 populations, Table (11).

Nature of dominance : The observed F_1 mean (0.410 cm) was higher than the arithmetic mean (0.395 cm) indicating nearly complete dominance of the larger head. Moreover, the observed F_2 mean (0.424 cm) was higher than the arithmetic mean(0.403 cm) indicating nearly partial dominance of the larger head.

Estimation of heterosis over the mid-parents and the better parent were (3.80 %) and (0.49 %) respectively. The inbreeding depression was found to be (-2.44 %), Table (12)

Nature of gene action. The observed F_1 mean (0.410 cm) was higher than both the arithmetic mean (0.395 cm) and the geometric mean (0.395 cm). Moreover, the observed F_2 mean (0.424 cm) was higher than both the arithmetic mean (0.403 cm) and the geometric mean (0.402 cm) which are nearly equal sygg-esting that genes may affect this character either additi-vely or cummulatively, Table (12).

The different kinds of gene effects showed that additive x additive (0.050) and dominance x dominance effect (0.014) were more important than additive (0.020), dominance (-0.035) and additive x dominance gene effect (-0.036) in the inheri-tance of head index, Table (13).

Number of genes involved : The Castle-Wright and Wright's formulae gave estimates of (0.050) and (0.086) pair of genes respectively, suggesting that the two parental varieties differed in one pair of genes, Table (13) .

Heritability : Broad sense heritability gage estimates of 85.00 % by using the F_1 variance as the environmental varia-nce. While the narrow sense heritability was found to be 50.00 % by using Warner formula (1952), Table (13).

Table(11): Statistics relative to head index for different populations in the nine crosses studied

Populations	N	$\bar{X}$	±	S.E	C.V.%
I- Small x Small head index					
NES 324 x NES 645					
P_1	30	0.26	±	0.007	8.83
Bc_1	100	0.30	±	0.005	16.42
F_1	10	0.27	±	0.009	11.28
F_2	100	0.28	±	0.005	18.21
Bc_2	100	0.28	±	0.004	15.22
P_2	40	0.28	±	0.005	5.21
II- Small x Medium head index					
1- NES 324 x TAM 428					
P_1	30	0.26	±	0.007	8.83
Bc_1	100	0.26	±	0.003	10.47
F_1	10	0.30	±	0.009	9.37
F_2	100	0.26	±	0.003	13.51
Bc_2	100	0.26	±	0.003	12.60
P_2	40	0.29	±	0.005	5.78
2- NES 645 x TAM 428					
P_1	40	0.28	±	0.005	5.21
Bc_1	100	0.24	±	0.003	13.50
F_1	10	0.24	±	0.004	4.96
F_2	100	0.23	±	0.004	18.10
Bc_2	100	0.27	±	0.004	18.05
P_2	40	0.29	±	0.005	5.78

Table (11): Cont.

Populations	N	$\bar{X}$	±	S.E.	C.V%
III- Small x Large head index					
1- NES 324 x G. 114					
P_1	30	0.26	±	0.007	8.83
Bc_1	100	0.29	±	0.005	15.70
F_1	10	0.30	±	0.008	8.55
F_2	100	0.30	±	0.004	13.52
Bc_2	100	0.32	±	0.005	16.20
P_2	40	0.38	±	0.007	5.82
2- NES 645 x G.15					
P_1	40	0.28	±	0.005	5.21
Bc_1	100	0.28	±	0.004	16.55
F_1	10	0.28	±	0.005	6.01
F_2	100	0.35	±	0.004	13.71
Bc_2	100	0.35	±	0.004	12.75
P_2	30	0.41	±	0.008	6.82
3- NES 645 x G.114					
P_1	40	0.28	±	0.005	5.21
Bc_1	100	0.28	±	0.004	14.13
F_1	10	0.36	±	0.010	11.60
F_2	100	0.31	±	0.005	15.64
Bc_2	100	0.33	±	0.005	16.46
P_2	40	0.38	±	0.007	5.82

Table (11): Cont.

Populations	N	$\bar{X}$ ±	S.E.	C.V %
IV- Medium x Large head index				
1- TAM 428 x G.15				
P_1	40	0.29 ±	0.005	5.78
Bc_1	100	0.27 ±	0.003	11.81
F_1	10	0.31 ±	0.004	4.24
F_2	100	0.30 ±	0.016	21.38
Bc_2	100	0.30 ±	0.006	19.80
P_2	30	0.41 ±	0.008	6.82
2- TAM 428 x G.114				
P_1	40	0.29 ±	0.005	5.78
Bc_1	100	0.27 ±	0.003	11.85
F_1	10	0.29 ±	0.009	9.66
F_2	100	0.28 ±	0.005	16.07
Bc_2	100	0.31 ±	0.005	15.11
P_2	40	0.38 ±	0.007	5.82
V- Large x Large head index				
G.15 x G.114				
P_1	30	0.41 ±	0.008	6.82
Bc_1	100	0.40 ±	0.005	13.50
F_1	10	0.41 ±	0.006	4.39
F_2	100	0.42 ±	0.005	10.61
Bc_2	100	0.42 ±	0.005	11.82
P_2	40	0.38 ±	0.007	5.82

Table (12): Estimates of nature of gene action; heterosis percentage (h^2%) over mid-parents and better parent and inbreeding depression percentage (I.D %) with respect to head index

Crosses	F_1 population			F_2 population			Heterosis(H%)		inbreeding depression (I. D. %)
	obser. mean	Calc. Arith.	Calc. Geom.	Obser. mean	Calc. Arith	Calc. Geom.	M.P.	B.P.	
I- Small x Small head index									
NES 324 x NES 645	0.266	0.269	0.269	0.280	0.268	0.267	- 1.12	- 3.27	- 3.70
II-Small x Medium head index									
1- NES 324 x TAM 428	0.299	0.279	0.278	0.259	0.279	0.288	7.17	1.70	13.38
2- NES 645 x TAM 428	0.242	0.285	0.284	0.232	0.263	0.263	-15.09	-17.69	4.13
III-Small x Large head index									
1- NES 324 x G.114	0.304	0.323	0.317	0.303	0.313	0.313	- 5.88	-20.42	0.33
2- NES 645 x G.15	0.283	0.342	0.335	0.350	0.312	0.311	-19.59	-32.60	-25.00
3- NES 645 x G.114	0.362	0.329	0.324	0.307	0.345	0.345	10.03	- 5.24	15.19
IV- Medium x Large head index									
1- TAM 428 x G.15	0.307	0.351	0.346	0.304	0.354	0.328	-12.54	-24.76	0.98
2- TAM 428 x G.114	0.290	0.338	0.335	0.280	0.314	0.313	-14.20	-24.08	3.45
V- Large x Large head index									
G.15 x G.114	0.410	0.395	0.395	0.424	0.403	0.402	3.80	0.49	-2.44

Table (13): Estimates of parameters of gene action; number of genes and heritability (h^2 %) in broad and narrow sense with respect to head index

Crosses	Gene action						Number of genes		Heritability%	
	m	a	d	aa	ad	dd	Castle Wright	Wrights. formula	B.S.	N.S.
I- Small x Small head index										
NES 324 x NES 645	0.280	0.030	0.037	C.040	0.034	-C.130	0.015	0.012	60.00	--
II- Small x Medium head index										
1- NES 324 x TAM 428	0.260	-0.010	0.027	0.010	0.012	0.111	1.201	2.108	10.00	20.00
2- NES 645 x TAM 428	0.230	-0.030	0.036	0.080	-0.020	-0.031	0.025	0.610	90.00	50.00
III- Small x Large head index										
1- NES 324 x G.114	0.300	-0.030	-0.003	0.020	0.C32	0.009	1.362	1.434	65.00	50.00
2- NES 645 x G.15	0.350	-0.070	-0.185	- 0.130	-0.003	0.101	1.228	1.844	90.00	50.00
3- NES 645 x G.114	0.310	0.050	0.028	0.010	0.009	0.205	1.431	1.704	33.33	33.33
IV- Medium x Large head index										
1- TAM 428 x G.15	0.300	-0.C30	-0.112	-0.070	0.025	0.236	0.060	0.078	99.26	74.07
2- TAM 428 x G.114	0.280	-0.040	-0.006	0.040	0.003	0.052	0.807	1.336	60.00	50.00
V- Large x Large head index										
G.15 x G.114	0.420	-0.020	-0.C35	0.050	-0.036	0.014	0.050	0.086	85.00	50.00

m = F_2
a = additive effect
d = dominance effect
aa = additive x additive type of epistasis
ad = additive x dominance type of epistasis
dd = dominance x dominance type of epistasis

5- Inheritance of head weight :

Head wight was studied in nine crosses. The parents were chosen to represent three types of head weight, light moderate and heavy.

Light type : Mean head weight ranged from (71 to 75 gm) was represented by the variety NES 645.

Moderate type : Mean head weight varies from (76 to 130 gm) as it was in the varieties NES 324 and TAM 428.

Heavy type : Mean head weight ranged from (131 to 183 gm) including the varieties G.15 and G.114.

I- Light x Moderate head weight : This group included the cross NES 645 x TAM 428. Head weight of the variety NES 645 ranged from 20 to 83 gm with a mean value (71.58 ± 6.44 gm) and a coefficient of variation of 29. 02 %. The other parent TAM 428 ranged from 41 to 125 gm having a mean of (77.08 ± 6.33 gm) and a coefficient of variation of 26.05% . The F_1 plants ranged from 83 to 167 gm with a mean of (119.70 ± 3.16 gm) and a coefficient of variation of 18.21% which is lower than those of both parents. This suggested homogeneity of the F_1 plants. The F_2 plants ranged from 20 to 146 gm covering the ranges of both parents and F_1 populations. The obtained F_2 mean was (48.29 ± 2.93 gm) with a coefficient of variation of 60.76 % which is higher than those of the parents and F_1 populations. These observations showed

transgressive segregation compared with the two parents. The continuous F_2 distribution indicated that head weight behaved as a quantitative character, Table (14).

Nature of dominance : The observed F_1 mean (119.70 gm) was higher than the arithmetic mean (74.33 gm) showing overdominance of the heavy parent. Meanwhile, the observed F_2 mean (48.29 gm) was lower than the arithmetic mean (97.01 gm). indicating inbreeding depression.

Estimates of heterosis over the mid-parents and the better parent were (61.04 %) and (55.29%) respectively. The inbreeding depression was 59.66 %, Table (15).

Nature of gene action : The observed F_1 mean (119.70 gm) was higher than both the arithmetic mean (74.33 gm) and the geometric mean (74.28 gm) which are nearly identical . On the other hand, the observed F_2 mean (48.29 gm). was lower than both the arithmetic mean (97.01 gm) and the geometric mean (94.32 gm) which are nearly equal, showing that the two types of gene action are acting with the same amount, Table (15).

The estimates of the different kinds of gene effects showed that dominance (154.32) and additive x additive (109.08) were the most important parts in this cross, Table (16).

Number of genes involved: The Castle - Wright and Wright's formula gave 0.100 and 1.343 pair of genes which indicated that this character seems to be cantrolled by one pair of genes Table (16).

Besides, parents were being nearly similar in their distribution and was impossible to use the Mendelian principles for estimating gene number.

Heritability : A heritability in broad sense of 44.81 % was obtained, while, the heritability in narrow sense could not be calculated due to the high variance of the F_1, Table (16)

II- Light x heavy head weight : This group included the two crosses NES 645 x G.15 and NES 645 x G.114.

1- NES 645 x G.15: The datafor head weight of the variety NES 645 were previously discussed. The other parent, G. 15, ranged from (125 to 209 gm having a mean of (182.50 ± 9.31) with a coefficient of variation of 16.29 %.Range of F_1 was 146 to 209 gm giving a mean of (175.50 ± 7.84 gm) and a coefficient of variation of 14.12 . Head weight of the F_2 population had range from 41 to 230 gm and covering the ranges of the two parents. Its mean was (114.49 ± 3.76 gm) with a coefficient of variation of 32.88 % which was higher than those of parents and F_1 populations. The continuous

distribution of the F_2 population indicated that head weight behaved as a quantitative character, Table (14).

Nature of dominance : The observed F_1 mean (175.50 gm) was higher than the arithmetic mean (127.04 gm), showing partial dominance of the heavy head. Meanwhile, the observed F_2 mean (114.49 gm) was lower than the arithmetic mean (151.27 gm), showing inbreeding depression.

Heterosis over mid parents and better parent gave estimates of 38.14 % and (-3.83 %) respectively. The inbreeding depression value was 34.76 %, Table (15).

Nature of gene action : The observed F_1 mean (175.50 gm) was higher than both the arithmetic mean (127.04 gm) and the geometric mean (114.29 gm), but closer to the arithmetic mean. The observed F_2 mean (114.49 gm) was lower than both the arithmetic mean (151.27 gm) and the geemetric mean (149.32 gm) which are nearly equal, indicating that two types of gene action are acting with the same amount, Table (15).

The estimates of the different kinds of gene effects showed that dominance, additive x additive, additive x dominance and dominance x dominance gave estimates of 75.94, 27.48, 45.50 and 92.12 respectively, Table (16)

Number of genes involved : The Castle-Wright and Wright's formula gave estimates of 1.915 and 2.646 pair of genes respectively, indicating that minimum number of genes affecting head weight was 2-3 pair of genes, Table (16).

Deduction according to Mendelian principles, showed that 28 plants out of 100 F_2 plants were within the range of the recessive parent (NES 645) which nearly fits the ratio (1 : 4) and suggests presence of (1-2) pair of gene difference.

Heritability : Heritability in broad sense was 56.48 % while narrow sense heritability could not be calculated ~~due to the heterotic effect~~, Table (16).

2- NES 645 x G.114 : The datafor head weight of the variety NES 645 were previously discussed. The other parent G.114 ranged from 62 to 167gm. with a mean value of (133.90 ± 9.67 gm) and a coefficient of variation of 33.05 %. The F_1 plants ranged from 146 to 209 gm, with a mean of (154.90 ± 11.65 gm) and a coefficient of variation of 23.78 % which is higher than those of both parents.. The F_2 plants ranged from 20 to 230 gm covering the ranges of both parents and F_1 plants. The obtained F_2 mean was (99.22 ± 4.29 gm) with a coefficient of variation of 43.22, which is more higher than that of parents and F_1 populations. The observation in the F_2 population showed to be continuous with some values exceeding those of the heavier parent indicating transgressive segregation, Table (14).

Nature of dominance : The observed F_1 mean (154.90 gm) was higher than the arithmetic mean (102.74 gm), suggesting overdominance of the heavy parent. Moreover, the observed F_2 mean (99.22 gm) was lower than the arithmetic mean (128.82 gm) indicating inbreeding depression.

Heterosis values over mid-parents and better parent were 55.64% and 15.68% respectively. The inbreeding depression was 35.95%, Table (15).

Nature of gene action : The observed F_1 mean was higher than both the arithmetic mean (102.74 gm) and the geometric mean (97.90 gm). Meanwhile, the observed F_2 mean (99.22 gm) was lower than both the arithmetic mean (128.82 gm) and the geometric mean (126.15 gm) which are nearly equal, indicating that both types of gene action may act with the same amount, Table (15)

The estimates of the different kinds of gene effects showed that dominance, additive x additive and dominance x dominance gave estimates of 104.28, 52.12 and 14.16 respectively, Table (16).

Number of genes involved : The Castle-Wright and Wright's formulae gave estimates of 1.007 and 2.417 indicating that the minimum number of genes affecting head weight was 1-2 pair of genes, Table (16).

Mendelian prinicples showed that 48 plants out of 100 F_2 plants studied were within the range of the recessive parent (NES 645), this seems to fit the ratio (1:2) suggesting the presence of one pair of genes difference .

Heritability : Heritability in broad semse was 26.22 % . Meanwhile, in the narrow sense it was 9.92 %, Table (16).

III- Moderate x Light head weight : This group included the cross NES 324 x NES 645. The data of the variety NES 645 were previously discussed and the other variety, NES 324, ranged from 62 to 104 gm with a mean of (80.93 ± 3.45 gm) and a coefficient of variation of 13.47. F_1 plants ranged from 83 to 125 gm with a mean of (94.40 ± 5.41 gm) and a coefficient of variation of 18.13 which is intermediate between those of both parents. Head weight of the F_2 plants started from 41 to 167 gm covering the ranges of both parents and F_1 populations. The obtained F_2 mean was (85.84 ± 3.51 gm) with a coefficient of variation of 40.84% which is higher than those of parents and F_1 populations. The continuity of the F_2 distribution showed that head weight was quantitatively inherited, there was also transgressive segregation beyond the heavier parent, Table (14).

Nature of dominance : The observed F_1 mean (94.40 gm) was higher than the arithmetic mean (76.25 gm) showing overdominance of the heavy parent. On the other hand, the observed F_2 mean (8 5.84 gm) was insignificantly higher than the arithmetic mean (85.33 gm) showing absence of dominance.

Heterosis over mid-parents and better parent gave estimates of 23.80 % and 16.64 % respectively and the inbreeding depression value was 9.07 %, Table (15).

Nature of gene action : The observed F_1 mean (94.40 gm) was higher than both the arithmetic mean (76.25 gm) and the geametric mean (76.11 gm). On the other hand, the observed F_2 mean (85.84 gm) was insignificantly higher than both the arithmetic mean (85.33 gm) and the geometric mean (84.84 gm) indicating that nature of gene action could not be determined, Table (15).

The estimates of the different kinds of gene effects showed that dominance (31.35 gm) and additive x additive (13.20) were the most important parts in this cross, Table (16).

Number of genes involved : The Castle-Wright and Wright's formula gave estimates of 0.012 and 0.100 pair of genes respectively. This indicates that the minimum number of genes affecting head weight was one pair of genes, Table (16). Meanwhile, the Mendelian principles could not be used because parental varieties were nearly similar in their distributions, Table (16).

Heritability. Heritability value in broad sense using the F_1 variance was 76.16 %, while the heritability in narrow sense could not be calculated due to heterotic effect, Table (16).

IV- **Moderatex Moderate head weight** : This group included the cross NES 324 x TAM 428. The data for head weight of the two parents, NES 324 and TAM 428, were previously discussed The F_1 plants ranged from 83 to 188 gm, with a mean value of (150.00 ± 14.24 gm) and a coefficient of variation of 30.01 % which is higher than those of parents. Weight in the F_2 population ranged from 41 to 167 gm covering the ranges of both parents and F_1 populations. The obtained F_2 mean was (86.82 ± 3.29 gm) with a coefficient of variation of 37.93 % which is higher than those of parents and F_1 populations. These observations showed transgressive segregation exceeding the higher limits of parents and the continuous F_2 distribution indicated that head weight behaved as a quantitative character, Table (14).

Nature of dominance : The observed F_1 mean (150.00 gm) was higher than the arithmetic mean (79.01 gm) showing presence of overdominance of the heavy head. Meanwhile, the observed F_2 mean (86.82 gm) was lower than the arithmetic mean (114.50 gm) indicating presence of inbreeding depression.

Heterosis over mid-parents and better parent gave estimates of (86.84 %) and (82.35 %) respectively. The inbreeding depression was 42.12 %, Table (15).

Nature of gene action : The observed F_1 mean (150.00gm) was higher than both the arithmetic mean (79.01 gm) and the geometric mean (78.98 gm) which are nearly equal. The

observed F_2 mean (86. 82 gm) was lower than both the arithmetic mean (114.50 gm) and the geometric mean (108.86 gm) indicating that the two types of gene action may act with the same amount, Table (15).

The estimates of the different kinds of gene effects showed that additive, dominance, additive x dominance and dominance x dominance gave estimates of 18.41, 68.26, 16.49 and 116.21 respectively, Table (16).

Number of genes involved : The number of genes could not be calculated because of the high variance of the F_1, Table (16).

The Mendelian principles could not be applied also because the two parents were similar in their distribution.

Heritability : Heritability in broad sense could not be calculated due to the high variance of the F_1, but the narrow sense heritability value was 6.76 %, Table (16)

V- Moderate x heavy : This group included the three crosses NES 324 x G.114, TAM 428 x G.15 and TAM 428 x G.114.

1- NES 324 x G.114 : The data for head weight of the two parents NES 324 and G.114 were previously discussed. The F_1 plants ranged from 104 to 209 gm, with a mean value of (175 . 00 $\pm$ 16.14 gm) and a coefficient of variation of

29.16 % which is intermediate between the two parents. The F_2 plants ranged from 41 to 125 gm, with a mean of (102.48 ± 4.21 gm) and a coefficient of variation of 41.03, which is higher than those of parents and F_1 populations. The continuous distribution of the F_2 indicated that head weight in this cross behaved as a quentitative character, Table (14)

Nature of dominance : The observed F_1 mean (175.00 gm) was higher than the arithmetic mean (107.42 gm) suggesting over-dominance of the heavy parent. Moreover, the observed F_2 mean (102.48 gm) was lower than the arithmetic mean (141.21 gm) indicating inbreeding depression.

The degree of heterosis over the mid-parents and the better parent were (62.91 %) and (30.69 %) respectively. The inbreeding depression value reached 41.44 %, Table (15).

Nature of gene action : The observed F_1 mean (175. 00 gm) was higher than both the arithmetic mean (107.42 gm) and the geometric mean (104.10 gm). Moreover, the observed F_2 mean (102.48 gm) was lower than both the arithmetic mean (141.21 gm) and the geometric mean (137.11 gm), which are nearly equal, indicating that the two types of gene action may be acting with the same amount, Table (15)

The estimates of the different kinds of gene effects showed that additive, dominance, additive x dominance and dominance x dominance gave estimates of 0.78, 63.95, 27.24 and 162.19 respectively, Table (16).

Number of genes involved : The number o genes by using Castle-Wright and Wright's formulae could not be calculated because of the high variance of the F_1, Table (16)

Also the Meadelian principles could not be applied due to that the two parents were similar in their distributions.

Heritability : Broad sense heritability could not be calculated due to the high variance of the F_1. On the other hand, the narrow sense heritability was 11.12 %, Table (16)

2- TAM 428 x G.15 : The data for head weight for the two parents, TAM 428 and G.15, were previously discussed. The F_1 plants ranged from 104 to 209 gm with a mean value of (146.60 ± 12.98 gm) and a coefficient of variation of 28.00% which is higher than those of the two parents. The F_2 plants ranged from 20 to 209 gm, covering the ranges of both parents and the F_1 showing transgressive segregation exceeding the limits of the higher parent. The obtained F_2 mean was (94.23 ± 4.10 gm) with a coefficient of variation of 43.52 % which is higher than those of parents and F_1 populations. The continuous distribution of F_2 indicated that head weight in this cross behaved as a quantitative. character, Table (14).

Nature of dominance : The observed F_1 mean (146.60 gm) was insignificantly higher than the arithmetic mean (129.79 gm)

indicating absence of dominance. Moreover, the observed F_2 mean (94.23 gm) was lower than the arithmetic mean (138.20 gm) suggesting inbreeding depression.

Heterosis over the mid parents and the better parent gave estimates of (12.95 %) and (-19.67 %). The inbreeding depression value was 35.72 %, Table (15).

Nature of gene action : The observed F_1 mean (146.60 gm) was higher than both the arithmetic mean (129.79 gm) and the geometric mean (118.60 gm) but closer to the arithmetic mean. Meanwhile, the observed F_2 mean (94.23 gm) was lower than both the arithmetic mean (138.20 gm) and the geometric mean (137.94 gm) which are nearly identical, suggesting that the two types of gene action may act with the same amount, Table (15).

The estimates of the different kinds of gene effects showed that dominance, additive x additive, additive x dominance and dominance x dominance effects gave estimates of 28.89, 12.08, 2.77 and 151.70 respectively, Table (16)

Number of genes involved : The number of genes by using Castle-Wright and Wright's formulae could not be calculated due to high variance of the F_1, Table (16)

Also the Mendelian principles could not be applied due to the absence of dominance.

Heritability : Broad and narrow sense heritability could not be calculated since there was high variance in the F_1 Table (16).

3- TAM 428 x G.114 : The data for head weight of the parents TAM 428 and G.114 were previously discussed, F_1 plants ranged from 188 to 230 with a mean value of (225.30 ± 9.62 gm) and a coefficient of variation of 13.51% which is lower than that of both parents, indicating homogeneity of the F_1 plants. The F_2 plants ranged from 20 to 167 gm, covering the ranges of both parents. Its means was (80.05 ± 3.66 gm) with a coefficient of variation of 45.76 %, which is higher than those of parents and F_1 populations. The continuous change in the F_2 population indicated that head weight in this cross behaved as a quantitative character, Table (14).

Nature of dominance : The observed F_1 mean (225.30 gm) was higher than the arithmetic mean (105. 49 gm) showing over-dominance of the heavy head. Meanwhile, the observed F_2 mean (80.05 gm) was lower than the arithmetic mean (165.39 gm) indicating inbreeding depression,

Heterosis values over the mid-parents and the better parent were (113.57 %) and (68.26 %) respectively. The inbreeding depression value was 64.47 % Table (15)

Nature of gene action : The observed F_1 mean (225. 30 gm) was higher than both the arithmetic mean (105.49 gm) and the geometric mean (101.59 gm). Moreover, the observed F_2 mean (80.05 gm) was lower than both the arithmetic mean (165.39 gm) and the geometric mean (154.16 gm), but closer to the geometric mean indicating multiplicative gene action, Table (15).

The estimates of the different kinds of gene effects showed that additive, dominance, additive x additive, additive x dominance and dominance x dominance effect estmates were 0.99, 222.63, 102.82, 29.40 and 135.74, respectively, Table (16).

Number of genes involved : The Castle-Wright and Wright's formulae gave estimates of (0.970 - 9.595) pair of genes, respectively, indicating that the minimum number of genes responsible for the parental difference in head weight was (1-10) pair of genes, Table (16).

The parental varieties were nearly similar in their distribution, and it was there fore, impossible to use the Mendelian principles for estimating gene number.

Heritability : A heritability in broad sense was found to be 31.01 % while the heritability in narrow sense could not be calculated because of the high variance of the F_1 Table (16).

VI- Heavy x Heavy head weight : This group was represented only by the cross G.15 x G.114. The data for head weight of the varieties G.15 and G.114 were previously discussed. The F_1 plants ranged from 104 to 209 gm with a mean of (157.90 ± 9.78 gm) and a coefficient of variation of 19.60% which is intermediate between those of both parents.

The F_2 plants ranged from 41 to 167 gm, with a mean of (107.82 ± 2.83 gm) and a coefficient of variation of 26.28 % which is higher than that of both parents and F_1 populations. The continuous distribution in the F_2 population indicated that head weight in this cross behaved as a quantitative character, Table (14).

Nature of dominance : The observed F_1 mean (157.90 gm) was insignificantly lower than the arithmetic mean (158.20 gm) showing absence of dominance. Moreover, the observed F_2 mean (107.82 gm) was lower than the arithmetic mean (158.05 gm) indicating inbreeding depression.

Heterosis values over the mid-parents and the better parent were (-0.19 %) and (-13.48 %) respectively. The inbreeding depression was 31.72 %, Table (15).

Nature of gene action : The observed F_1 mean (157.90 gm) was lower than the arithmetic mean (158.20 gm) but higher than the geometric mean (156.32 gm). On the other hand, the observed F_2 mean (108.82 gm) was lower than both the arithmetic mean (158.05 gm) and the geometric mean(158.05 gm)

which are identical, indicating that the two types of gene action may act with the same amount, Table (15).

The estimates of the different kinds of gene effects showed that additive, dominance , additive x additive and dominance x dominance gave estimates of 9.30, 73.78, 74.08 and 52.76, respectively, Table (16).

Number of genes involved :Number of genes could not be calculated by using Castle-Wright and Wright's formulae due to the high variance of the F_1 , Table (16).

Mendelian principles also could not be applied due to absence of dominance.

Heritability : Heritability in broad and norrow sense could not be calculated because of the high variance of the F_1 , Table (16).

Table (14) Frequency distribution of head weight in estimates in the nine crosses studied

Crosses	Class centers: 20	41	62	83	104	125	146	167	188	209	230	Number of plants	$\bar{X}$ ± S.E	C.V%
I- Light x Moderate head weight														
NES 645 x TAM 428														
P_1	2	24	9	5								40	71.58 ± 6.44	29.02
Bc_1	21	24	20	21	8	5	1					100	61.47 ± 3.01	48.88
F_1				2	3	3	2	1				10	119.70 ± 3.16	18.21
F_2	26	37	21	12	2	1	1					100	48.29 ± 2.93	60.76
Bc_2	11	20	20	10	9	10	8	6	1	5		100	89.65 ± 5.55	61.88
P_2		3	14	17	3	3						40	77.08 ± 6.33	26.05
II- Light x Heavy head weight														
1- NES 645 x G.15														
P_1	2	24	9	5								40	71.58 ± 6.44	29.02
Bc_1		8	8	22	11	22	10	9	5	2	3	100	116.38 ± 4.55	39.08
F_1							1	4	3	2		10	175.50 ± 7.84	14.12
F_2		2	12	14	27	19	12	9	1	2	2	100	114.49 ± 3.75	32.88
Bc_2		1	4	12	26	18	19	11	7	2		100	126.34 ± 3.39	26.86
P_2						1	6	6	7	8	2	30	182.50 ± 8.31	16.29

Table (14) : Cont.

Crosses	Class centers 20	41	62	83	104	125	146	167	188	209	230	Number of plants	$\bar{X}$	+	S.E	C.V %
2- NES 645 x G.114																
P_1	2	24	9	5								40	71.58	±	6.44	29.02
Bc_1	1	10	21	22	12	15	8	8	3			100	95.00	±	3.80	40.05
F_1							5	1	3	1		10	154.90	±	11.65	23.78
F_2	1	8	23	17	23	8	9	5	4	1	1	100	99.22	±	4.29	43.22
Bc_2		2	9	13	16	11	22	12	7	5	3	100	95.00	±	3.80	40.05
P_2			4	7	11	10	4	4				40	133.90	±	9.67	23.05
III- Moderate x Light head weight																
NES 324 x NES 645																
P_1			6	20	4							30	80.93	±	3.45	13.47
Bc_1	3	25	15	23	12	11	7	1	2	1		100	83.05	±	3.82	45.99
F_1				5	4	1						10	94.40	±	5.41	18.13
F_2		15	26	19	18	14	5	3				100	85.84	±	3.51	40.84
Bc_2	3	10	9	21	21	9	12	6	1			100	95.23	±	3.71	38.94
P_2	2	24	9	5								40	71.58	±	6.44	29.02

Table (14) : Cont .

Crosses	Class centers											Number of plants	$\bar{X}$	+	S.E	C.V %
	20	41	62	83	104	125	146	167	188	209	230					
IV- Moderate x Moderate head weight																
NES 324 x TAM 428																
P_1			6	20	4							30	80.93	±	3.45	13.47
Bc_1		12	18	27	15	14	5	5	4			100	95.34	±	3.58	37.60
F_1				1	1	2	3	1	1			10	150.00	±	14.24	30.01
F_2		15	26	19	19	13	5	3				100	86.82	±	3.29	37.93
Bc_2		18	34	18	25	2	2	1				100	76.93	±	2.67	34.65
P_2		3	14	17	3	3						40	77.08	±	6.33	26.05
V- Moderatex Heavy head weight																
1- NES 324 x G.114																
P_1			6	20	4							30	80.93	±	3.45	13.47
Bc_1		9	16	22	21	13	7	8	3	1		100	101.96	±	3.84	37.68
F_1					2	1	2	1	2	2		10	175.00	±	15.14	29.16
F_2		7	23	19	15	15						100	102.48	±	4.21	41.03
Bc_2		12	11	21	28	13	5	4	3	1	2	100	101.18	±	4.32	42.66
P_2			4	7	11	10	4	4				40	133.90	±	9.67	23.05

Table (14): Cont.

Crosses	Class centers 20	41	62	83	104	125	146	167	188	209	230	Number of plants	$\bar{X}$ + S.E.	C.V %
2- TAM 428 x G.15														
P_1		3	14	17	3	3						40	77.08 ± 6.33	26.05
Bc_1	19	24	19	12	8	6	4	4	1	1	2	100	72.28 ± 4.89	67.63
F_1					2	3	1	1	2	1		10	146.60±12.98	28.00
F_2	4	14	13	23	17	13	7	7	1	1		100	94.23± 4.10	43.52
Bc_2		2	10	13	16	22	20	8	8	1		100	122.22± 3.84	31.43
P_2						1	6	6	7	8	2	30	182.50± 9.31	61.29
3- TAM 428 x G.114														
P_1		3	14	17	3	3						40	77.08 ± 6.33	26.05
Bc_1	1	8	21	12	14	16	13	7	4	1	3	100	106.25 ± 4.96	46.71
F_1									3	1	6	10	225.30 ± 9.62	13.51
F_2	3	21	29	14	13	10	8	2				100	80.05 ± 3.66	45.76
Bc_2	1	8	11	21	19	16	11	7	5	1		100	105.26 ± 4.08	38.75
P_2			4	7	11	10	4	4				40	133.90 ± 9.67	23.05

Table (14): Cont.

Crosses	Class centers											Number of plants	$\bar{X}$ ± S.E	C.V %
	20	41	62	83	104	125	146	167	188	209	230			
VI- Heavy x Heavy head weight														
G.15 x G.114														
P_1					1	6	6	7	8	2		30	182.50 ± 9.31	16.29
Bc_1	6	6	12	13	18	12	14	10	8	1		100	130.99 ± 4.76	36.32
F_1				1	2	1	4	1	1			100	157.90 ± 9.78	19.60
F_2	2	8	18	37	18	10	7					100	107.82 ± 2.83	26.28
Bc_2		5	12	31	22	16	10	2	1	1		100	121.69 ± 3.12	25.62
P_2		4	7	11	10	4	4					40	133.90 ± 9.67	23.05

Table (15): Estimates of nature of gene action ; heterosis percentage (H %) over mid-parents and better parent and inbreeding depression percentage (I.D %) with respect to head weight per plant.

Crosses	F_1 Population			F_2 Population			Heterosis (H%)		inbreeding depression (I. D %)
	Obser. mean	Calc. Arith.	Calc. Geom.	Obser mean	Calc. Arith	Calc. Geom.	M.P.	B.P	
I- Light x Moderate head weight									
NES 645 x TAM 428	119.70	74.33	74.28	48.29	97.01	94.32	61.04	55.29	59.66
II- Light x Heavy head weight									
1- NES 645 x G.15	175.50	127.04	114.29	114.49	151.27	149.32	38.14	- 3.83	34.76
2- NES 645 x G.114	154.90	102.74	97.90	99.22	128.82	126.15	55.64	15.68	35.95
III- Moderate x Light head weight									
NEX 324 x NES 645	94.40	76.25	76.11	85.84	85.33	84.84	23.80	16.64	9.07
IV- Moderate x Moderate head weight									
NES 324 x TAM 428	150.00	79.01	78.98	86.82	114.50	108.86	86.84	85.35	42.12
V- Moderate x Heavy head weight									
1- NES 324 x G.114	175.00	107.42	104.10	102.48	141.21	137.11	62.91	30.69	41.44
2- TAM 428 x G. 15	146.60	129.79	118.60	94.23	138.20	137.94	12.95	-19.67	35.72
3- TAM 428 x G. 114	225.30	105.49	101.59	80.05	165.39	154.16	113.57	68.26	64.47
VI- Heavy x Heavy head weight									
G.15 x G.114	157.90	158.20	156.32	107.82	158.05	158.05	- 0.19	-13.48	31.72

Table (16): Estimates of parameters of gene action; number of genes and heritability (h^2%) in broad and norrow sense with respect to head weight per plant.

Crosses	Gene action						Number of genes		Heritability %	
	m	a	d	aa	ad	dd	Castle Wright	Wrights. formula	B.S.	N.S
I- Light x Moderate head weight										
NES 645 x TAM 428	98.29	-28.18	154.32	109.08	-25.57	-22.99	0.100	1.343	44.81	--
II- Light x Heavy head weight										
1- NES 645 x G.15	114.49	-9 .96	75.94	27.48	45.50	92.12	1.915	2.646	56.68	--
2- NES 645 x G.114	99.22	-34.50	104.28	52.12	-3.34	14.16	1.007	2.417	26.22	9.92
III-Moderate x Light head weight										
NES 324 x NES 645	85.84	-12.18	31.35	13.20	-16.86	-28.45	0.012	0.100	76.16	--
IV- Moderate x Moderate head weight										
NES 324 x TAM 428	86.82	18.41	68.26	- 2.74	16.49	116.21	--	--	--	6.76
V- Moderate x heavy head weight										
1- NES 324 x G.114	102.48	0.78	63.95	- 3.64	27.24	162.19	--	--	--	11.12
2- NES 428 x G.15	94.23	-49.64	28.89	12.08	2.77	151.70	--	--	--	--
3- TAM 428 x G.114	80.05	0.99	222.63	102.82	29.40	135.74	0.970	9.595	31.01	--
VI- Heavy x heavy head weight										
G.15 x G.114	107.82	9.30	73.78	74.08	-15.0	52.76	--	--	--	--

m = F_2
a = additive effect
d = dominance effect
aa = additive x additive type of epistasis
ad = additive x dominance type of epistasis
dd = dominance x dominance type of epistasis

Inheritance of seed weight per plant:

Seed weight was studied in nine crosses. The parents were chosen to represent three types of seed weight, light, moderate and heavy in seed weight

Light in seed weight varieties :Mean of seed weight per plant ranged from (45 to 50 gm), it was represented by the varieties NES 645 and TAM 428..

Moderate in seed-weight varieties : Mean sead weight per plant varies from (51 to 100 gm) as it was in the varieties NES 324 and G.114

Heavy in seed-weight varieties : Mean seed weight per ranged from (101 to 120 gm), including the variety G.15.

I- Light x Light in seed weight varieties : This group included the cross NES 645 x TAM 428. Seed weight of the variety NES 645 ranged from 26 to 70 gm with a mean value of (45.78 ± 3.89 gm) and a coefficient of variation of 25.27 % The other parent, TAM 428, ranged from 37 to 70 gm, having a mean of (50.15 ± 4.11 gm) and a coefficient of variation of 26.22 %. The F_1 plants ranged from 59 to 103 gm giving a mean of (77.90 ± 4.51 gm) and a coefficient of variation of 18.31 %. which is lower than that of the parents indicating homogeneity of the F_1 plants. Seed weight of the F_2 population had a rather wide range of variation extending from 15 to 92 gm and covering the ranges of the two parents and F_1 plants. Its mean was (31.06 ± 1.91 gm) with a coefficient of variation of 61.55 % which was higher than those

of parents and F_1 populations. The continuous distribution of the F_2 population indicated that seed weight behaved as a quantitative character, Table (17).

Nature of dominance : The observed F_1 mean (77.90 gm) was higher than the arithmetic mean (47.96 gm) indicating over-dominance of the heavy head. On the other hand, the observed F_2 mean (31.06 gm) was lower than the arithmetic mean (62.93 gm), showing inbreeding depression.

The estimates of heterosis over the mid-parents and the better parent were (62.43 %) and (55.33 %), respectively. Inbreeding depression value was 60.13 %, Table (18).

Nature of gene action : The observed F_1 mean (77.90 gm) was higher than both the arithmetic mean (47.96 gm) and the geometric mean (47.91 gm). Moreover, the observed F_2 mean was lower than both the arithmetic mean (62.93 gm) and the geometric mean (61.12 gm) which are nearly equal, indicating probably that both gene actions are acting with the same amount, Table (18).

The data of gene effects for seed weight indicated that dominance (102.04), additive x dominance (100.35) and additive x additive (72.10) were the most important kinds for the inheritance of seed weight, while the additive (-18.45) and dominance x dominance effects (-16.71) were less important for inheritance of this character, Table (19).

Number of genes involved : Estimated number of genes by Castle-Wright and Wright's formulae was (0.015) and(1.372) pair of genes, respectively, Table (19).

The Mendelian principles could not be used which may be due to similarity between the two parents.

Heritability: Broad sense heritability was 46.52 % using the F_1 variance. Moreover,the heritability in narrow sense could not be calculated because of the heterotic effect, Table (19).

II- Light x Moderate in seed weight varieties: This group involved the two crosses NES 645 x G.114 and TAM 428 X G.114.

1- NES 645 x G.114 : The data of the parent NES 645 were previously mentioned concerning its range , mean and coefficient of variation. The mean of the parent G.114 was (87.00 ± 6.28 g m) with a range from 70 to 114 gm and a coefficient of variation of 23.07 % . At the same time, the mean of the F_1 plants was (100.80 ± 7.57 gm) having a range from 103 to 125 gm and a coefficient of variation of 23.75%.

The F_2 plants having a range from 15 to 125 gm covering the ranges of both parents and F_1 population. The mean of the F_2 plants was (63.88 ± 2.71 gm) and its coefficient of variation was 42.43 %, which is more higher than those of parents and F_1 populations. The F_2 distribution did not

show segregation indicating that two parents may have common genetic constitution, Table (17).

Nature of dominance :The observed F_1 mean (100.80 gm) was higher than the arithmetic mean (66.40 gm) showing nearly partial dominance of the heavy parent. Moreover, the observed F_2 mean (63.88 gm) was lower than the arithmetic mean (83.60 gm) indicating inbreeding depression.

The estimates of heterosis percentage were (51.81 %) and (15.83 %) over the mid-parents and the better parent, respectively. The inbreeding depression was 36.63 %, Table (18).

Nature of gene action : The observed F_1 mean (100.80 gm) was higher than both the arithmetic mean (66.40 gm) and the geometric mean (63.12 gm). Moreover, the observed F_2 mean (63.88 gm) was lower than both the arithmetic mean (83.60 gm) and the geometric mean (81.81 gm) which are nearly equal, indicating probably that both types of gene action are acting with the same amount, Table (18).

The values of the different kinds of gene effects for seed weight showed that additive x dominance (166.80), dominance (71.24) and additive x additive effect (36.84) were more important than dominance x dominance (5.20) and additive (- 22.66), Table (19).

Number of genes involved : The Castle- Wright and Wright's formulae gave (1.316) and (3.149) pair of genes, respectively. suggesting that the parental varieties differed in (1-3) pair of genes, Table (19).

The Mendelian principles showed that 70 plants out of 100 F_2 plants studied were within the range of the higher parent NES 645, giving a ratio of (1:3) which indicates that those parents differ in one pair of genes.

Heritability : Broad sense heritability was found to be as low as 21.98 %. A narrow sense heritability could not be calculated ~~due to the heterotic effect,~~ Table (19).

2. TAM 428 x G.114 : The data for seed weight of the two parents TAM 428 and G.114 were previously discussed. The seed weight of the F_1 started from 114 to 125 gm with a mean value of (146.60 ± 6.31 gm) and a coefficient of variation of 13.61 % which is lower than those of parents sugyesting homogeneity of the F_1 plants. Seed weight of F_2 population had a rather wide range of variation extending from 15 to 114 gm and covering the ranges of the two parents. Its mean value was (52.05 ± 2.38 gm) with a coefficient of variation of 45.73 % , which was higher than those of parents and F_1 plants. The continuous F_2 distribution suggested that this character seemed to be quantitatively inherited, Table (17).

Nature of dominance : The observed F_1 mean (146.60 gm) was higher than the arithmetic mean (64.58 gm), suggesting overdominance of the heavy head. Moreover, the observed F_2 mean (52.05 gm) was lower than the arithmetic mean (107.59 gm) indicating inbreeding depression.

Heterosis estimates percentage were (113.76 %) and (68.50 %) over the mid-parents and the better parent respectively. The inbreeding depression was 64.50 % Table (18).

Nature of gene action : The observed F_1 mean (146.60 gm) was higher than both the arithmetic mean (68.58 gm) and the geometric mean (66.05 gm) . On the other hand, the observed F_2 mean (52.05 gm) was lower than both the arithmetic mean (107.59 gm) and the geometric mean (100.27 gm) but closer to the geometric mean indicating that the nature of gene action was more multiplicative than additive , Table (18)

The data of gene effects for seed weight suggesting that the additive x dominance (157.42) and dominance effect (147.81) were the most important kinds for the inheritance of seed weight. On the other hand, the dominance x dominance (82.59), additive x additive (69.78) and additive effect were less important Table (19).

indicating homogeneity of the F_1 plants. Besides, the distribution of seed weight of the F_2 generation ranged from 37 to 125 gm and showed transgressive segregation over the range of the heavier parent (G.15). Its mean value was (74.40 ± 2.45 gm) with a coefficient of variation of 32.88% being higher than those of parents and F_1 plants. The continuity of the F_2 distribution indicated that this character was quantitatively inherited, Table (17).

Nature of dominance : The observed F_1 mean (114.20 gm) was higher than the arithmetic mean (81.39 gm) indicating nearly partial dominance of the heavy parent. Moreover, the observed F_2 mean (74.40 gm) was lower than the arithmetic mean (97.79 gm) showing inbreeding depression.

Heterosis estimates were (40.31 %) and (-2.39 %) over the mid-parents and the better parent, respectively. The inbreeding depression value was 34.85 %, Table (18).

Nature of gene action : The observed F_1 mean (114.20 gm) was higher than both the arithmetic mean (81.39 gm) and the geometric mean (73.19 gm). Furthermore the observed F_2 mean (74.40 gm) was lower than both the arithmetic mean (97.79 gm) and the geometric mean (96.41 gm) which are nearly equal , indicating that genes may affect this character either additively or cummulatively, Table (18)

Data of gene effects for seed weight in this cross showed that the additive x dominance (193.75), dominance x

dominance (56.22) and dominance effect (51.49) were the most important kinds for the inheritance of seed weight. However, the additive x additive (18.68) and additive gene effect (-6.22) were less important for inheritance of this character, Table (19).

Number of genes involved : The Castle-Wright and Wright's formulae gave estimates of (1.893) and (4.289) pair of genes respectively, suggesting that the two parents differed in (2-4) pair of genes, Table (19).

The Mendelian principles showed that 70 plants out of 100 F_2 plants studied were within the range of the one parent (NES 645) giving ratio nearly fitting (1:3) which indicates that those parents differ in one pair of genes with some modifires.

Heritability : Heritability in broad sense was 55.97 % using the F_1 variance. Moreover, the narrow sense heritability could not be calculated due to the heterotic effects Table (19).

2- TAM 428 X G.15 : The data for seed weight of the two varieties TAM 428 and G.15 were previously discussed. The seed weight of the F_1 started from 81 to 125 gm having a mean value of (95.40 $\pm$ 8.46 gm) with a coefficient of variation of 17.86 % which is lower than that of both parents indicating homogeneity of the F_1 plants. The data of the F_2 plants for seed weight ranged from 15 to 125 gm covering the ranges of the two parents and the F_1 plants. Its mean

value was (60.66 ± 2.67 gm) with a coefficient of variation of 44.05 % which is higher than those of the two parents and the F_1 populations . The continuous distribution of the F_2 population indicated that this character seemed to be quantitatively inherited, Table (17).

Nature of dominance : The observed F_1 mean (95.40 gm) was insignificantly higher than the arithmetic mean (83.58 gm) indicating absence of dominance. Meanwhile,the observed F_2 mean (60.66 gm) was lower than the arithmetic (89.49 gm) mean suggesting inbreeding depression.

The estimates of heterosis over the mid-parents and the better parent were (14.14 %) and (-18.46 %), respectively. The inbreeding depression value was 36.42 % Table (18)

Nature of gene action : The observed F_1 mean (95.40 gm). was insignificantly higher than the arithmetic mean (83.58 gm) but significantly higher than the geometric mean (76.60) Moreover , the observed F_2 mean (60.66 gm) was lower than both the arithmetic mean (89.49) and the geometric mean (89.29 gm) which are nearly identical, indicating that the two types of gene action may be acting with the same amount, Table (18).

The data of gene effects for seed weight indicated that additive x dominance (159.96), dominance x dominance (94.47) and dominance effect (22.25) were the most important

parts for the inheritance of seed weight charader. However , the additive x additive (10.42) and additive effect (- 32.47) were less important, Table (19).

Number of genes involved : The number of genes could not be estimated by using Castle - Wright and Wright's formulae because the F_1 variance was higher than the F_2 variance, Table (19).

The Mendelian principles also could not be used precisely in the absence of dominance.

Heritability : Broad and narrow-sense heritability could not be calculated. This may due to that the variance of F_1 was higher than the variance of F_2, Table (19).

IV- Moderate x Light in seed weight varieties : This group involved the two crosses NES 324 x NES 645 and NES 324 x TAM 428.

1- NES 324 x NES 645 : The data for seed weight of the variety NES 645 were previously discussed. The other parent NES 324 ranged from 37 to 70 gm with a mean of (52.73 ± 2.23 gm) and a coefficient of variation of 13.36 %. The F_1 population ranged from 48 to 81 gm with a mean value of (61.30 ± 3.54 gm). The coefficient of variation was 18.25 % showing that F_1 mean was nearly intermediate between the two parents.

The F_2 population having a range from 15 to 114 gm which exceeded the ranges of both parents and F_1 population. The obtained F_2 mean was (54.82 ± 2.29 gm) . While the coefficient of variation was 41.74 % , being higher than those of both parents and F_1 as expected. The F_2 distribution showed to be continuous, suggesting a case of quantitative inheritance, Table (17).

Nature of dominance : The observed F_1 mean (61.30 gm) was higher than the arithmetic mean (49.25 gm), indicating over-dominance of the heavy head. Moreover, the observed F_2 mean (54.82 gm) was insignificantly lower than the arithmetic mean (55.28) showing absence of dominance.

Heterosis over the mid-parents and the better parent gave estimates of (24.47 %) and (16.25 %). The inbreeding depression was 10.57 %, Table (18).

Nature of gene action : The observed F_1 mean (61.30 gm) was higher than both the arithmetic mean (49.25 gm) and the geometric mean (49.13) which are nearly equal. On the other hand, the observed F_2 mean (54.82 gm) was insignificantly lower than both the arithmetic mean (55.28 gm) and the geometric mean (54.94 gm) suggesting that nature of gene action could not be determined, Table (18).

The data of gene effects for seed weight showed that additive x dominance (112.93), dominance (25.57) and additive x additive effect (13.52) were more important than

dominance x dominance (-25.21) and additive effect (-8.32) in the inheritance of seed weight character in this cross, Table (19).

Number of genes involved : The Castle -Wright and Wright's formulae gave estimates of (0.015) and (0.106), respectively, indicating that the parental varieties differed in one pair of genes Table (19).

The Mendelian principles could not be used due to similarity between the two parents.

Heritability : A broad sense heritability gave estimates of 76.10 % but the narrow sense heritability could not be calculated because of heterotic effect, Table (19).

2- NES 324 x TAM 428 : The data for seed weight of the two parents NES 324 and TAM 428 were previously discussed. The mean of the F_1 population was (97.50 ± 0.32 gm) with a range extending from 59 to 125 gm and a coefficient of variation of 30.02 which showed an intermediate value between those of parents, seed weight of the F_2 plants started from 26 to 114 gm , covering the ranges of both parents and F_1 populations. The obtained F_2 mean was (96.16 ± 2.15 gm) with a coefficient of variation of 38.24 % which is higher than those of parents and F_1 populations. The continuity of the F_2 distribution showed transgressive segregation over the higher

parent indicating that seed weight was quantitatively inherited, Table (17).

Nature of dominance : The observed F_1 mean (97.50 gm) was higher than the arithmetic mean (51.44 gm), indicating overdominance of the heavy head. Meanwhile the observed F_2 mean (96.16 gm) was higher than the arithmetic mean (74.47 gm) indicating also overdominance of the heavy head.

The estimation of heterosis percentage gave (89.54 %) and (84.90 %) over the mid -parents and the better parent respectively. The inbreeding depression value was 1.37 %, Table (18).

Nature of gene action : The observed F_1 mean (97.50 gm) was higher than both the arithmetic mean (51.44 gm) and the geometric mean (51.42 gm). Also the observed F_2 mean (96.16 gm) was higher than both the arithmetic mean (74.47 gm) and the geometric mean (70.82 gm) which are nearly equal suggesting that genes may effect this character either additively or cummulatively, Table (18).

The estimates of the different kinds of gene effects for seed weight showing that dominance x dominance (235.56), additive x dominance (110.45) and additive effect (12.32) were more important than additive x additive (-161.16) and dominance effect (-115.09) in the inheritance of this character, Table (19).

Nature of dominance : The observed F_1 mean (113.80 gm) was higher than the arithmetic mean (69.88 gm) showing overdominance of the heavy parent. On the other hand, the observed F_2 mean (66.53 gm) was lower than the arithmetic mean(91.84 gm) indicating inbreeding depression.

The estimates of heterosis over the mid parents and the better parent were (62.85 %) and (30.77 %) , respectively. The inbreeding depression value was 41.54 %, Table (18).

Nature of gene action : The observed F_1 mean (113.80 gm) was higher than both the arithmetic mean (69.88 gm) and the geometric mean (67.74 gm). The observed F_2 mean (66.53 %) was lower than both the arithmetic mean (91.84 gm) and the geometric mean (89.17 gm) which are nearly equal, indicating that the two types of gene action may act with the same amount, Table (18).

The data of gene effects for seed weight in this cross indicated that the additive x dominance (148.75), dominance x dominance (107.07) and dominance effect (41 .01) were important than additive (0.98) and additive x additive effect (-2.92) in the inheritance of this character, Table (19).

Number of genes involved : The number of genes by Castle-Wright and Wright's formulae could not be calculated due to heterotic effect, Table (19).

The Mendelian principles showed that 63 plants out of 100 F_2 plants studied were within the range of the recessive parent NES 324, giving a ratio of (1:3) which indicates that these parents differ by one pair of genes.

Heritability : Broad sense heritability could not be calculated due to the heterotic effect. Moreover, the narrow sense heritobility was 14.97 %, Table (19).

VI) Heavy x moderate in seed weight varieties : This group includes the cross G.15 x G.114. The data for seed seight of the two varieties G.15 and G.114 were previously discussed. The seed weight of F_1 ranged from 70 to 125 gm with a mean value (102.60 ± 6.35 gm) and a coefficient of variation of 19.69 %, seed weight of the F_2 population had a rather wide range of variation extending from 26 to 114 gm, and covering the ranges of the two parents and F_1 plants. Its mean value was (70.18 ± 1.84 gm) with a coefficient of variation of 26.23 %, which was higher than those of parents and F_1 plants. The continuous F_2 distribution suggested that this character seemed to be quantitatively inherited. Table (17).

Nature of dominance : The observed F_1 mean (102.60 gm) was insignificantly higher than the arithmetic mean (102.00 gm) indicating the absence of dominance. Meanwhile, the observed F_2 mean (70.18 gm) was lower than the arithmetic mean (102.30 gm) showing inbreeding depression.

Heterosis over the mid-parents and the better parent gave estimates of (0.59 %) and (-12.30 %), respectively. The inbreeding depression was found to be 31.60 %, Table (18).

Nature of gene action : The observed F_1 mean (102.60 gm) was insignificantly higher than both the arithmetic mean (102.00 gm) and the geometric mean (100.89 gm). On the other hand, the observed F_2 mean (70.18 gm) was lower than both the arithmetic mean (102.30 gm) and the geometric mean (102.30 gm) which are identical, indicating that the two types of gene action may act with the same amount, Table (18).

The data of gene effects for seed weight in this cross indicated that the additive x dominance (149.34), additive x additive (47.96), dominance x dominance (32.56) and additive effect (5.96) were the most important parts while the dominance effect gave estimates of (-5.44), Table (19).

Number of genes involved : The number of genes could not be calculated by using Castle-Wright and Wright's formulae due to the variance of the F_1 was higher than the variance of the F_2, Table (19)

Also the Mendelian principles could not be used due to the absence of dominance.

Heritability : Broad sense heritability could not be calculated due to the high variance of the F_1, but narrow sense heritability was found to be 37.58 %, Table (19).

Table (17): Frequency distribution of seed weight in estimates in the nine crosses studied

Crosses	Class centers 15	26	37	48	59	70	81	92	103	114	125	Number of plants	X + S.E	C.V %
I- Light x Light in seed weight varieties														
NES 645 x TAM 428														
P_1		8	11	11	4	6						40	45.78 ± 3.89	25.27
Bc_1	19	18	17	19	17	3	6	1				100	39.86 ± 1.95	48.85
F_1					2	2	3	2	1			10	77.90 ± 4.51	18.31
F_2	32	30	16	12	7	1	1	1				100	31.06 ± 1.91	61.55
Bc_2	11	17	17	12	4	9	9	8	6	1	6	100	58.31 ± 3.61	61.82
P_2			13	13	8	6						40	50.15 ± 4.11	26.22
II- Light x Moderate in seed weight varieties														
1- NES 645 x G.114														
P_1		8	11	11	4	6						40	45.78 ± 3.89	25.27
Bc_1	1	5	18	19	14	13	12	5	8	4	1	100	61.76 ± 2.47	40.10
F_1									5	1	4	10	100.80 ± 7.57	23.75
F_2	2	7	17	13	12	22	8	5	7	4	3	100	63.88 ± 2.71	42.43
Bc_2		1	5	14	9	12	8	18	12	10	11	100	84.42 ± 2.94	34.82
P_2						12	7	11	4	6		40	87.00 + 6.28	23.07

Table (17): Cont.

Crosses	Class centers 15	26	37	48	59	70	81	92	103	114	125	Number of plants	X	+ S.E	C.V %
2- TAM 428 x G.114															
P_1			13	13	8	6						40	50.15	± 4.11	26.22
Bc_1	1	6	19	6	13	11	16	10	6	5	7	100	70.40	± 3.12	44.37
F_1										1	9	10	146.60	± 6.31	13.61
F_2	4	20	19	19	7	13	8	6	2	2		100	52.05	± 2.38	45.73
Bc_2	1	5	10	20	5	17	9	11	4	6	2	100	68.59	± 2.65	38.67
P_2						12	7	11	4	6		40	87.00	± 6.28	23.07
III- Light x Heavy in seed weight varieties.															
1- NES 645 x G.15															
P_1			8	11	11	4	6					40	45.78	± 3.89	25.27
Bc_1	6	3	18	12	12	17	10	5	7	10		100	75.96	± 2.94	38.64
F_1							1	3	2	4		10	114.20	± 5.13	14.22
F_2		12	5	16	20	17	12	10	3	4		100	74.40	± 2.45	32.88
Bc_2	1	1	4	15	27	31	13	12	8	6		100	82.18	± 2.21	26.87
P_2						1	3	5	7	14		30	117.00	± 5.27	17.90

Table (17): Cont.

Crosses	Class centers											Number of plants	X	+ S.E.	C.V %
	15	26	37	48	59	70	81	92	103	114	125				
2- TAM 428 x G.15															
P_1			13	13	8	6						40	50.15	± 4.11	26.22
Bc_1	20	21	14	14	5	10	4	4	2	2	4	100	47.03	± 3.18	27.28
F_1							2	3	1	1	3	10	95.40	± 8.46	17.86
F_2	6	12	9	13	20	13	9	7	7	3	1	100	60.66	± 2.67	44.05
Bc_2			7	9	11	18	15	18	8	7	7	100	79.50	± 2.49	31.38
P_2							1	3	5	7	14	30	117.00	± 5.27	17.90
IV- Moderatex light in seed weight varieties															
1- NES 324 x NES 645															
P_1			3	14	11	2						30	52.73	± 2.23	13.36
Bc_1	4	22	12	19	12	11	9	7	1	2	1	100	54.04	± 2.49	46.14
F_1				3	4	2	1					10	61.30	± 3.54	18.25
F_2	2	15	13	24	15	16	4	4	5	2		100	54.82	± 2.29	41.74
Bc_2	3	7	13	15	22	12	7	8	9	4		100	62.36	± 2.47	54.80
P_2		8	11	11	4	6						40	45.78	± 3.89	25.27

Table (17) : Cont.

Crosses	Class centers											Number of plants	X	±	S.E	C.V %
	15	26	37	48	59	70	81	92	103	114	125					
2- NES 324 x TAM 428																
P_1			3	14	11	2						30	52.73	±	2.23	13.36
Bc_1		10	8	17	27	13	11	5	5	2	2	100	62.03	±	2.33	37.50
F_1					1	1	2	1	2	1	2	10	97.50	±	0.32	30.02
F_2		11	23	15	16	15	12	4	1	3		100	96.16	±	2.15	28.24
Bc_2		16	26	19	13	22	2	2	1			100	49.71	±	1.76	35.33
P_2			13	13	8	6						40	50.15	±	4.11	26.22
V- Moderate x Moderate in seed weight varieties :																
NES 324 x G.114																
P_1			3	14	11	2						30	52.73	±	2.23	13.36
Bc_1		4	13	17	16	23	9	5	6	3	4	100	66.29	±	2.50	37.68
F_1							2	1	1	2	4	10	113.30	±	10.51	29.20
P_2		3	15	24	14	10	13	6	6	4	5	100	66.53	±	2.74	41.19
Bc_2		9	8	20	11	24	10	8	3	2	5	100	65.31	±	2.77	42.36
P_2						12	7	11	4	6		40	87.00	±	6.28	23.07

Table (17): Cont.

Crosses	Class centers 15	26	37	48	59	70	81	92	103	114	125	Number of plants	X	+	S.E.	C.V %
VI- Heavy x Moderate in seed weight varieties																
G.15 x G.114																
P_1							1	3	5	7	14	30	117.00	±	5.27	17.90
Bc_1	5	6	5	10		14	15	9	13	6	17	100	85.15	±	3.09	36.27
F_1						1	1	1	4	2	1	10	102.60	±	6.35	19.69
F_2	2	3	15	15		30	18	7	8	2		100	70.18	±	1.84	26.23
Bc_2		5	2	13		27	22	10	16	3	2	100	79.19	±	2.02	25.51
P_2						12	7	11	4	6		40	87.00	±	6.28	23.07

Table (18): Estimates of nature of gene action; heterosis percentage (H %) over mid-parents and better parent and inbreeding deprossion percentage (I.D %) with respect to seed weight per plant.

Crosses	F_1 population.			F_2 population			Heterosis (H%)		inbreeding depression (I.D. %)
	Obser. mean	Calc. Arith.	Calc. Geom.	Obser mean	Calc. Arith	Calc. Geom.	M.P.	B.P.	
I- Light x Light in seed weight varieties.									
NES 645 x TAM 428	77.90	47.96	47.91	31.06	62.93	61.12	62.43	55.33	60.13
II- Light x Moderote in seed weight varieties									
1- NES 645 x G.114	100.80	66.40	63.12	63.88	83.60	81.81	51.81	15.83	36.63
2- TAM 428 x G.114	146.60	68.58	66.05	52.05	107.59	100 .27	113.76	68.50	64.50
III-Light x heavy in seed weight varieties									
1- NES 645 x G.15	114.20	81.39	73.19	74.40	97.79	96.41	40.31	- 2.39	34.85
2- TAM 428 x G.15	95.40	83.58	76.60	60.66	89.49	89.29	14.14	-18.46	36.42
IV- Moderate x Light in seed weight varieties									
1- NES 324 x NES 645	61.30	49.25	49.13	54.82	55.28	54.94	24.47	16.25	10.57
2- NES 324 x TAM 428	97.50	51.44	51.42	96.16	74.47	70.82	89.54	84.90	1.37
V - Moderate x Moderate in seed weight varieties									
NES x G.114	113.80	69.88	67.74	66.53	91.84	89.17	62.85	30.77	41.54
VI- Heavy x Moderate in seed weight varieties									
G.15 x G.114	102.60	102.00	100.89	70.18	102.30	102.30	0.59	-12.30	31.60

Table (19): Estimates of parameters of gene action; number of genes and heritability (h^2%) in broad and narrow sense with respect to seed weight per plant.

Crosses	Gene action						Number of genes		Heritability %	
	m	a	d	aa	ad	dd	Castle Wright	Wrights formula	B.S.	N.S.
I- Light x Light in seed weight varieties										
NES 645 x TAM 428	31.06	-18.45	102.04	72.10	100.35	- 16.71	0.015	1.372	46.52	--
II-Light x Moderate in seed weight varieties										
1- NES 645 x G.114	63.88	-22.66	71.24	36.84	166.80	5.20	1.316	3.149	21.98	--
2- TAM 428 x G.114	52.05	- 1.81	147.81	67.78	157.42	82.59	1.009	10.058	29.70	--
III- Light x Heavy in seed weight varieties.										
1- NES 645 x G.15	74.40	- 6.22	51.49	18.68	193.75	56.22	1.893	4.289	55.97	--
2- TAM 428 x G.15	60.66	-32.47	22.25	10.42	159.96	94.47	--	--	--	--
IV- Moderate x Light in seed wight varieties										
1- NES 324 x NES 645	54.82	- 8.32	25.57	13.52	112.93	-25.21	0.015	0.105	76.10	--
2- NES 324 x TAM 428	96.16	12.32	-115.09	-161.16	110.45	235.56	--	--	--	15.78
V- Moderate x Moderate in seed weight varieties										
NES 324 x G.114	66.53	0.98	41.01	- 2.92	148.75	107.07	--	--	--	14.97
IV- Heavy x Heavy in seed weight varieties										
G.15 x G.114.	70.18	5.96	-5.44	47.96	149.34	32.56	--	--	--	37.58

m = F_2

a = additive effect

d = dominance effect

aa = additive x additive type of epistasis

ad = additive x dominance type of epistasis

dd = dominance x dominance type of epistasis

7- Correlation between some characters

Phenotypic correlation was calculated between seed weight per plant and some economic characters in the F_2 population, ie. , plant height, head length, head width, head index and head weight, . Correlation coefficient values are presented in table (20) and figure (1).

The correlation coefficient for seed weight per plant and each of plant height, head length, head width and head index showed the following insignificant positive values : (+ 0.214), (+ 0.067) , (+ 0.315) and (+ 0.347) respectively. The correlation between seed weight per plant and head weight had significant positive value (+ 0.659).

Table (20) Phenahypic correlation between some characters studied in grain sorghum.

Character	r value				
	Plant hight (cm)	Head length (cm)	Head width (cm)	Head index (cm)	Head weight (gm)
Seed weight per plant	+0.214	+0.067	+0.315	+0.347	+0.659*

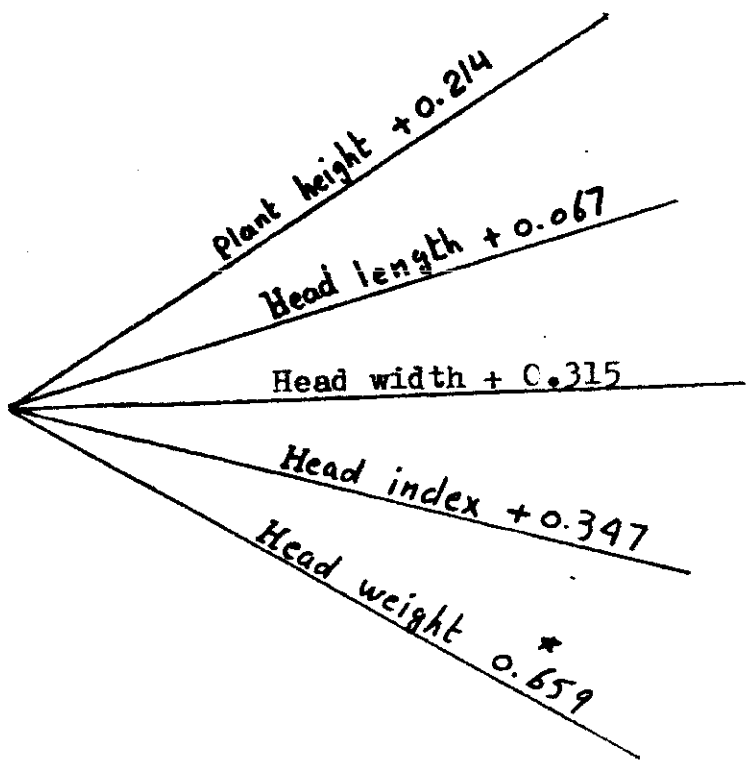

Fig. (1): Correlation coefficients between some characters studied in grain sorghum