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ESTIMATION OF HETEROSIS AND INBREEDING DEPRESSION IN 4 BARLEY UNDER NORMAL AND WATER STRESS CONDITIONS.

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ABSTRACT: *The objective of the present investigation was to estimate heterosis and inbreeding depression controlling the agronomic traits and yield and its components of 4 barley crosses, by means of the six populations (P_1, P_2, F_1, F_2, BC_1 and BC_2) of the four barley crosses. Results revealed that, positive heterotic effects relative to the mid parent and better parent were found for most of the studied traits under both conditions. Generally, the most promising crosses were the two crosses 2 and 4, were found to be higher in magnitude, which will be interest in breeding programs for improving the most studied traits in barley.*

Key words: *Barley, heterosis, inbreeding depression.*

INTRODUCTION

Barley (*Hordeum vulgare* L.) is as ancient as the origin of agriculture itself. The antiquity of barley is documented to periods of 5000 to 7000 B.C or earlier. It is said that barley is the most widely adapted of all grains. It is more tolerant to drought and to saline and alkaline soils than other cereals. Like other cereals it has utility as a feed and food grain, and since ancient times it has been the preferred grain in preparing malt and as a starch source for alcoholic beverages. Its largest use for animal feed. Barley is the world's fourth most important crop, the fourth ranking cereal in the USA and the second ranking cereal in Canada and some other countries.

In Egypt barley is one of the most important winter cereal crops grown mainly in rainfed areas where limited water supply is a feature such as in the Northwest Coastal region and North of Sinai, also grow over wide range of soil variability and under many diverse climatic conditions compared with many other grain crops. So, it can be grown in irrigated saline lands and poor soil conditions. It has also been grown in the newly reclaimed lands and the old ones. In this respect, Katta *et al.* (2009) and Amer (2010), reported the possibility of developing some barley genotypes combining high yield potential under a wide range of environmental stresses.

Therefore, the main objective of this study included the induction of new promising barley genotypes that are able to produce high yield and are more tolerant to water stress condition.

MATERIALS AND METHODS

The experimental material comprised four parental varieties of barley based on their variability under drought stress to obtain the following four crosses; cross 1 (Giza 126 x Giza 129); cross 2 (Giza 126 x Giza 131); cross 3 (Giza 131 x Giza 129) and (CC89 x Giza 131). Pedigree of parental genotypes is given in Table (1).

The present study was carried out at the Experimental Farm of Sakha Agricultural Research Station, Kafr El-Sheikh Governorate, Egypt, during the three growing seasons of 2013/14, 2014/15 and 2015/16. In 2013/14 season, the parental genotypes were crossed to obtain the hybrid grains. In 2014/15 season, the hybrid grains of the four crosses were sown to give F_1 plants, at the same time, these plants were selfed to produce F_2 and some of F_1 plants of each cross were backcrossed to each of the two parents to produce the two backcrosses (BC_1 and BC_2), at the same time the crosses were made again between the parents of each cross to obtain enough F_1 grains. In 2015/16 season, the basic generation (P_1, P_2, F_1, F_2, BC_1 and BC_2) of the four crosses were sown in a randomized complete blocks design with three replications under normal (three irrigation after sowing; irrigation at tillering, at elongation and at heading stage (favorable condition)) and water stress condition (sowing irrigation only). There was three rows for each of P_1,P_2 and F_1 generation , seven rows for each of BC_1, BC_2 and twenty five rows for the F_2 generation. Row was 1.5m in length, 30 cm. apart and 15 cm. between grains within a row. Data were recorded on 30, 30, 300 and 75 plants were selected at random for both parents, F_1, F_2 and backcrosses of each cross.

The amount of irrigation water supplied and total rainfall in m^3/fad* for different treatments are presented in Table (2). Monthly mean air temperature, mean relative humidity and rainfall (mm/month) in winter season of 2015/16 at experimental site are presented in Table (3).

Table (1): Name, pedigree, origin and degree of drought tolerance of four barley genotypes.

No.	Genotypes	Pedigree	*Origin*	drought tolerance
1	Giza 126	BaladiBahteem/SD729-por12762-Bc	Local variety (Egypt)	T
2	*Giza 129*	*Deir Alla 106/Cel//As46/Aths*2*	Local variety (Egypt	S
3	*Giza 131*	*CM67-B/CENTENO//CAM-B/3/ROW906.73 /4 / GLORIA-BAR/COME-B/5/ FALCON –BAR /6/ LINO*	Local variety (Egypt	T
4	*CC 89*	*Panniy/Salmas/5/Baca"s"/3/AC253//CI08887/CI0 5761/4/JLB70-01*	ICARDA	S

Tolerant (T), Sensitive (S)

Table (2): Amount of irrigation water supplied and total rainfall in m^3/fed for different treatments.

Treatment	water applied (m^3/ fad) at				Total irrigation, (m^3/ fad)	Rainfall, (m^3/ fad)	Total water (m^3/ fad)
	Sowing	II	III	VI			
T1 (normal)	550	221.6	340.8	378	1490.4	84.21	1574.61
T 2 (stress)	550	-	-	-	550	84.21	634.21

* Fadden (fad.) = 4200 m^2

Table (3): Monthly mean air temperature (C°), mean relative humidity (RH %) and rainfall (mm/month) in winter season of 2015/16 at Sakha site.

Months		Temperature (C°)		RH%	Rainfall (mm)
		maximum	minimum		
December, 2015	(1-15)	18.66	8.6	77.23	22.35
	(16-31)	18.88	8.1	77.20	2.65
January, 2016	(1-15)	19.65	6.98	76.60	21.46
	(16-31)	18.01	5.84	75.47	24.55
February, 2016	(1-15)	21.49	8.68	48.9	0.00
	(16-28)	24.51	10.66	67.7	0.00
March, 2016	(1-15)	25.65	11.75	73.46	10.70
	(16-31)	22.81	11.57	71.6	2.50
April, 2016	(1-15)	28.29	17.88	64.86	0.00
	(16-31)	31.21	19.94	58.76	0.00
May, 2016	(1-15)	32.35	23.21	58.7	0.00
	(16-31)	29.44	23.07	59.3	0.00

*Sakha Agric. Res. Station, Egypt.

The data were collected on the basis of individual plant for days to heading, days to maturity, grain filling period, grain filling rate, plant height, spike length, peduncle length, number of tillers, number of spikes per plant, number of grains per spike, grains weight per spike 100-grain weight, biological yield per plant and grain yield per plant. The growing conditions were identical for all the six generations followed by the standard practices.

Statistical and genetic analysis:

Heterosis was calculated as the deviation of F_1 mean from the mid-parent and better parent values and expressed in percentage according to Mather and Jinks (1982). Inbreeding depression was calculated as the difference between the F_1 and F_2 means as a percentage of F_1. The "t" test was used to determine the significance of these deviations where the standard error (SE) was calculated as follows:

SE for mid parental heterosis ($\bar{F}_1 - \overline{MP}$)= $(V_{\bar{F}1} + \frac{1}{4} V_{\bar{P}2} + \frac{1}{4} V_{\bar{P}2})^{\frac{1}{2}}$

SE for better parental heterosis ($\bar{F}_1 - \overline{BP}$)= $(V_{\bar{F}1} + V_{\overline{BP}})^{\frac{1}{2}}$

SE for inbreeding depression ($\bar{F}_1 - \bar{F}_2$)= $(V_{\bar{F}1} + V_{\bar{F}2})^{\frac{1}{2}}$

where, the t is the deviation/SE at the corresponding degrees of freedom.

Simth (1952) proposed the following equation to determine potence ratio (P), which can be defined as follows:

$P = \bar{F}_1 - \overline{MP} / \frac{1}{2}(\bar{P}_1 - \bar{P}_2)$

Where,

($\bar{F}_1$) first generation mean, ($\bar{P}_1$) the mean of the largest parent, ($\bar{P}_2$) the mean of the smallest parent and ($\overline{MP}$) mid-parent value.

RESULTS AND DISCUSSION

Mean and variance of mean:

Mean and variance of mean for the studied traits in the four crosses for six populations P_1, P_2, F_1, F_2, BC_1 and BC_2 under two conditions of irrigation are presented in Tables (4 a-e) . These data were used to calculate the scalling test and six parameters as Gamble (1962) procedure.

Analysis of variance indicted significant differences among generations in all traits under this study. The results revealed that, generation means decreased under stress than in normal and significantly different for all the studied traits in all crosses towards earliness for heading, maturity and grain filling period, except for grain yield/plant in the P_1 of the third cross. Amer (2011) found that mean performance was decreased significantly under stress than normal condition. The F_1 mean values exceeded the mid values of the two parental means for most of the studied traits in the four crosses under both conditions. The F_2 population mean performance values were intermediate between the two parents and less than F_1 mean performance values for grain yield and its components under normal irrigation and water stress conditions. However, the two populations (BC_1 and BC_2) mean performance values varied under the two irrigation treatments and each trait tended toward the mean of its recurrent parent. These results agreed with those obtained by El-Sayed (2007) and El-Shawy (2008).

Heterosis and inbreeding depression:

Heterosis percent, potence ratio and inbreeding depression for all studied traits in the four crosses are presented in Tables (5 a - b).

In self – pollinated crops such as barley, plant breeders have been investigated the possibility of developing hybrid cultivars. Thus, the utilization of heterosis in various crops overall the world has tremendously increased the production either for human food or livestock feed. Heterosis is a complex phenomenon which depends on the balance of different combinations of genotypic effect as well as the distribution of plus or minus alleles in parents.

Heterosis is expressed as the percentage deviation of F_1 mean performance from the mid parent or better parent of the trait. High positive values of heterosis would be of interest for most traits under investigation, however, for days to heading, days to maturity and grain filling period, negative values would be of value from the barley breeders point of view, either by producing early mature cultivars to be used in case of intensive agricultural rotation and to make barley plants evading unfavorable weather conditions and disease infection.

For earliness (days to heading, maturity and grain filling period), highly significant negative desirable heterotic effects over mid and better parent were detected in the fourth cross (CC89 x Giza 131) under both conditions and in the second and the third crosses (Giza 126 x Giza 131) and (Giza 131 x Giza 129), respectively under normal condition for days to heading. However, over-dominance (PR > -1) was responsible for such heterosis in all cases. Moreover, mid-prent heterosis was highly significant in the third cross for days to maturity and grain filling period under both conditions and in the first cross for days to maturity at stress condition, as a result of partial dominance (PR < -1). El-Bawab (2003), Eid (2006), El-Shawy (2008), Khattab *et al*. (2010), El-Akhdar (2011) and Mohamed (2014) found that the heterotic effect for days to 50% flowering was more affected by over-dominance. While, El-Bawab (2003) found significant negative heterotic effect for maturity date.

The first, the second and the fourth crosses gave highly significant positive heterotic effects over mid and better parent under both condition for grain filling rate a result of *over*- dominance in all cases, except for the third cross under normal condition due to partial dominance (PR < +1) Meanwhile, the third cross (Giza 131 x Giza 129) under normal condition showed highly significant positive heterotic effects relative to mid parent, where partial dominance was existed.

Table (4 -a): Mean ($\bar{X}$), variance (s^2) and variance of mean ($S^2_{\bar{X}}$) of P_1, P_2, F_1, F_2, BC_1 and BC_2 populations of four crosses for days to heading, days to maturity, grain filling period and filling rate under normal and water stress conditions.

Traits	Crosses	Statistical Parameter	Normal						stress					
			P_1	P_2	F_1	F_2	BC_1	BC_2	P_1	P_2	F_1	F_2	BC_1	BC_2
Days to heading (day)	1	$\bar{X}$	83.90	85.20	86.20	85.72	81.48	86.79	80.00	82.70	84.10	81.24	79.85	82.04
		S^2	0.51	0.37	0.37	20.11	16.71	16.22	0.62	0.63	0.51	22.63	16.69	13.36
		$S^2_{\bar{X}}$	0.02	0.01	0.01	0.07	0.22	0.22	0.02	0.02	0.02	0.08	0.22	0.18
	2	$\bar{X}$	83.90	85.30	82.30	81.52	79.57	80.24	80.20	79.90	80.70	77.70	83.79	81.57
		S^2	0.51	0.42	0.42	17.59	10.68	14.83	0.58	0.30	0.63	17.17	10.63	13.00
		$S^2_{\bar{X}}$	0.02	0.01	0.01	0.06	0.14	0.20	0.02	0.01	0.02	0.06	0.14	0.17
	3	$\bar{X}$	85.60	85.10	82.70	83.32	82.88	84.83	80.40	82.80	82.00	80.47	82.53	84.91
		S^2	0.46	0.51	0.29	19.97	18.89	14.90	0.46	0.58	0.76	27.64	14.33	24.44
		$S^2_{\bar{X}}$	0.02	0.02	0.01	0.07	0.25	0.20	0.02	0.02	0.03	0.09	0.19	0.33
	4	$\bar{X}$	83.90	85.10	81.00	81.32	79.88	85.12	78.30	80.00	76.80	80.85	80.07	84.84
		S^2	0.51	0.30	0.62	29.72	22.67	20.76	0.22	0.41	0.79	23.71	11.50	19.62
		$S^2_{\bar{X}}$	0.02	0.01	0.02	0.10	0.30	0.28	0.01	0.01	0.03	0.08	0.15	0.26
Days to maturity (day)	1	$\bar{X}$	119.17	114.47	121.27	117.88	120.49	116.67	117.50	113.50	114.80	115.85	115.80	115.50
		S^2	0.63	0.81	0.75	12.39	10.23	10.14	0.47	0.50	0.58	6.37	4.44	5.64
		$S^2_{\bar{X}}$	0.02	0.03	0.03	0.04	0.14	0.14	0.02	0.02	0.02	0.02	0.06	0.08
	2	$\bar{X}$	119.23	116.63	121.33	117.63	118.69	118.88	117.70	115.80	117.10	115.33	116.83	116.80
		S^2	0.67	0.79	0.85	10.04	7.76	9.05	0.49	0.62	0.30	9.01	8.01	6.72
		$S^2_{\bar{X}}$	0.02	0.03	0.03	0.03	0.10	0.12	0.02	0.02	0.01	0.03	0.11	0.09
	3	$\bar{X}$	118.07	114.20	115.00	116.13	117.61	115.08	117.07	113.50	114.50	114.95	114.43	113.80
		S^2	0.62	0.65	0.83	8.12	6.29	6.91	0.55	0.28	0.47	6.47	4.81	5.41
		$S^2_{\bar{X}}$	0.02	0.02	0.03	0.03	0.08	0.09	0.02	0.01	0.02	0.02	0.06	0.07
	4	$\bar{X}$	118.03	116.53	115.30	116.24	117.32	117.84	116.57	115.30	114.37	115.67	115.47	115.53
		S^2	0.72	0.81	0.56	7.44	5.22	6.19	0.60	0.68	0.52	6.26	4.40	5.29
		$S^2_{\bar{X}}$	0.02	0.03	0.02	0.02	0.07	0.08	0.02	0.02	0.02	0.02	0.06	0.07
Grain filling period	1	$\bar{X}$	39.40	31.40	37.17	34.38	40.84	34.63	37.50	30.80	30.70	32.04	35.71	34.03
		S^2	1.14	1.28	2.07	27.07	23.60	21.37	0.88	0.79	1.04	25.79	22.80	20.24
		$S^2_{\bar{X}}$	0.04	0.04	0.07	0.09	0.31	0.28	0.03	0.03	0.03	0.09	0.30	0.27
	2	$\bar{X}$	39.00	36.60	40.80	37.78	36.07	37.67	37.70	35.60	36.20	35.82	33.08	35.29
		S^2	1.24	1.49	1.61	26.44	21.74	23.04	1.04	0.87	1.20	25.60	20.02	21.48
		$S^2_{\bar{X}}$	0.04	0.05	0.05	0.09	0.29	0.31	0.03	0.03	0.04	0.09	0.27	0.29
	3	$\bar{X}$	37.90	31.70	33.00	35.01	35.08	30.29	36.20	30.77	32.47	32.81	31.81	29.57
		S^2	1.54	1.87	1.59	33.59	25.34	27.70	1.27	1.50	0.74	28.10	23.26	25.95
		$S^2_{\bar{X}}$	0.05	0.06	0.05	0.11	0.34	0.37	0.04	0.05	0.02	0.09	0.31	0.35
	4	$\bar{X}$	40.20	36.50	34.77	34.76	40.45	32.72	38.07	35.50	33.60	34.76	34.01	31.36
		S^2	1.06	1.71	2.05	35.58	27.31	26.93	0.75	1.29	1.70	29.05	25.36	23.99
		$S^2_{\bar{X}}$	0.04	0.06	0.07	0.12	0.36	0.36	0.03	0.04	0.06	0.10	0.34	0.32
Grain filling rate	1	$\bar{X}$	0.58	0.76	0.95	0.46	0.64	0.59	0.52	0.54	0.94	0.50	0.45	0.60
		S^2	0.001	0.004	0.003	0.066	0.040	0.059	0.002	0.007	0.008	0.098	0.067	0.069
		$S^2_{\bar{X}}$	0.0003	0.0001	0.0001	0.0002	0.0005	0.0007	0.0006	0.0002	0.0002	0.0003	0.0009	0.0009
	2	$\bar{X}$	0.79	0.77	1.13	0.69	0.75	0.67	0.67	0.61	0.82	0.49	0.54	0.67
		S^2	0.002	0.004	0.005	0.077	0.056	0.052	0.004	0.005	0.006	0.089	0.066	0.073
		$S^2_{\bar{X}}$	0.0006	0.0001	0.0001	0.0002	0.0007	0.0006	0.0001	0.0001	0.0002	0.0002	0.0008	0.0009
	3	$\bar{X}$	1.15	0.63	1.01	0.74	0.97	0.71	0.94	0.40	0.38	0.58	0.59	0.61
		S^2	0.01	0.01	0.005	0.10	0.07	0.07	0.004	0.005	0.006	0.091	0.082	0.059
		$S^2_{\bar{X}}$	0.0003	0.0003	0.0001	0.0003	0.0009	0.0009	0.0001	0.0001	0.0002	0.0003	0.001	0.0007
	4	$\bar{X}$	0.59	0.89	0.94	0.85	0.62	0.73	0.46	0.62	0.66	0.84	0.65	0.64
		S^2	0.002	0.005	0.007	0.092	0.058	0.069	0.003	0.004	0.008	0.105	0.075	0.077
		$S^2_{\bar{X}}$	0.0006	0.0001	0.0002	0.0003	0.0007	0.0009	0.0001	0.0001	0.0002	0.0003	0.001	0.001

Cross 1 (Giza 126 x Giza 129), Cross2 (Giza 126 x Giza 131), Cross 3 (Giza 131 x Giza 129) and cross 4 (CC89 x Giza131)

Table (4-b): Mean ($\bar{X}$), variance (s^2) and variance of mean (($S^2_{\bar{x}}$) of P_1, P_2, F_1, F_2, BC_1 and BC_2 populations of four crosses for plant height, spike length, peduncle length and number of tillers/ plant under normal and water tress conditions.

Traits	Crosses	Statistical Parameter	Normal						stress					
			P_1	P_2	F_1	F_2	BC_1	BC_2	P_1	P_2	F_1	F_2	BC_1	BC_2
Plant height (cm)	1	$\bar{X}$	99.20	101.80	102.10	100.28	96.84	98.89	98.50	99.70	101.10	100.77	93.84	98.20
		S^2	2.44	5.13	4.44	68.66	60.22	53.61	13.91	2.08	2.58	84.77	69.43	70.22
		$S^2_{\bar{x}}$	0.08	0.17	0.15	0.23	0.80	0.71	0.46	0.07	0.09	0.28	0.93	0.94
	2	$\bar{X}$	98.70	102.50	106.90	105.29	103.25	103.71	97.50	96.40	105.60	104.14	93.20	96.79
		S^2	6.42	4.60	5.47	67.69	58.35	57.18	4.19	13.08	7.70	77.98	63.76	62.25
		$S^2_{\bar{x}}$	0.21	0.15	0.18	0.23	0.78	0.76	0.14	0.44	0.26	0.26	0.85	0.83
	3	$\bar{X}$	100.40	100.00	103.90	101.35	95.37	102.57	98.90	98.10	100.80	99.55	94.21	86.92
		S^2	18.87	15.93	13.33	132.77	110.59	118.25	8.58	8.16	9.27	100.78	85.93	92.56
		$S^2_{\bar{x}}$	0.63	0.53	0.44	0.44	1.47	1.58	0.29	0.27	0.31	0.34	1.15	1.23
	4	$\bar{X}$	103.70	103.00	104.30	103.19	99.33	102.87	98.00	98.70	103.20	101.77	93.80	100.53
		S^2	4.77	3.72	3.73	59.04	49.93	48.52	9.72	7.87	3.89	128.43	106.81	98.85
		$S^2_{\bar{x}}$	0.16	0.12	0.12	0.20	0.67	0.65	0.32	0.26	0.13	0.43	1.42	1.32
Spike length (cm)	1	$\bar{X}$	7.60	8.50	10.40	9.62	8.04	8.22	6.50	7.20	9.50	7.02	7.83	7.41
		S^2	0.25	0.26	0.25	2.86	2.07	2.36	0.26	0.17	0.26	3.17	2.36	2.66
		$S^2_{\bar{x}}$	0.01	0.01	0.01	0.01	0.03	0.03	0.01	0.01	0.01	0.01	0.03	0.04
	2	$\bar{X}$	7.70	9.87	10.30	8.42	9.57	8.57	7.20	6.60	9.70	8.09	8.88	8.70
		S^2	0.22	0.19	0.22	2.95	1.98	2.30	0.17	0.25	0.22	2.91	2.32	1.97
		$S^2_{\bar{x}}$	0.01	0.01	0.01	0.01	0.03	0.03	0.01	0.01	0.01	0.01	0.03	0.03
	3	$\bar{X}$	10.63	10.67	11.60	9.82	10.16	9.91	9.50	9.33	10.47	9.51	9.08	9.80
		S^2	0.24	0.23	0.25	1.69	1.33	1.16	0.26	0.23	0.26	1.62	1.45	1.10
		$S^2_{\bar{x}}$	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.02	0.01
	4	$\bar{X}$	7.63	10.30	11.50	9.36	8.09	9.08	7.40	9.60	10.70	8.88	7.23	8.04
		S^2	0.24	0.22	0.26	2.28	1.71	1.83	0.25	0.25	0.22	2.88	1.91	2.18
		$S^2_{\bar{x}}$	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.03	0.03
Peduncle Length (cm)	1	$\bar{X}$	26.10	24.60	33.20	24.27	28.81	24.17	22.80	18.40	23.50	22.34	22.08	20.00
		S^2	1.33	1.08	1.20	16.75	16.37	14.69	1.41	1.28	0.88	17.46	14.18	13.92
		$S^2_{\bar{x}}$	0.04	0.04	0.04	0.06	0.22	0.20	0.05	0.04	0.03	0.06	0.19	0.19
	2	$\bar{X}$	29.80	27.80	33.60	32.03	25.47	31.27	26.00	27.00	29.70	26.58	26.32	27.44
		S^2	0.99	1.20	1.28	27.54	19.06	21.85	1.45	1.45	1.25	22.38	19.87	15.14
		$S^2_{\bar{x}}$	0.03	0.04	0.04	0.09	0.25	0.29	0.05	0.05	0.04	0.07	0.26	0.20
	3	$\bar{X}$	25.20	23.50	29.30	24.79	25.72	25.32	23.30	22.10	27.20	23.03	25.45	23.01
		S^2	0.99	0.88	1.25	29.72	29.91	20.82	1.04	1.13	1.41	18.22	17.36	11.26
		$S^2_{\bar{x}}$	0.03	0.03	0.04	0.10	0.40	0.28	0.03	0.04	0.05	0.06	0.23	0.15
	4	$\bar{X}$	26.40	28.90	31.70	30.03	26.61	29.88	23.40	26.80	27.40	25.56	25.23	27.59
		S^2	0.46	1.33	1.04	30.53	24.29	25.08	1.49	0.99	1.70	27.86	13.15	18.79
		$S^2_{\bar{x}}$	0.02	0.04	0.03	0.10	0.32	0.33	0.05	0.03	0.06	0.09	0.18	0.25
Number of tillers/ plant	1	$\bar{X}$	21.50	19.40	23.80	20.84	17.20	18.72	9.70	17.80	18.50	11.80	10.64	14.19
		S^2	2.12	1.08	1.20	38.32	26.59	30.10	2.91	1.20	1.71	25.06	20.02	19.99
		$S^2_{\bar{x}}$	0.07	0.04	0.04	0.13	0.35	0.40	0.10	0.04	0.06	0.08	0.27	0.27
	2	$\bar{X}$	21.10	17.40	25.80	22.34	17.92	23.19	15.30	14.20	17.00	16.77	16.52	18.63
		S^2	1.54	2.32	1.82	83.36	57.16	67.32	1.04	1.61	1.03	14.69	12.50	11.51
		$S^2_{\bar{x}}$	0.05	0.08	0.06	0.28	0.76	0.90	0.03	0.05	0.03	0.05	0.17	0.15
	3	$\bar{X}$	23.70	17.40	24.60	18.41	21.80	14.99	17.50	14.60	14.40	11.68	14.00	10.65
		S^2	2.70	3.14	1.70	81.75	64.30	72.85	1.71	1.28	1.70	22.31	21.32	19.50
		$S^2_{\bar{x}}$	0.09	0.10	0.06	0.27	0.86	0.97	0.06	0.04	0.06	0.07	0.28	0.26
	4	$\bar{X}$	20.50	18.10	21.10	19.13	23.00	18.48	17.40	17.30	20.60	18.15	19.16	16.37
		S^2	2.53	1.75	1.75	61.74	54.24	50.25	3.35	4.98	1.90	43.09	37.51	35.48
		$S^2_{\bar{x}}$	0.08	0.06	0.06	0.21	0.72	0.67	0.11	0.17	0.06	0.14	0.50	0.47

Cross 1 (Giza 126 x Giza 129), Cross2 (Giza 126 x Giza 131), Cross 3 (Giza 131 x Giza 129) and cross 4 (CC89 x Giza131)

Table (4-c): Mean ($\bar{X}$), variance (s^2) and variance of mean ($S^2_{\bar{x}}$) of P_1, P_2, F_1, F_2, BC_1 and BC_2 populations of four crosses for number of spike/ plant, number of grains/ plant, grains weight/ spike and 100-grains weight under normal and water stress conditions.

Traits	Crosses	Statistical Parameter	Normal						stress					
			P_1	P_2	F_1	F_2	BC_1	BC_2	P_1	P_2	F_1	F_2	BC_1	BC_2
Number of spikes / plant (spike)	1	$\bar{X}$	15.50	16.60	19.30	17.28	13.64	17.80	8.30	14.00	14.50	13.53	8.08	12.51
		S^2	1.91	0.87	1.04	23.18	14.99	20.89	1.25	1.86	1.50	19.98	18.32	16.33
		$S^2_{\bar{x}}$	0.06	0.03	0.03	0.08	0.20	0.28	0.04	0.06	0.05	0.07	0.24	0.22
	2	$\bar{X}$	14.90	16.00	18.40	16.47	14.00	16.00	12.50	14.20	15.90	13.89	11.32	14.07
		S^2	4.02	4.14	4.80	45.32	33.97	35.73	2.33	0.99	1.13	13.22	10.68	11.25
		$S^2_{\bar{x}}$	0.13	0.14	0.16	0.15	0.45	0.48	0.08	0.03	0.04	0.04	0.14	0.15
	3	$\bar{X}$	20.30	16.20	25.90	19.54	18.84	15.73	16.60	14.20	20.40	17.19	15.88	13.83
		S^2	2.70	2.86	2.58	41.03	27.22	32.04	1.70	1.41	2.32	21.89	20.94	13.04
		$S^2_{\bar{x}}$	0.09	0.10	0.09	0.14	0.36	0.43	0.06	0.05	0.08	0.07	0.28	0.17
	4	$\bar{X}$	15.20	15.90	19.40	16.71	14.68	16.76	10.70	13.70	15.00	14.52	12.04	14.65
		S^2	2.44	1.75	1.49	37.83	29.90	28.73	2.08	1.87	1.66	22.81	21.04	17.18
		$S^2_{\bar{x}}$	0.08	0.06	0.05	0.13	0.40	0.38	0.07	0.06	0.06	0.08	0.28	0.23
Number of grains / spike (grain)	1	$\bar{X}$	67.40	63.90	73.90	71.53	67.28	61.36	65.07	61.40	71.10	68.43	64.83	59.37
		S^2	7.42	16.44	7.33	157.13	113.88	123.88	4.34	14.32	5.06	143.36	120.17	102.37
		$S^2_{\bar{x}}$	0.25	0.55	0.24	0.52	1.52	1.65	0.14	0.48	0.17	0.48	1.60	1.36
	2	$\bar{X}$	67.47	65.80	68.10	66.55	65.43	64.21	60.80	64.90	67.70	65.85	58.12	63.04
		S^2	8.12	5.96	4.85	153.22	122.65	129.47	5.89	9.61	13.87	156.71	125.51	122.66
		$S^2_{\bar{x}}$	0.27	0.20	0.16	0.51	1.64	1.73	0.20	0.32	0.46	0.52	1.67	1.64
	3	$\bar{X}$	69.73	64.70	73.60	71.55	66.99	61.92	58.40	61.70	68.40	63.74	57.67	60.48
		S^2	7.24	6.01	9.35	136.32	103.12	110.75	9.77	7.25	5.42	130.50	102.06	105.31
		$S^2_{\bar{x}}$	0.24	0.20	0.31	0.45	1.37	1.48	0.33	0.24	0.18	0.44	1.36	1.40
	4	$\bar{X}$	64.53	65.60	69.40	66.99	63.79	60.36	60.07	64.30	68.50	61.07	57.87	58.48
		S^2	10.19	6.87	14.32	155.20	105.87	127.69	4.96	6.42	3.16	139.65	110.82	107.06
		$S^2_{\bar{x}}$	0.34	0.23	0.48	0.52	1.41	1.70	0.17	0.21	0.11	0.47	1.48	1.43
grains weight/ spike (gm)	1	$\bar{X}$	3.22	2.47	4.11	3.84	3.04	2.90	2.96	2.11	3.29	2.89	2.96	2.45
		S^2	0.04	0.03	0.05	0.74	0.55	0.55	0.05	0.01	0.05	0.74	0.55	0.55
		$S^2_{\bar{x}}$	0.001	0.001	0.002	0.002	0.007	0.007	0.002	0.0003	0.002	0.002	0.007	0.007
	2	$\bar{X}$	3.28	3.39	4.06	3.61	3.31	3.35	2.66	3.01	3.62	2.82	2.41	3.07
		S^2	0.02	0.06	0.01	1.00	0.87	0.79	0.06	0.04	0.04	0.74	0.50	0.54
		$S^2_{\bar{x}}$	0.001	0.002	0.0005	0.003	0.012	0.011	0.002	0.001	0.001	0.002	0.007	0.007
	3	$\bar{X}$	3.03	2.60	3.48	2.87	3.32	2.89	2.84	2.57	3.01	2.68	2.48	2.72
		S^2	0.03	0.04	0.05	0.69	0.46	0.49	0.04	0.06	0.05	0.51	0.35	0.39
		$S^2_{\bar{x}}$	0.001	0.001	0.002	0.002	0.006	0.007	0.001	0.002	0.002	0.002	0.005	0.005
	4	$\bar{X}$	3.72	3.53	4.21	3.94	3.09	2.94	2.89	2.79	3.31	3.08	2.52	2.59
		S^2	0.03	0.05	0.05	0.91	0.50	0.70	0.06	0.03	0.03	1.02	0.71	0.55
		$S^2_{\bar{x}}$	0.001	0.002	0.002	0.003	0.007	0.009	0.002	0.001	0.001	0.003	0.009	0.007
100-grain weight (g)	1	$\bar{X}$	4.76	4.46	5.73	5.16	4.82	4.84	4.62	4.09	5.09	4.89	4.75	4.26
		S^2	0.05	0.03	0.05	1.47	1.06	0.94	0.05	0.02	0.02	0.79	0.52	0.58
		$S^2_{\bar{x}}$	0.002	0.001	0.002	0.005	0.014	0.013	0.002	0.001	0.001	0.003	0.007	0.008
	2	$\bar{X}$	5.03	4.91	6.32	5.47	5.19	5.61	4.58	4.67	5.41	4.86	4.37	4.42
		S^2	0.05	0.05	0.08	1.06	1.01	0.82	0.06	0.05	0.07	1.02	0.50	1.42
		$S^2_{\bar{x}}$	0.002	0.002	0.003	0.004	0.014	0.011	0.002	0.002	0.002	0.003	0.007	0.019
	3	$\bar{X}$	4.86	4.60	6.06	5.21	5.11	4.62	4.59	4.50	4.21	3.88	4.07	3.74
		S^2	0.06	0.08	0.03	1.27	0.91	0.93	0.04	0.04	0.02	0.95	0.73	0.86
		$S^2_{\bar{x}}$	0.002	0.003	0.001	0.004	0.012	0.012	0.001	0.001	0.001	0.003	0.010	0.011
	4	$\bar{X}$	5.21	5.10	5.86	5.34	4.74	5.08	4.73	4.54	5.37	4.95	4.35	4.55
		S^2	0.08	0.05	0.05	1.17	1.00	0.98	0.07	0.02	0.05	1.12	0.94	0.72
		$S^2_{\bar{x}}$	0.003	0.002	0.002	0.004	0.013	0.013	0.002	0.001	0.002	0.004	0.012	0.010

Cross 1 (Giza 126 x Giza 129), Cross2 (Giza 126 x Giza 131), Cross 3 (Giza 131 x Giza 129) and cross 4 (CC89 x Giza)

Table (4-e): Mean ($\bar{X}$), variance (s^2) and variance of mean ($S^2_{\bar{x}}$) of P_1, P_2, F_1, F_2, BC_1 and BC_2 populations of four crosses for biological yield/ plant and grain yield /plant under normal and water stress conditions.

Traits	Crosses	Statistical Parameter	Normal						stress					
			P_1	P_2	F_1	F_2	BC_1	BC_2	P_1	P_2	F_1	F_2	BC_1	BC_2
Biological yield / plant (g)	1	$\bar{X}$	70.39	68.33	77.33	72.11	73.08	66.56	69.25	67.67	70.74	68.11	66.75	61.98
		S^2	4.61	8.90	6.10	86.87	66.33	55.60	5.60	7.63	7.69	80.75	57.01	58.87
		$S^2_{\bar{x}}$	0.15	0.30	0.20	0.29	0.88	0.74	0.19	0.25	0.26	0.27	0.76	0.78
	2	$\bar{X}$	82.93	83.83	85.22	81.26	78.71	80.21	79.87	75.01	80.98	77.79	72.30	73.96
		S^2	5.86	7.72	7.01	83.29	52.45	66.01	6.88	7.17	9.77	81.70	70.38	59.50
		$S^2_{\bar{x}}$	0.20	0.26	0.23	0.28	0.70	0.88	0.23	0.24	0.33	0.27	0.94	0.79
	3	$\bar{X}$	85.27	68.94	86.40	76.57	82.20	63.39	80.08	65.31	81.47	70.35	77.40	60.25
		S^2	6.36	8.28	6.25	75.08	59.22	56.94	7.13	5.79	7.15	78.44	61.97	59.54
		$S^2_{\bar{x}}$	0.21	0.28	0.21	0.25	0.79	0.76	0.24	0.19	0.24	0.26	0.83	0.79
	4	$\bar{X}$	70.37	80.27	88.70	79.26	76.76	75.88	65.64	78.64	82.93	70.57	72.43	62.37
		S^2	7.42	8.58	6.59	75.95	50.98	54.37	7.91	6.23	8.37	80.74	55.30	57.75
		$S^2_{\bar{x}}$	0.25	0.29	0.22	0.25	0.68	0.72	0.26	0.21	0.28	0.27	0.74	0.77
Grain yield / plant (g)	1	$\bar{X}$	22.70	23.95	35.38	15.38	25.83	19.11	19.56	16.60	28.90	20.45	15.69	17.72
		S^2	1.41	3.25	2.30	67.07	62.98	45.38	3.15	5.21	5.72	85.82	65.19	62.66
		$S^2_{\bar{x}}$	0.05	0.11	0.08	0.22	0.84	0.61	0.10	0.17	0.19	0.29	0.87	0.84
	2	$\bar{X}$	30.96	27.97	34.14	25.01	26.72	24.70	25.37	21.74	29.73	23.51	22.57	20.00
		S^2	3.78	3.90	6.54	76.54	64.02	50.64	4.31	5.32	7.65	84.16	65.45	66.20
		$S^2_{\bar{x}}$	0.13	0.13	0.22	0.26	0.85	0.68	0.14	0.18	0.26	0.28	0.87	0.88
	3	$\bar{X}$	29.65	19.94	33.25	24.71	33.44	20.95	34.08	12.38	12.30	18.63	18.39	17.66
		S^2	4.67	4.41	3.85	77.78	66.37	54.37	3.35	3.57	6.83	79.25	67.42	45.91
		$S^2_{\bar{x}}$	0.16	0.15	0.13	0.26	0.88	0.72	0.11	0.12	0.23	0.26	0.90	0.61
	4	$\bar{X}$	23.80	26.39	32.78	28.83	24.39	23.28	20.38	22.08	30.08	25.50	21.40	19.69
		S^2	3.50	4.90	6.87	79.62	63.31	58.41	4.11	5.51	8.40	93.31	64.31	67.92
		$S^2_{\bar{x}}$	0.12	0.16	0.23	0.27	0.84	0.78	0.14	0.18	0.28	0.31	0.86	0.91

Cross 1 (Giza 126 x Giza 129), Cross2 (Giza 126 x Giza 131), Cross 3 (Giza 131 x Giza 129) and cross 4 (CC89 x Giza131)

For plant height, the data presented in Table 5-a indicated that, the second and the third crosses exposed highly significant mid and better parental heterosis due to over-dominance (PR > +1) under both conditions, while the first and the fourth crosses revealed highly significant mid and better parental heterosis under water stress condition and significant or highly significant over mid parent heterosis under normal condition a result of over-dominance in all cases.

The data in Table 5-a and Table 5-b pointed out that, the first, the second, the third and the fourth crosses revealed highly significant mid and better parental heterosis for spike length, peduncle length and no.of grains and weight per spike under both conditions due to over – dominance,in all crosses for the traits in consideration, with few exceptions i.e, mid parental heterosis under normal condition; better parent heterosis at stress condition in the first cross and better parent heterosis in the fourth cross under stress condition for peduncle length, where this values were only significant. Moreover, in the case of better parent heterosis at normal condition for no.of grains/spike where the heterotic effect did·nt reach to the level of significant.

Table (5-a) : Heterosis, potence ratio and inbreeding depression in four crosses for days to heading, days to maturity, filling period, filling rate, plant height, spike length, peduncle length, number of tillers/ plant and number of spike/ plant, under normal and water stress conditions.

Traits	Crosses	Normal				Stress			
		Heterosis		Heterosis		Heterosis		Hetrosis	
		MP	PR	BP	ID%	MP	PR	BP	ID%
Days to heading	1	1.95**	2.54	2.74**	0.56	3.38**	2.04	5.12**	3.40**
	2	-2.72**	-3.29	-1.91**	0.95**	0.81**	4.33	1.00**	3.72**
	3	-3.10**	-10.60	-2.82**	-0.75*	0.49*	0.33	1.99**	1.87**
	4	-4.14**	-5.83	-3.46**	-0.40	-2.97**	-2.76	-1.92**	-5.27**
Days to maturity	1	3.81**	1.89	5.94**	2.80**	-0.61**	-0.35	1.15**	-0.91**
	2	2.88**	2.62	4.03**	3.05**	0.30*	0.37	1.12**	1.51**
	3	-0.97**	-0.58	0.70**	-0.98**	-0.68**	-0.44	0.88**	-0.39*
	4	-1.69**	-2.64	-1.06**	-0.82**	-1.35**	-2.46	-0.81**	-1.14**
Grain filling period	1	5.00**	0.44	18.38**	7.51**	-10.10**	-1.03	-0.32	-4.36**
	2	7.94**	2.50	11.48**	7.40**	-1.23	-0.43	1.69*	1.05
	3	-5.17**	-0.58	4.10**	-6.09**	-3.02**	-0.37	5.52**	-1.05
	4	-9.34**	-1.94	-4.74**	0.03	-8.65**	-2.47	-5.35**	-3.45**
Grain filling rate	1	41.79**	3.11	25.00**	51.58**	77.36**	41.00	74.07**	46.81**
	2	44.87**	35.00	43.04**	38.94**	28.13**	6.00	22.39**	40.24**
	3	13.48**	0.46	-12.17**	26.73**	-43.28**	-1.07	-59.57**	-52.63**
	4	27.03**	1.33	5.62*	9.57**	22.22**	1.50	6.45*	-27.27**
Plant height	1	1.59**	1.23	0.29	1.78**	202**	3.33	1.4**	0.33
	2	6.26**	3.32	4.29**	1.51*	8.92**	15.73	8.31**	1.38*
	3	3.69**	18.50	3.49**	2.45**	2.34**	5.75	1.92*	1.24
	4	0.92**	2.71	0.58	1.08	4.93**	13.86	4.56**	1.39
Spike length	1	29.19**	5.22	22.35**	7.50**	38.69**	7.57	31.94**	26.11**
	2	17.31**	1.40	4.36**	18.25**	40.58**	9.33	34.72**	16.60**
	3	8.92**	47.50	8.72**	15.34**	11.15**	12.35	10.21**	9.17**
	4	28.21**	1.90	11.65**	18.61**	25.88**	2.00	11.46**	17.01**
Peduncle Length	1	30.97*	10.47	27.20**	26.90**	14.08**	1.32	3.07*	4.94**
	2	16.67**	4.80	12.75**	4.67**	12.08**	-6.40	10.00**	10.51**
	3	20.33**	5.82	16.27**	15.39**	19.82**	7.50	16.74**	15.33**
	4	14.65**	-3.24	9.69**	5.27**	9.16**	-1.35	2.24*	6.72**
Number of tillers / plant	1	16.38**	3.19	10.70**	12.44**	34.55**	1.17	3.93*	36.24**
	2	34.03**	3.54	22.27**	13.41**	15.25**	4.09	11.11**	1.35
	3	19.71**	1.29	3.80*	25.16**	-10.28**	-1.14	-17.71**	18.89**
	4	9.33**	1.50	2.93	9.34**	18.73**	65.00	18.39**	11.89**
Number of spikes / plant	1	20.25**	5.91	16.27**	10.47**	30.04**	1.18	3.57	6.69**
	2	19.09**	5.36	15.00**	10.49**	19.10**	3.00	11.97**	12.64**
	3	41.92**	3.73	27.59**	24.56**	32.47**	4.17	22.89**	15.74**
	4	24.76**	11.00	22.01**	13.87**	22.95**	1.87	9.49**	3.20

(*) and (**) significant at 0.05 and 0.01 levels probability, respectively.

Cross 1 (Giza 126 x Giza 129), Cross2 (Giza 126 x Giza 131), Cross 3 (Giza 131 x Giza 129) and cross 4 (CC89 x Giza131)

Table (5-b) : Heterosis, potence ratio and inbreeding depression in four crosses for number of grains/ plant, grains weight/ spike, 100- grains weight, biological yield/ plant and grain yield/ plant under normal and water stress conditions.

Traits	Crosses	Normal				Stress			
		Heterosis MP	PR	Heterosis BP	ID%	Heterosis MP	PR	Hetrosis BP	ID%
Number of grains / spike	1	12.57**	4.71	9.64**	3.21	12.45**	4.29	9.27**	3.76
	2	2.20**	1.76	0.93	2.28	7.72**	2.37	4.31**	2.73
	3	9.49**	2.54	5.55**	2.79	13.91**	5.06	10.86**	6.82
	4	6.65**	8.13	5.79**	3.47	10.16**	2.99	6.53**	10.85
grains weight/ spike	1	44.72**	3.39	27.64**	6.57**	29.53**	1.76	11.15**	12.16**
	2	21.92**	13.27	19.76**	11.08**	27.92**	4.51	20.27**	22.10**
	3	23.84**	3.05	14.85**	17.53**	11.48**	2.30	5.99**	10.96**
	4	15.98**	6.11	13.17**	6.41**	16.55**	9.40	14.53**	6.65**
100- grain weight	1	24.30**	7.47	20.38**	9.95**	16.74**	2.75	10.17**	3.93**
	2	27.16**	22.50	25.65**	13.45**	17.10**	17.56	15.85**	10.17**
	3	28.12**	10.23	24.69**	14.03**	-7.47**	-7.56	-8.28**	7.84**
	4	14.90**	13.82	12.48**	8.87**	15.73**	7.68	13.53**	7.82**
Biological yield/plant	1	11.49**	7.74	9.86**	6.76**	3.33**	2.89	2.15*	3.72**
	2	2.24**	4.09	1.66	4.65**	4.57**	1.46	1.39	3.94**
	3	12.05**	1.14	1.33	11.38**	12.08**	1.19	1.74*	13.65**
	4	17.76**	2.70	10.50**	10.64**	14.96**	1.66	5.46**	14.90**
Grain yield / plant	1	51.68**	19.29	47.72**	56.53**	59.85**	7.31	47.75**	29.24**
	2	15.85**	3.12	10.27**	26.74**	26.19**	3.40	17.19**	20.92**
	3	34.07**	1.74	12.14**	25.68**	-47.05**	-1.01	-63.91**	-51.46**
	4	30.60**	5.93	24.21**	12.05**	41.69**	10.41	36.23**	15.23**

(*) and (**) significant at 0.05 and 0.01 levels probability, respectively.
Cross 1 (Giza 126 x Giza 129), Cross2 (Giza 126 x Giza 131), Cross 3 (Giza 131 x Giza 129) and cross 4 (CC89 x Giza131)

The data shown in Table 5-b illustrated that, highly significant mid and better parent heterosis in positive direction were obtained in the crosses; 1, 2 and 4 for number of tillers/plant under both conditions, as a result of over- dominance in all cases, except in the fourth cross under normal condition where the heterotic effect over better parent was not significant, as a result of over-dominance in all cases. Mean while, the third cross under normal condition had significant mid and better parent heterosis, as a result of over- dominance also.

For number of spikes/plant, all crosses exhibited mid and better parental heterosis under both conditions due to over-dominance (PR >+1), except in the first cross at stress condition were better parent heterosis was not significant.

The data shown in Table 5-b showed that, highly significant mid and better parent heterosis in positive direction were obtained in the crosses; 1, 2 and 4 for 100-grain weight and grain yield/plant under both conditions, , as a result of over- dominance in all cases. While, the third cross under normal condition had highly significant mid and better parent heterosis, due to over-dominance also.

For biological yield/ plant, the first and the fourth crosses exhibited significant mid and better parental heterosis under both conditions due to over-dominance (PR >+1), while the second and the third crosses had highly significant mid parental heterosis under normal condition and better parental heterosis for the third cross under water stress condition. However, it could be concluded that, the fourth cross (CC89 x Giza 131) had highly significant better parent heterosis-which considered as useful heterosis from the breeders point of view- under both conditions for all studied traits, except for plant height and no.of tillers/plant at normal condition; the first cross (Giza 126 x Giza 129) for grain filling rate, spike length, peduncle length, number of tillers/ plant, number of grains/spike, grains weight/spike, 100- grain weight, biological yield/plant and grain yield/plant under both conditions; the second cross (Giza 126 x Giza 131) for grain filling rate, plant height, spike length, peduncle length, number of tillers/ plant, number of spikes/plant, grains weight/spike, 100- grain weight and grain yield/plant under both conditions and the third cross (Giza 131 x Giza 129) for plant height, spike length, peduncle length, number of spikes/plant, number of grains/spike and grains weight/spike under both conditions . These crosses could be used in suitable breeding programs aiming to improve barley either at normal irrigation or stress condition. Moreover, the heterotic effects in these crosses mostly attributed to over-dominance which helps the breeder to discover a transgresive segregation in early generations. El-Shawy (2008), Khattab et al. (2010) and El-Akhdar (2011) obtained over-dominance prevailing in most crosses.

Inbreeding depression were found to be highly significant in positive direction for no.of days to heading and maturity in the second cross under both environmental conditions which means that F_2 population in theses cases was more earlier than that of F_1,s. The same direction was observed for days to heading at stress condition in the first and third crosses; and for days to maturity and grain filling period in the first cross at normal condition. However, the presence in vigor in F2 could be arributed to additive and epistatic gene action. Such crosses for these traits are excepted to give segregates superior to the better parent in these traits, which may be handled through pedigree method.

On the other hand, inbreeding depression values were found to be significant and/or highly significant in positive direction for grain filling rate, spike length, peduncle length, no.of tillers/ plant, no.of spikes/plant, grains weight/spike, 100-grain weight, biological yield/plant and grain yield/plant in all crosses under both environmental conditions, with some few exceptions i.e., in the third and fourth crosses at stress condition for grain filling rate; the second cross no.of tillers/ plant; in the fourth cross at stress condition for no.of spikes/plant and the third cross at stress condition for grain yield/plant, were the values of inbreeding depression were highly significant in negative direction or insignificant values. However in the first case the expression of heterosis in the F_1 followed by a respectively reduction in F_2 would be attributed to the direct effect of homozygosity which was in harmony with the results obtained by Mahmoud Badeaa (2006), Abd-El-Haleem *et al* .(2010) in cotton, Khattab *et al.* (2010) and El-Akhdar (2011). While in the excepted cases, low inbreeding depression might suggests that, increasing retention in vigor in F2 is expected to be mainly due to accumulation of favorable additive genes (Shukla and Gautam (1990).

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تقدير قوة الهجين والتربيه الداخليه فى الشعير تحت ظروف الرى الطبيعى والإجهاد المائى

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الملخص العربى

أجريت هذه الدراسة بمزرعة محطة البحوث الزراعيه بسخا – كفرالشيخ خلال ثلاث مواسم ٢٠١٣/٢٠١٤, ٢٠١٤/٢٠١٥ و٢٠١٥/٢٠١٦ لدراسة تأثير الفعل الجينى باستخدام نظام العشائر الستة (الأب الأول, الأب الثانى, الجيل الأول, الجيل الثانى, الهجين الرجعى الأول و الهجين الرجعى الثانى) لأربعة هجن من الشعير هى : (جيزه ١٢٦ x جيزه ١٢٩), (جيزه ١٢٦ x جيزه ١٣١), (جيزه ١٣١ x جيزه ١٢٩) و (سى سى ٨٩ x جيزه ١٣١). تم زراعة العشائر الستة لهذه الهجن تحت ظروف الرى العادية والإجهاد المائى. تم دراسة محصول الحبوب ومكوناته. أظهرت النتائج وجود تقديرات عالية المعنوية موجبة لقوة الهجين بالمقارنة بمتوسط الأبوين والأب الأفضل تم الحصول عليها فى معظم الصفات المدروسة تحت كلا البيئتين. بصورة عامة فان أفضل الهجن المبشرة كانت الهجين الثانى والرابع مما يشير إلى أهمية هذه الهجن فى برامج التربية لتحسين معظم الصفات المحصولية فى الشعير.