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BREEDING BREAD WHEAT FOR LOW AND FULL – INPUT PRODUCTION SYSTEMS

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ABSTRACT

Six parents, differing widely in their yield characteristics, and their fifteen crosses resulted from diallel crosses between them.were evaluated under two environmental conditions i.e., low–input production system L1 (35 KgN / faddan and two irrigations) and full–input conditions L2 (70 Kg N/faddan and five irrigations). Highly significant differences among genotypes, parents and F1 crosses were detected for all traits studied except main culm ear length of crosses at low–input condition, no heterotic effect was found for main culm ear length at the two levels and their combined data. Combined analysis over limited and full conditions revealed that the interactions of genotypes with levels were found to be highly significant for all traits studied. General combining ability (GCA) and specific combining ability (SCA) variances were found to be highly significant for plant height, ear yield and grain yield per plant under low and full–input production systems and their combined data. Additive and additive x additive types of gene action were of greater importance in the inheritance of all traits except grain yield per plant under full conditions. Results obtained by using **Hayman (1954)** approach revealed that, the presence of additive (D) and dominance gene effects (H1 and H2) in the inheritance of plant height, no. of headed tillers, no. of grains per main culm ear, ear yield and 1000–grain weight at the two levels. Dominant genes seemed to be acting in positive direction for all traits except heading date at the full conditions, as revealed by positive value of h^2 parameter. Narrow sense heritability estimates showed high values for heading date, ear yield, 1000–grain weight and low values for grain yield per plant at the two levels. The best general combiner under low–input conditions were Sakha 61 and Giza 168 for earliness and plant height , Milan and Chil's for no. of headed tillers and grain yield per plant. Also the best specific combinations were (Four crosses) Sakha 61 with both of Milan and Chil's and Giza 168 with both of Milan and Chil's. However, under the full– input production system, Sakha 61 and Giza 168 proved to be good combiner for earliness and plant height, Gemmeiza 7 and

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Chil's proved to be good combiner for grain yield per plant. The best specific combinations were Giza 168 x Chil's and Giza 168 x Milan. Therefore, it could be recommended that these superior genotypes which proved to be good combiners under low input conditions may be used in the future breeding programme for to developing new bread wheat cultivars hoping to tolerate water stress and nitrogen deficiency.

Key words: Bread wheat, (*Triticum aestivum* L), Diallel crosses, Additive and dominance genetic components, Heritability

INTRODUCTION

Wheat is the most widely grown and consumed food crop in Egypt and breeding efforts are directed mainly towards higher yielding cultivars to face the fastest increase in wheat consumption and to reduce wheat imports. Moreover, increasing food demands have led to cultivate wheat under marginal conditions. So, adaptation of agricultural crops to their environment has been a key factor to the yield increases which have occurred since the spread of crops to new environments **(Evans, 1980).**

Salvatore (1996) stated that the adapting crops to low-input cultivation is the only avenue to increase agricultural production in the short term. While, **Simmonds (1984)** reported that genotypes selected for adaptation and performance in high-input conditions, are not well adapted to low-input conditions. Exploiting differences in nutrient utilization efficiency is a strategy on which to focus in the future (**Fischer *et al* 1989**).

Choice of the most efficient breeding methodology depends upon a better knowledge of the genetic systems controlling the characters to be selected. Several studies have commonly used diallel analysis to estimate the general and specific combining ability and genetic components in wheat breeding **(Ketata *et al* 1976; Hendawy, 1994; Hewezi, 1996; El-Seidy & Hamada 1997; Awaad 1996; Khattab & Afiah 1998; Koumber 2001 and Esmail 2002).**

Therefore, plant breeding research and breeding methodology must be oriented to the developing of new wheat cultivars adapted to low– input conditions as well as full conditions.

The objectives of the present study were to estimate the general and specific combining ability to identify potential parents and high specific hybrid combinations under low–input and full input conditions to utilizing as new genetic resources in wheat breeding programs or developing new improved cultivars of bread wheat; to investigate the genetic system controlling selected traits in a set of bread wheat varieties and their interactions with the specific environmental conditions and detect the influence of water deficit and nitrogen on yield and agronomic characters of twenty-one wheat genotypes under investigation.

MATERIALAND METHODS

The present investigation was carried out at EL-Gemmieza Agricultural Research Station, Agricultural Research Center (ARC), Egypt, during two successive seasons 2002/2003 and 2003/ 2004 .

The names and origin of the six parental varieties are presented in Table (1). The six parents and their fifteen hybrids were tested under two different environmental conditions i.e., (low–input conditions – 35 Kg N / faddan and two irrigations) and (full– input conditions 70 Kg N / faddan and five irrigations) in two adjacent experiments, respectively. The experiment were arranged in a randomized complete block design with three replicates per each level. The experimental units consisted of single rows 2 meters long with 30 cm. between rows. distance between plants within rows were 10 cm. The data were recorded on 10 plants for each of the parents and F1's. Eight characters were studied, i.e., heading date (days), plant height (cm.), number of headed tillers per plant,main culm ear length (cm.), number of grains per spike, 1000–grain weight (g) ear yield (g) and grain yield per plant (g) .

The data recorded were subjected to analysis of variance according to **Steel** and **Torrie(1980)** to determine whether there is significant difference among genotypes. General and specific combining ability estimates (GCA and SCA) were obtained by employing **Griffing (1956)** diallel cross analysis designated as method 2 model 1. The data were also subjected to assessment the components of genetic variance following the procedure described by **Hayman (1954)**.

Table 1. The names and pedigree of six bread wheat cultivars and lines

No.	Genotypes	Pedigree	Origin
P_1	Sakha 61	Inia / RL 4220 // 7 C / Yr's .	Egypt
P_2	Line (1)	BL 1133/3/ CMH79A – 955 * 2 / CNO 7911	Egypt
		CMH 79 A . 955 / Bow "s"	
P_3	Giza 168	Giza 156 / 7 C MIL / BUC // Seri	Egypt
P_4	Gemmieza7	CMH 74 A . 630 / SX // Seri82 /3 / Agent	Egypt
P_5	Milan	VS 3 . 600 / MRL / 3 / Bow // YK / TRF	Cimmyt
P_6	Chil's	BJY / Jup	Cimmyt

RESULTS AND DISCUSSION

Analysis of variance presented in Table (2) revealed that low and full conditions mean squares were found to be highly significant for all traits studied except for 1000 grain weight, indicating that the genotypes performance varied from limited to full irrigation and nitrogen applications. Highly significant differences among genotypes, parents and F_1 crosses were detected for all traits studied except main culm ear length of

Table 2. Mean square estimates of ordinary analysis and combining ability for all traits studies under the two levels and their combined data .

Source of variance	Single d.f	Comb. d. f	Heading date			Plant height (cm)			No headed tillers per plant			Main culm ear length (cm)		
			L_1	L_2	Comb	L_1	L_2	Comb.	L_1	L_2	Comb	L_1	L_2	Comb.
Levels		1			1697.302**			9053.419**			278.007**			218.040**
Rep within levels	2	4	0.954	29.343	15.149	20.447	1.064	10.756	0.861	5.802	3.332	0.803	0.67	0.736
Genotypes	20	20	80.343**	61.524**	132.977**	172.531**	130.119**	182.677**	11.956**	37.677**	40.773**	2.092**	7.322**	7.486**
Parents	5	5	204.079**	120.229**	311.458**	186.183**	183.882**	285.841**	22.333**	37.824**	58.952**	5.802**	12.594**	17.390**
Crosses	14	14	41.592**	42.762**	76.679**	117.395**	69.830**	158.605**	8.142**	36.370**	32.791**	0.849	5.908**	4.483**
Par. Vs. crosses	1	1	4.177	30.668**	28.741*	876.174**	719.341**	3.863	13.461**	55.240**	61.619**	0.947	0.761	0.005
Genotypes × levels		20			8.890*			119.973**			8.860**			1.928**
parents × levels		5			12.850*			84.224**			1.205			1.005
Crosses × levels		14			7.675			27.620			11.720**			2.273**
Par. Vs. crosses × levels		1			6.104			1591.651**			7.082			1.703
G. C. A	5	5	93.073**	63.091**	461.306	112.381**	105.708**	632.017**	10.689**	32.366**	115.623**	1.946*	8.545**	26.939**
S. C. A	15	15	4.683	6.313	23.533**	39.220**	22.594**	32.897**	1.751	5.957**	15.823**	0.281	0.406	1.002
G.C.A × levels		5			7.186			22.249			13.541**			4.533**
S.C.A × levels		15			9.455			152.542**			7.299**			1.059
Error	40	80	3.923	4.930	4.426	11.691	8.529	10.107	1.957	2.254	2.106	0.67	1.07	0.87
G. C. A / S.C A			19.875	9.994	19.603	2.865	4.679	19.212	6.105	5.433	7.307	6.925	21.047	26.885

* and ** Significant at 0.05 and 0.01 levels of probability , respectively

L 1 = Low input L2 = Full conditions Comb =Combined data

Table 2. Cont.

Source of variance	Single d.f	Comb d.f	No. of grains per main culm ear			Ear yield (g)			1000-grain weight (g)			Grain yield per plant (g)		
			L_1	L_2	Comb.	L_1	L_2	Comb.	L_1	L_2	Comb.	L_1	L_2	Comb
Levels	-	1	-	-	13290.612**	-	-	2.34**	-	-	21.750	-	-	2046.031**
Rep within levels	2	4	46.383	33.983	40.183	0.028	0.525	0.141	74.082**	11.590	42836**	55.099	44.273	49.686
Genotypes	20	20	120.798**	800.975**	648.025**	0.308**	1.692**	1.47**	45.606**	102.646**	111.750**	79.787**	105.364**	158.157**
Parents	5	5	251.008**	1256.678**	1294.985**	0.625**	3.27**	3.16**	35.028**	163.183**	166.627**	101.516**	44.995**	139.794**
Crosses	14	14	79.988**	658.748**	453.819**	0.192**	1.179**	0.885**	49.812**	84.840**	93.805**	57.751**	71.816**	99.337**
Par. Vs. crosses	1	1	41.073	513.635**	132.108**	0.343**	1.02**	1.27**	39.605**	49.247**	88.590**	279.640**	876.882**	1073.449**
Genotypes × levels	-	20	-	-	273.748**	-	-	0.528**	-	-	36.502**	-	-	26.994**
parents × levels	-	5	-	-	212.701**	-	-	0.733**	-	-	31.583**	-	-	6.716
Crosses × levels	-	14	-	-	284.918**	-	-	0.485**	-	-	40.847**	-	-	30.230**
Par. Vs. crosses × levels	-	1	-	-	422.601**	-	-	0.093	-	-	0.262	-	-	83.073**
G. C. A	5	5	58.933	906.321**	2111.104**	0.708**	4.75**	4.34**	37.978**	110.561**	339.442**	57.306**	34.150*	252.851**
S. C. A	15	15	34.043	53.881	160.331**	0.174**	0.671**	0.517**	7.610	8.767	35.853**	16.359*	35.445**	126.592**
G.C.A × levels	-	5	-		784.657**	-	-	1.124**	-	-	106.172**	-	-	21.517*
S.C.A × levels	-	15	-		103.442**	-	-	0.328**	-	-	13.277	-	-	28.819**
Error	40	80	24.540	35.499	30.020	0.028	0.046	0.037	5.620	7.081	6.351	6.816	10.295	8.55
G. C. A / S.C. A	-	-	1.731	16.821	13.167	4.06	7.08	8.39	4.990	12.611	9.539	3.503	0.963	1.997

* and ** Significant at 0.05 and 0.01 levels of probability, respectively.
L 1 = Low input   L2 = Full conditions   Comb. =Combined data

crosses under low input levels, indicating the existence of genetic variability between the plant materials under investigation. Parent Vs. crosses mean squares, as an indication to average heterosis over all hybrids, were found to be significant for all traits in all cases, except for number of grains per main calm ear and heading date under limited environmental conditions L_1.

No heterotic effect was found for main culm ear length. The mean performance of the tested genetic material for all traits studied under the two different environmental conditions(L_1 and L_2) and their combined data are presented in Table (3).

The results indicated that full irrigation and nitrogen fertilizer regimes increased the mean performance of all traits studied as compared with inadequate irrigation and fertilization regimes. The deleterious effects of water stress during various growth stages of wheat plants were shown by many investigators (**Salter & Goode, 1967; Husain & Aspinall, 1970; Jamieson *et al* 1995 and Saini, 1997**). They reported that the sensitivity to water deficit is particularly acute during the reproductive development because reproduction involves several processes that are extremely vulnerable to a change in plant water status, so drought at any time during the reproductive phase can reduce grain yield.

Combined analysis over limited and full conditions revealed that the interactions of genotypes with levels were found to be highly significant for all traits studied reflecting the fact that these plant genetic materials were inconsistent from one environment to another. Parents x levels interaction showed significant estimating for all traits except for grain yield per plant, no. of headed tillers per plant and main culm ear length. Also, the interaction of crosses x levels were found to be highly significant for all traits under investigation except heading date and plant height. Parents Vs. crosses interactions were found to be significant for plant height, no. of grains per main culm ear and grain yield per plant.

General combining ability and specific combining ability variances were found to be highly significant for plant height, ear yield and grain yield per plant under low and full input production systems and their combined data, indicating the importance of both additive and non-additive genetic variances in the inheritance of these traits. Moreover, GCA variances were highly significant for heading date, main culm ear length, 1000 grain weight and no. of grains per main culm ear in all cases except the later character under low-input production systems only.

With exception of grain yield per plant under normal conditions GCA / SCA ratios were found to be greater than unity, indicating that additive and additive x additive types of gene action were of greater importance in the inheritance of these traits. The presence of large amount of additive effects, suggests the potential for obtaining further improvements for yield and its components through selection programmes. However, **Baker (1978)** reported that where SCA is small relative to the GCA,

Table 3. Mean performance of the parents and F1's evaluated under low and Full conditions and their combined data.

Genotypes	Heading date			Plant height (cm)			No. of spikes / plant			Main culm ear length (cm)		
	L_1	L_2	Comb.	L_1	L_2	Comb.	L_1	L_2	Comb.	L_1	L_2	Comb.
Sakha 61	81.66	88.40	85.03	97.57	97.99	97.78	8.66	11.05	9.85	10.76	12.04	11.40
Line-1	77.80	87.40	82.60	113.90	109.04	111.47	3.54	4.09	3.82	13.85	17.47	15.66
Giza 168	83.86	92.70	88.28	101.28	105.99	103.63	9.09	11.85	10.47	10.66	13.33	11.99
Gemmeiza 7	87.13	93.90	90.51	113.52	121.71	117.62	9.76	11.76	10.76	13.04	15.28	13.06
Milan	97.60	98.83	98.22	100.42	109.42	104.92	10.47	13.57	12.02	10.85	12.95	11.90
Chil's	97.33	104.03	100.68	96.23	113.04	104.63	11.19	13.71	12.45	10.95	12.62	11.78
Sakha 61 x Line-1	85.33	91.20	88.26	97.28	117.38	107.33	9.18	10.09	9.63	11.37	15.71	13.54
Giza 168	84.26	89.76	87.01	83.80	106.14	94.97	8.06	18.88	13.47	11.04	13.80	12.42
Gemmeiza7	86.86	94.20	90.53	88.61	115.85	102.25	8.28	11.12	9.70	10.71	14.38	12.54
Milan	90.98	103.27	97.12	85.37	110.85	98.11	10.66	17.28	13.97	10.76	11.94	11.35
Chil's	88.06	97.83	92.94	88.09	113.56	100.82	12.23	15.61	13.92	10.66	12.81	11.73
Line-1 x Giza 168	85.33	92.93	89.13	94.99	119.66	107.32	8.14	8.56	8.35	11.51	14.94	13.22
x Gemmeiza 7	84.60	92.53	88.56	102.66	122.57	112.61	7.18	8.38	7.78	12.18	15.90	14.04
x Milan	85.46	92.86	89.16	97.34	121.99	109.66	8.07	8.52	8.29	12.04	16.61	14.32
x Chil's	84.33	93.46	88.89	99.71	120.99	110.35	10.25	11.59	10.92	11.18	16.09	13.63
Giza 168 x Gemmeiza7	86.0	95.20	90.6	94.97	118.33	106.65	9.80	13.04	11.42	11.18	13.42	12.30
x Milan	91.86	96.93	94.39	100.14	113.09	106.62	12.81	16.90	14.85	11.28	12.62	12.45
x Chil's	91.46	97.80	94.63	96.81	116.14	106.47	11.30	14.56	12.93	11.37	13.85	12.61
Gemmeiza x Milan	88.93	98.60	93.76	99.28	123.43	111.35	10.28	14.99	12.63	12.19	13.23	12.71
x Chil's	91.60	99.66	95.63	103.33	120.18	111.75	10.95	15.87	13.41	12.19	14.38	13.28
Milan x Chil's	96.93	100.06	98.49	101.09	114.99	108.04	9.89	10.76	10.32	11.52	13.18	12.35
$\bar{X}$	87.97	95.31	91.64	97.92	114.88	106.40	9.51	12.48	10.99	11.49	14.12	12.80
L.S.D 0.05	3.27	3.66	2.42	5.64	4.82	3.65	2.31	2.47	1.67	1.35	1.71	1.07
L.S.D 0.01	4.36	4.89	3.21	7.54	6.44	4.84	3.08	3.30	2.21	1.80	2.28	1.42

L1- Low input condition L2 - Full condition Comb. -- Combined Data

Table 3. Cont.

Genotypes	No. of grains/ main culm ear			Ear yield (g)			1000-grain weight (g)			Grain yieldper plant (g)		
	L_1	L_2	Comb.	L_1	L_2	Comb.	L_1	L_2	Comb.	L_1	L_2	Comb.
Sakha 61	65.85	78.09	71.97	1.72	1.75	1.73	41.36	39.68	40.52	14.95	22.15	18.55
Line-1	82.17	118.56	100.36	2.91	4.49	3.70	47.51	57.11	52.31	10.29	18.26	14.27
Giza 168	63.90	70.42	67.16	1.82	1.90	1.86	39.64	39.21	39.42	16.53	22.56	19.54
Gemmeiza 7	69.52	88.90	79.21	2.54	2.38	2.46	46.43	45.04	45.73	22.72	27.91	25.31
Milan	61.33	64.85	63.59	2.00	1.88	1.94	39.51	36.39	37.95	20.97	25.54	23.25
Chil's	55.09	65.52	60.31	2.35	2.06	2.21	43.39	44.52	43.95	26.35	28.35	27.35
Sakha 61 x Line-1	53.99	95.52	74.75	1.97	2.82	2.39	37.78	45.91	41.84	18.16	27.91	23.03
Giza 168	62.78	80.22	71.50	2.06	1.82	1.94	38.09	40.84	39.46	16.67	34.29	25.48
Gemmeiza7	60.66	80.36	70.51	2.23	2.38	2.31	46.66	42.16	44.16	18.54	26.43	22.48
Milan	57.99	60.71	59.35	2.36	1.91	2.13	40.42	40.33	40.37	24.98	32.82	28.90
Chil's	67.66	74.61	71.13	2.32	1.83	2.07	40.36	39.89	40.12	28.50	28.49	28.49
Line-1 x Giza 168	70.09	99.14	84.61	2.22	3.06	2.64	44.38	48.04	46.21	18.02	26.30	22.16
x Gemmeiza 7	69.95	110.71	90.33	2.98	3.47	3.22	50.18	53.77	51.97	21.41	31.17	26.29
x Milan	69.61	106.75	88.18	2.69	3.58	3.13	44.43	50.96	47.69	21.57	30.28	25.92
x Chil's	63.03	107.87	85.45	2.41	2.89	2.65	47.16	55.81	51.48	24.59	33.47	29.03
Giza 168 x Gemmeiza7	68.09	92.76	80.42	2.45	2.78	2.61	46.57	37.29	41.93	23.98	33.80	28.89
x Milan	62.99	72.24	67.61	2.45	2.30	2.37	43.85	43.92	43.88	31.19	38.79	34.99
x Chil's	61.89	90.81	76.35	2.59	2.47	2.53	47.48	43.92	45.70	29.28	35.87	32.57
Gemmeiza x Milan	60.42	78.38	69.40	2.22	2.55	2.38	50.06	44.11	47.08	22.75	38.18	30.46
x Chil's	72.37	87.52	79.94	2.53	2.65	2.59	49.44	48.75	49.09	26.71	41.82	34.26
Milan x Chil's	66.28	73.09	69.68	2.33	3.90	3.12	43.98	48.52	46.25	23.12	26.16	24.64
$\bar{X}$	65.03	85.57	75.30	2.34	2.61	2.47	44.22	45.05	44.63	21.96	30.03	25.99
L.S.D 0.05	8.17	9.83	6.29	0.27	0.35	0.22	3.91	4.39	2.89	4.30	5.29	3.36
L.S.D 0.01	10.92	13.13	8.35	0.36	0.47	0.29	5.23	5.87	3.84	5.75	7.07	4.46

L1- Low input condition **L2 – Full condition** **Comb. – Combined Data**

performance of a single cross progeny can be predicted on the basis of the GCA of its parents. Many investigators using **Griffing (1956)** approach suggested the importance of additive and non-additive gene effects in the inheritance of yield and some of its components; **Guo-Liang Jiang (1998); Esmail (2002) and Sharma & Sain (2003)** found similar results.

The interactions of both types of combining ability i.e., GCA x levels and SCA x levels were found to be highly significant for all traits studied except heading date and plant height for GCA x levels and main culm ear length for SCA x levels. The magnitude of the interactions of GCA x levels were higher than those of SCA x levels- for no. of headed tiller per plant, main culm ear length, no. of grains per main calm ear, ear yield and 1000-grain weight, indicating that additive and additive x additive types of gene action appeared to be more affected by environmental conditions than non-additive did. Conversely, GCA x levels / SCA x levels were lower in magnitudes than unity for grain yield per plant, heading date and plant height, indicating that non-additive genetic components appeared to be more affected by nitrogen fertilizer and irrigation regimes than additive and additive x additive genetic effects .

Estimates of general combining ability effects (GCA) for individual parental lines in each trait at the two levels are presented in Table (4). High positive values of GCA effects would be of interest in all traits studied except heading date and plant height, high negative values would be preferred from the wheat breeder point of view. Examining Table (4) we note that Sakha 61, Line (1) and Giza 168 showed significant negative GCA effects for heading date, so these parents seem to be the best combiner for earliness. Also, Sakha 61 and Giza 168 exhibited highly significant negative GCA effects at the two levels for plant height, indicating that the two Egyptian wheat cultivars may be used in wheat breeding program to develop semi dwarf cultivars .

Concerning ear characters, line (1) and Gemmeiza 7 were the best general combiners at the two levels for number of grains and length of the main culm ear and ear yield, except Gemmeiza 7 at the normal conditions (L2) for ear yield.

Regarding to yield characters, under low input conditions, the two exotic varieties Milan and Chil's had highly significant positive GCA effects for number of headed tillers per plant and grain yield per plant, as well as line (1) and Gemmeiza 7 for 1000 grain wheat. On the other hand, under normal conditions, Sakha 61, Giza 168, Milan and Chil's could be considered as excellent combiners for number of headed tillers per plant, as well as line (1) and Chil's for 1000 grain weight and Gemmeiza 7 and Chil's for grain yield per plant.

In brief, estimates of GCA effects for yield characters revealed that only Chil's variety is recommended as source of excellent germ plasm which can be used in wheat breeding programs. **Gupta *et al* (2003)** Stated that the inclusion of the good foreign

Table 4. Estimates of general combining ability effects for the parental varieties evaluated under low and full conditions.

Parental variety	Heading date		Plant height (cm)		No. of headed tillers per plant		Main culm ear length (cm)	
	L1	L2	L1	L2	L1	L2	L1	L2
Sakha 61	-2.120 **	-1.767**	-5.896**	-5.539 **	-0.107	0.959 **	-0.548**	-0.766**
Line-1	-4.394 **	-3.675**	4.290**	2.067 **	-2.087 **	-4.010 **	0.696**	1.918 **
Giza 168	-1.144 **	-1.146**	-1.525*	-2.351 **	0.211	1.033 **	-0.339**	-0.522**
Gemmeiza 7	-0.444	0.100	3.804**	4.962 **	-0.074	-0.060	0.512**	0.455 *
Milan	4.196 **	2.775**	-0.175	-0.117	0.757 **	1.025 **	-0.119	-0.593**
Chil 's	3.906 **	3.713**	-0.497	0.978	1.300 **	1.053 **	-0.202*	-0.492*
L.S.D 0.05 "gi"	0.74	0.83	1.29	1.09	0.53	0.56	0.19	0.43
L.S.D 0.01 "gi"	0.99	1.12	1.72	1.46	0.70	0.76	0.26	0.56
L.S.D 0.05 gi-gj	1.16	1.29	1.99	1.70	0.82	0.87	0.30	0.65
L.S.D 0.01gi-gj	1.54	1.73	2.66	2.28	1.09	1.17	0.40	0.88

Parental variety	No. of grains per main culm ear		Ear yield (g)		1000 – grain weight (g)		Grain yield per plant (g)	
	L1	L2	L1	L2	L1	L2	L1	L2
Sakha 61	-2.553 **	-6.426 **	-0.250 **	-0.504 **	-2.940 **	-3.362 **	-2.127 **	-1.994 **
Line-1	4.472 **	19.764 **	0.213 **	0.814 **	1.173 **	6.664 **	-3.678 **	-3.068 **
Giza 168	-0.198	-2.876 *	-0.122 **	-0.257 **	-1.238 **	-2.869 **	-0.196	0.500
Gemmeiza 7	1.913 *	3.565 **	0.139 **	0.038	3.277 **	0.096	0.634	2.128 **
Milan	-1.909 *	-9.768 **	-0.042	-0.038	-0.975 *	-1.847 **	1.474 **	0.893
Chil 's	-1.725	-4.259 **	0.062	-0.053	0.703	1.318 *	3.893 **	1.543 *
L.S.D 0.05 " gi"	1.86	2.24	0.063	0.080	0.89	1.00	0.98	1.32
L.S.D 0.01 " gi "	2.49	2.99	0.084	0.108	1.19	1.34	1.31	1.76
L.S.D 0.05 gi- gj	2.89	3.47	0.097	0.125	1.38	1.55	1.52	2.04
L.S.D 0.01" gi- gj	3.86	4.64	0.130	0.167	1.85	2.07	2.03	2.73

* and ** significant at 5 % and 1 % levels of probability, respectively.
L1 : low input L2 : Full conditions

wheat genetic stocks has been an important step forward to support the wheat breeding program of the country in view. **Christie and Shattuck (1992)** reported that once identified the best parental combiners can be crossed to identify optimal hybrid combinations or hybridized with the intent of selecting promising genotypes within the segregating generations. In recurrent selection schemes, parents possessing high combining ability can be crossed with one another in the attempts to accumulate desirable alleles within a base population.

Estimates of specific combining ability effects (SCA) presented in Table (5) which showed that under low input conditions, significant negative SCA effects were detected in four crosses for days to heading and six crosses for plant height. With regard to ear characters, highly significant positive SCA effects were detected in five crosses for ear yield and two crosses for number of grains, while three crosses for ear yield, four crosses for number of grains per main culm ear and one for main culm ear length at the full irrigation and nitrogen levels (L2) .

Estimates of SCA effects for grain yield per plant and its components revealed that, four F_1 hybrid combinations (Sakha 61 with each of Milan and Chil's and Giza 168 with each of Milan and Chil's) had significant positive SCA effects under low input levels, two of them (Sakha 61 x Chil's and Giza 168 x Milan) exhibited also significant positive SCA effects for number of headed tillers per plant and Giza 168 x Chil's showed highly significant SCA effects for 1000 grain weight .

Under full irrigation and nitrogen fertilizer levels (L_2), six hybrids for number of headed tillers per plant, three crosses for 1000 grain weight and six crosses for grain yield per plant were found to be good specific combiners. The best two specific combinations for grain yield and its components under normal levels were Giza 168 with both of Chil's and Milan.

Normally SCA would not contribute directly to the improvement of self-pollinated crops except where commercial exploitation of hybrids is feasible. In crosses showing high SCA effects and involving one good combiner, one would expect to show desirable transgressive segregates, providing that the additive genetic system present in the good combiner as well as the complementary and epistatic effects present in the crosses, act in the same direction to reduce undesirable plant characteristics and maximize the characters in view. However, combinations with high positive values of SCA effects were obtained from crossing high x high, high x low and low x low combiners. Consequently, it could be concluded that GCA effects of the parental lines were generally unrelated to the SCA effects of their respective crosses. Similar conclusion was also reported by **Abdallah, *et al*(1999), Koumber (2001)** and **Esmail(2002)**. Therefore, most of the previous crosses exhibited high SCA effect for yield and some of its components especially number of headed tillers per plant could be exploited in

Table 5. Estimates of specific combining ability effects for the fifteen crosses evaluated under low and full conditions.

Genotypes	Heading date		Plant height (cm)		No. of headed tillers per plant		Main culm ear length(cm)	
	L_1	L_2	L_1	L_2	L_1	L_2	L_1	L_2
Sakha 61 × Line 1	3.87 **	1.33	0.96	5.97**	1.86*	0.65	- 0.26	0.43
Giza 168	- 0.44	-2.63*	-6.70**	-0.85	- 1.55*	4.40**	0.44	0.96
Gemmieza7	1.46	0.55	-7.22**	1.60	-1.05	-2.27	-0.75**	0.56
Milan	0.93	6.94**	-6.48**	1.63	0.49	2.81**	- 0.069	-0.82
Chil 's	-1.69	0.57	-3.44	3.25*	1.53*	1.12	-0.079	-0.058
Line 1 × Giza 168	-2.89**	2.44 *	-5.69**	5.06 **	0.50	-0.94	-0.33	-0.573
Gemmieza 7	1.46	0.79	-3.35	0.66	-0.17	-0.04	-0.51	-0.596
Milan	-2.31*	-1.55	-4.69*	5.16 **	-0.11	-0.98	-0.026	1.167*
Chil 's	-3.15**	-1.88	-2.01	3.07 *	1.52 *	2.06 *	-0.79**	0.54
Giza 168×Gemmieza7	-0.39	0.93	-5.23**	0.84	0.15	-0.42	-0.478	-0.63
Milan	0.84	-0.010	3.91*	0.67	2.32**	2.36**	0.25	-0.39
Chil 's	0.73	-0.081	0.90	2.63	0.27	-0.006	0.42	0.124
Gemmieza7× Milan	-2.79**	0.411	-2.26	3.70*	0.08	1.55*	0.31	-0.132
Chil 's	0.16	0.539	2.09	-0.63	0.21	2.39**	0.38	0.291
Milan ×Chil 's	0.86	-1.735	3.84*	-0.74	-1.67*	-3.81**	0.35	0.148
L.S.D. 0.05 (sij)	2.05	2.29	3.53	3.02	1.45	1.55	0.53	1.17
L.S.D. 0.01 (sij)	2.74	3.07	4.72	4.03	1.93	2.07	0.71	1.56
L.S.D. 0.05 (sij-sik)	3.05	3.42	5.27	4.50	2.15	2.31	0.79	1.74
L.S.D. 0.01 (sij-sik)	4.08	4.57	7.05	6.02	2.88	3.09	1.06	2.33
L.S.D. 0.05(sij- skl)	2.83	3.17	4.88	4.17	1.99	2.14	0.74	1.61
L.S.D. 0.01 (sij-skl)	3.78	4.24	6.53	5.57	2.67	2.86	0.98	2.16

* and** Significant at 5 % and 1 % levels of probability , respectively

L_1 : Low – input L_2 : Full conditions .

Table 5. Cont.

Genotypes	No. of grains per main culm ear		Ear yield(g)		1000- grain weight (g)		Grain yield per plant (g)	
	L_1	L_2	L_1	L_2	L_1	L_2	L_1	L_2
Sakha 61 × Line 1	-12.95**	-3.39	-0.331**	-0.106	-4.67**	-2.45	1.99	2.94
Giza 168	0.50	3.94	0.090	-0.034	-1.95	2.02	-2.97	5.76**
Gemmieza7	-3.73	-2.35	0.003	0.236*	2.11	0.37	-1.93	-3.73
Milan	-2.57	-8.67**	0.310**	-0.166	0.12	0.48	3.66**	3.89*
Chil 's	6.91**	-0.27	0.166	-0.231*	-1.63	-3.12*	4.77**	-1.08
Line 1 × Giza 168	0.78	-3.32	-0.216*	-0.114	0.23	-0.81	-0.071	-1.15
Gemmieza 7	-1.46	1.81	0.293**	0.004	1.51	1.96	2.49	2.08
Milan	2.01	11.18**	0.184*	0.187	0.004	1.08	1.81	2.43
Chil 's	-4.75	6.79*	-0.207*	-0.481**	1.06	2.77*	2.41	4.96**
Giza 168×Gemmieza 7	1.34	6.49*	0.095	0.382**	0.31	-4.98**	1.58	1.15
Milan	0.066	-0.68	0.269**	-0.017	1.84	3.58*	7.94**	7.37**
Chil 's	-1.22	12.36**	0.311**	0.168	3.79**	0.42	3.61**	3.80*
Gemmieza7× Milan	-4.61	-0.99	-0.222*	-0.069	3.54**	0.80	-1.33	5.14**
Chil 's	7.15**	2.64	-0.009	0.056	1.23	2.27	0.22	8.12
Milan ×Chil 's	4.88	1.54	-0.032	1.37**	0.034	3.99**	-4.21**	-6.29**
L.S.D. 0.05 (sij)	5.12	6.16	0.173	0.222	2.45	2.75	2.69	3.62
L.S.D. 0.01 (sij)	6.84	8.23	0.231	0.296	3.27	3.67	3.61	4.83
L.S.D. 0.05 (sij-sik)	7.64	9.19	0.258	0.331	3.66	4.10	4.03	5.39
L.S.D. 0.01 (sij-sik)	10.21	12.28	0.345	0.442	4.88	5.48	5.38	7.21
L.S.D. 0.05(sij- skl)	7.07	8.51	0.239	0.306	3.38	3.79	3.73	4.99
L.S.D. 0.01 (sij-skl)	9.46	11.37	0.319	0.409	4.52	5.08	4.98	6.67

* and* * Significant at 5 % and 1 % levels of probability , respectively
L 1 : Low – input L2 : Full conditions .

future wheat breeding programs for improving wheat crop.

According to **Hayman (1954)** approach, the half diallel analysis provides us with six genetic components i.e., D, H_1 ,H_2 ,F, h^2 and E, also, several ratios could be derived from the analysis (Table 6) provided further information about the genetic architecture of each character. Results revealed that both additive genetic variance (D) and dominance gene effects (H_1 and H_2) were found to be highly significant for plant height, no. of headed tillers per plant, no. of grains per main culm ear, ear yield and 1000- grain weight at low and full conditions, heading date, main culm ear length and grain yield per plant at low condition only, indicating the presence of additive (D) and non- additive (H_1 and H_2) components of variation in the expression of these traits.

Also, H_2 is smaller than H_1 which means that the positive and negative alleles at the relevant loci are in unequal proportion in the parents for all traits at the low-input and full-input production systems. The estimated values of dominance components (H_1 and H_2) were greater than the corresponding additive component (D) for plant height and grain yield per plant at the two different environmental conditions, no. of grains per main culm ear, 1000-grain weight and ear yield at the low-input and no. of headed tillers per plant at the full-conditions indicating that dominance genetic variation is more important in the inheritance of these traits, and these results is ascertained by the estimates of average degree of dominance over all loci (H_1 / D) 1/2, which exceeded the unity for these traits indicating the presence of over-dominance.

While, combining ability analysis (Table-2) indicated that the additive gene action for all traits studied was predominant except for grain yield/ plant at the full condition. This contradiction between the two different approaches could be due to the presence of non- allelic interactions.

The parameter h2 measured the over all dominance effects of heterozygous loci, were found to be significantly positive for all traits except heading date at the full condition, suggesting dominant genes seemed to be acting in positive direction and ascertained the prevalence of dominant effect over all loci in all crosses, and confirmed the results obtained by parents vs. crosses (Table-2).

Estimated values of (F) component is an indicator of the relative frequencies of dominant vs. recessive alleles in the parents. Excess of dominant alleles in the parental lines was detected for ear yield at the two levels, i.e. positive (F) values. However, predominance of dominant alleles at level 1(L_1) and recessive at level 2 (F negative) were found for ear length and no. of grains per main culm ear and grain yield per plant, indicating that the degree of dominance or recessiveness may be determined by the growing conditions at the low-input and full production system. Similar results were previously reported by **Hendawy (1994) and Hewezi (1996)**

When positive and negative alleles are equally distributed in the

Table 6. Estimates of genetic components and ratios derived from 6 x 6 diallel analysis for all traits studied under low-input and full conditions.

Components	Heading date		Plant height (cm)		No. of headed tillers per plant		Main culm ear length (cm)		No. of grains per main culm ear		Ear yield		1000-grain weight (g)		Grain yield per plant (g)	
	L_1	L_2	L_1	L_2	L_1	L_2	L_1	L_2	L_1	L_2	L_1	L_2	L_1	L_2	L_1	L_2
D	66.76 **	38.05 **	58.02 **	58.57 **	6.81 **	11.80 **	1.82 **	3.79 **	75.14 **	407.08 **	1.87 **	9.78 **	8.72 **	51.96 **	30.80 **	10.99
H_1	17.42 *	21.00	129.73 **	61.88 **	5.26 **	20.98 **	1.02 **	0.64	136.01 **	198.17 **	6.93 **	8.65 **	27.59 **	31.48 **	49.21 **	100.82 **
H_2	13.85 *	17.75	100.29 **	52.86 **	4.79 **	18.81 **	0.63 **	0.65 *	93.51 *	139.72 **	3.54 **	6.72 **	16.54 **	23.65 **	46.77 **	99.10 **
F	30.28 *	12.12	26.54	15.74	2.62	- 3.811	1.48 **	- 0.44	97.04 *	- 11.69	1.34 **	4.99 **	-3.93	2.66	6.21	- 4.81
H 2	0.20	5.49	187.05 **	153.90 **	2.56 **	11.49 **	0.14	- 0.06	4.14 **	104.41 **	0.66 **	0.96 **	6.91	9.29 *	58.73 **	187.23 **
E	1.26	2.03	4.04	2.72	0.64	0.81	0.11	0.41	8.53	11.81 *	0.009	0.019	2.96 **	2.43	3.04	4.00
(H1/ D) ½	0.51	0.55	1.49	1.03	0.88	1.33	0.75	0.41	1.34	0.69	1.92	0.94	1.77	0.78	1.26	3.03
H2 /4H1	0.19	0.21	0.193	0.21	0.23	0.22	0.15	0.25	0.17	0.18	0.13	0.19	0.15	0.18	0.24	0.24
KD / KR	2.59	1.55	1.36	1.30	1.56	0.78	3.38	0.75	2.85	0.96	1.46	1.70	0.77	1.07	1.17	0.86
r(wr+vr) * yr	0.88 *	- 0.19	0.88 *	-0.90 *	- 0.90 *	- 0.11	0.92 **	-0.69	0.64	- 0.83 *	0.07	0.09	- 0.192	0.103	- 0.79	- 0.18
Heritability, h^2 n	0.81	0.693	0.51	0.619	0.560	0.617	0.57	0.78	0.244	0.836	0.686	0.664	0.625	0.774	0.478	0.233

* and** Significant at 5 % and 1 % levels of probability, respectively.
L 1 : Low – input L2 : Full conditions

parental cultivars the proportion of H2/4H1 is expected to be 0.25. The values of H2/4H1 obtained here were found to be close to this magnitude for grain yield and no. of headed tillers per plant at the two levels and main culm ear length at the full condition only, indicating that negative and positive alleles were equally distributed among the parents. However, asymmetry of positive and negative alleles in the parental lines were found in the other traits, where the estimated ratio was found to be below 0.25.

The ratio of dominant to recessive genes KD/KR was more than unity indicated the majority of dominant genes in the parental cultivars for heading date, plant height and ear yield at the two levels. However, for the other traits the ratio exhibited more dominant genes at one level and more recessive ones at the other level, indicating that the degree of dominance or recessiveness may be determined by the growing conditions.

The correlation coefficient (r) between the parental order of dominance (wr + vr) and the parental mean performance (yr) was found to be positive and significant for heading date, plant height and main culm ear length at low input conditions, revealing that low performance of these traits behaved as a dominant traits, on the other hand, significant negative correlation coefficients were detected for plant height and no-of grains per main culm ear at full conditions and no- of headed tillers per plant at low input conditions indicating an excess of dominant genes controlling the performance of these traits

High narrow sense heritability (h^2n) estimates were detected for heading date, ear yield, main culm ear length and no. of grains per main culm ear at level 2 only and 1000-grain weight at the two levels. **Ketata *et al* (1976)**; **Awaad (1996) and Esmail (2002),** found similar results.

Moderate heritability values were obtained for plant height, no. of headed tillers at the two levels, main culm ear length at level 1 only, indicating that improvement of these traits could be achieved through pedigree method and these results are supported by the findings of **Awaad (1996) and El-Seidy & Hamada** (1997)

Low heritability estimates were found for grain yield per plant at the two levels and no. of grains per main culm ear at low input level (less than 50%) suggesting, growing large segregating populations and more adequate testing of selection, low heritability for grain yield was also obtained by **El-Seidy & Hamada (1997); Khattab & Afiah(1998) and Esmail (2002)**. However, **Kearsey (1993)** stated that low value of heritability does not necessarily mean that there's little to be gained by selection but simply that gains may be hard own, while **Moreno-Gonzalez and Cubero (1993)** reported that for traits with low heritability, the genetic gain will increase if they are selected on a family basis.

From the results obtained here, it could be recommended that the superior genotypes which proved to be good and specific combiners under low input conditions may be used in the future breeding programme for to developing new bread wheat cultivars hoping to tolerate water stress and nitrogen deficiency.

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تربية قمح الخبز لنظم الإنتاج المثلي والحدية

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١- قسم بحوث القمح - معهد بحوث المحاصيل الحقلية- مركز البحوث الزراعية- الجيزة- مصر

٢- قسم الوراثة والسيتولوجى - المركز القومي للبحوث - الدقي - القاهرة - مصـــــــر

أجريت هذه الدراسة بمحطة بحوث الجميزة التابعة لمركز البحوث الزراعية في موسمي٢٠٠٢ /٢٠٠٣ و٢٠٠٣/٢٠٠٤ وذلك بهدف تقييم عدد ١٥ هجين فردى ناتجة من التهجين الدائرى بين ستة تراكيب وراثية ذات أصول متباعدة من قمح الخبز تحت نظامين مختلفين من نظم الإنتاج الأول (التسميد بـ ٣٥ كيلو جرام نتروجين / فدان مع إعطاء ريتين فقط) والثاني (التسميد بـ ٧٠ كيلو جرام نتروجين مع إعطاء ٥

ريات) وذلك للتعرف على أفضل التراكيب الوراثية سواء كانت الأصناف أو الهجن الناتجة منها لاستغلالها في برامج تربية القمح للحصول على أصناف جديدة تصلح للزراعة تحت ظروف المدخلات الأقل من ماء الري ومن التسميد الآزوتى وكذلك تحت الظروف المثلي.

وكانت النتائج المتحصل عليها كالاتى

- كان التباين الوراثى الراجع لكل من التراكيب الوراثية من الآباء والهجن معنويا لكل الصفات ماعدا صفة طول سنبلة الساق الرئيسي في الهجن فقط كما لم تظهر قوة هجين لهذه الصفة وذلك في كل من المستويين والتحليل المشترك لهما.
- اظهر التحليل التجميعي للبيانات وجود تفاعل عالي المعنوية بين التراكيب الوراثية والظروف البيئية المستخدمة في كل الصفات تحت الدراسة.
- كان تباين كل من القدرة العامة والخاصة على التآلف عالي المعنوية لصفات طول النبات - محصول السنبلة ومحصول النبات الفردي تحت كلا من المستويين والتحليل المشترك لهما مما يدل على أهمية كل من الفعل الجينى المضيف وغير المضيف في وراثة هذه الصفات.
- أهمية كل من الفعل الجينى المضيف(D) والسيادي (H1 and H2) في وراثة صفات طول النبات وعدد السنابل وعدد حبوب السنبلة الرئيسية ومحصول السنبلة ووزن الألف حبة تحت كلا المستويين.
- تماثل توزيع الاليلات الموجبة والسالبة بين الآباء لصفتي عدد السنابل ومحصول النبات الفردي في كلا من المستويين كما كانت الجينات السائدة تعمل في الاتجاه الموجب في كل الصفات ما عدا صفة التزهير.
- كانت قيم الكفاءة الو راثية بمعناها الدقيق عالية لصفات التزهير - محصول السنبلة ووزن الألف حبه ومنخفضة لصفة محصول النبات الفردي في كلا المستويين.
- أفضل التراكيب الو راثية التي تم التعرف عليها تحت الظروف الحدية (المدخلات الأقل لماء الري والتسميد الازوتى) من الأصناف المصرية سخا ٦١، جيزة ١٦٨ لصفتي التبكير وطول النبات ومن الأصناف المستوردة ,Milan Chil's لصفتي عدد السنابل ومحصول النبات الفردي حيث تفوقت هذه الأصناف في قدرتها العامة على التالف عن باقي الآباء .
- ومن التراكيب الو راثية الجديدة أربعة هجن هي
- Chil's x جيزة ١٦٨ Milan x , جيزة ١٦٨ Chil's x ,سخا٦١ Milan x سخا٦١.
- أعطت أفضل تأثيرات مرغوبة ومعنوية لقدرتها الخاصة على التالف . بينما تحت الظروف المثلي تفوقت الأصناف

سخا ٦١ ، جيزة ١٦٨ لصفتي التبكير وطول النبات وجميزة ٧ ، Chil's لصفة محصول النبات الفردي وكانت أفضل الهجن الهجينان سخا ٦١ × Chil's وجيزة ١٦٨ × Milan.

- لذلك نوصى باستخدام هذه التراكيب الو راثية المتفوقة في برامج تربية القمح تحت الظروف الحدية للحصول على أصناف جديدة تتحمل ظروف نقص مياه الري وقلة التسميد الازوتى وكذلك الاستفادة من التراكيب الأخرى المتفوقة تحت الظروف المثلي وضرورة استمرار استعمال الأصول الو راثية المستوردة من المراكز العالمية المتخصصة في ال Crossing blocks في برامج تربية القمح في مصر.

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