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DEVELOPING AND EVALUATION OF NEW WATERMELON HYBRIDS AND THEIR HETEROSIS

A. H. Kherebe[1], K. E. A. Abdel-Ati[1], M. M. Saleh[2] and R. R. A. El-Hawagry[2]

1- Veg. Dept. Fac. Agric., Cairo University
2- Hort. Res. Institute, ARC

ABSTRACT

This study was conducted during the period from 2001 to 2005 to develope and evaluate new watermelon hybrids. Selfing and crossing were carried out in the greenhouse, while evaluations were conducted under low tunnels. Ten inbred lines of watermelon were used as parents of this study; nine were developed from the verities Charleston Gray, Congo, Crimson Sweet, Giza 1, Klondike, Kodhi, Mehesny (a local variety), Peacock WR66, Sugar Baby and the 10[th] was the inbred line 7150 of Spanish origin. These inbreds were crossed in a half diallel mating producing 45 F_1 hybrids. Produced seeds of 5 F_1 hybrids were insufficient and excluded from the evaluation. The ten parental inbred lines, their 40 F_1 hybrids and the commercial F_1 hybrid Aswan (control) were evaluated in the field using drip-irrigation system. The parent Sugar Baby produced a high early yield (EY) in both seasons. The hybrids Giza 1 × Sugar Baby, Sugar Baby × Klondike, Sugar Baby × Peacock and Charleston Gray × Klondike produced a high EY which were not significantly different from both the check hybrid Aswan and the parental lines Kodhi and Sugar Baby. The hybrid Charleston Gray × Klondike exhibited significant positive high-parent heterosis for EY in the two seasons. The two hybrids Charleston Gray × Klondike and Charleston Gray × Congo produced, significantly, the highest total yield (TY) being 36.54 and 36.49 ton/fed, respectively, without significant differences from the control which produced TY of 33.46 ton/fed and also without significant differences from the crosses Crimson Sweet × Congo, Crimson Sweet × Klondike, Crimson sweet × Mehesny, Crimson Sweet × Peacock, Giza 1 × Sugar Baby and Sugar Baby × Peacock. The hybrids Charleston Gray × Congo, Charleston Gray × Klondike and Kodhi × Sugar Baby showed significant positive better-parent heterosis values for TY. The hybrids Charleston Gray × Klondike and Charleston Gray × Mehesny significantly produced the heaviest fruits among all evaluated genotypes. Ten hybrids showed significant superiority over the check hybrid ranging from 21.2% to 66.1%. Out of them only 4 hybrids exhibited significant positive better-parent heterosis ranging from 17.8% to 23.7%. Only two hybrids out of the 40 evaluated hybrids significantly surpassed their better-parents in fruit length (FL). The parents Charleston Gray, Congo and Peacock beside two hybrids produced elongate fruits, and cv. Klondike and 21 hybrids produced oval fruits. The remaining cvs. and hybrids produced spherical fruits. The genotypes that produced the least fruit rind thickness (FRT) in the two seasons were the parents Kodhi, Sugar Baby, Peacock and the hybrid Giza 1 × Sugar Baby. In the two seasons, most of the evaluated hybrids were not significantly different in FRT from their better parents, i.e., the parents having thin rind. The genotypes that produced fruits having the highest total soluble solids (TSS) content were the parent Klondike and the hybrid Giza 1 × Sugar Baby (11.1% and 11.7%, respectively). The hybrid Giza 1 × Sugar Baby was the only one which significantly surpassed the standard hybrid Aswan in TSS. Only 5 hybrids significantly surpassed their better-parents in fruit TSS with a range from 6.1% to 12.2% with the hybrid Kodhi × Charleston Gray having the highest estimate.

Key words: ***Watermelon, Hybrids, Yield, Fruit quality characters, Heterosis.***

INTRODUCTION

Watermelon (*Citrullus lanatus* (Thunb.) Mastum.& Nakai) is one of the most economic vegetable crops grown in Egypt. This crop offers good potentialities for exploitation of hybrid vigour in improving yield and other quality traits.

Brar and Nandpuri (1976) studied the P_1, P_2, F_1, F_2, BC_1 and BC_2 of three watermelon crosses. Over dominance occurred for low yield in the cross Special 1 × Charleston Gray. Average fruit weight showed considerable heterosis due to partial dominance for high fruit weight in two crosses and over dominance in the third. Heterosis for TSS was observed in F_1 hybrids of two crosses. Round fruit shape was partially dominant over long shape in two crosses. Sachan and Nath (1976) reported, from a ten parent diallel crosses, that fruit weight increased to a maximum of 16% and TSS increased to a maximum of 21% over that of the better parent. In promising hybrids, yield increased by 87% over the yield of the better parent. In a diallel analysis of seven varieties (Sidhu and Brar ,1977), heterosis was greatest for yield per plant. Heterosis was the highest in the cross Sugar Baby × Shipper for yield and in the cross Durgapar Mitha × Black Diamond for fruit weight. Hussain *et al* (1977) from an evaluation of ten F_1 hybrids and their five parental varieties revealed heterosis over mid-parents and superior-parents values for average fruit weight, TSS and yield, with the greatest yield being produced by the cross Sugar Baby × Sugar Surika.

Sidhu and Brar (1985) used 7 parents and their 21 F_1 hybrids to study heterosis in watermelon. The results showed that the crosses Sugar Baby × Shipper and Shipper × Black Diamond exhibited the highest value of heterosis for fruit yield over the better parent being 28.87 % and 21.55 %, respectively. El-Lithy (1986) found that hybrid vigour was strongly expressed in rind thickness in the original cross towards the thin rind.

Salim (1989) reported that the maximum better parent heterosis for TSS was recorded in the cross Peacock × Crimson Sweet (19.40%) followed by the crosses Sun Shady × Crimson Sweet (10.33%) and Sun Shady × Giza 21 (9.73 %). The hybrid vigour of the heavy fruits was observed in five crosses, with average degree of heterosis ranging from 14.33 % in the cross Crimson Sweet × Giza 21 to 40.21 % in the cross Sun Shady x Crimson Sweet. Only two crosses significantly decreased in rind of fruit than the thin parent by –18.95% in the cross Peacock × Congo and –18.02 % in the cross Congo × Crimson Sweet.

Rajendran and Thamburaj (1993) studied heterosis in 6 watermelon inbred lines and their 30 F_1 hybrids. The results showed significant heterosis for fruit yield per vine and TSS content. Rajan Bansal *et al* (2002) studied heterosis in watermelon using ten female parents and three male parents. They reported that the maximum heterosis for fruit yield / plant was

recorded in the cross Sel-B × Shipper (47.55 %) followed by the crosses Hw-1 × A.M (46.22 %) and DM × Shipper (45.48 %). The cross DM × Shipper exhibited the maximum heterosis (18.84 %) over the better parent for TSS followed by the cross Sel- B × Shipper (11.77 %).

Wang *et al* (2002) developed a high yielding watermelon hybrid 'Aiye l' by crossing B_2 with T_{13}. Fruits are nearly round shaped, having high sugar content and fine sweet flavour.

Tao *et al* (2004) developed two new watermelon F_1 hybrids. The first hybrid was developed by crossing A 320 (female) with B 119 (male). Average fruit weight was approximately 2.5 kg and sugar content was 12.8 % - 13.8 %. The second one was developed by crossing N 120 with T 163. Fruits were green with stripes, and the flesh was crispy. The rind was firm and sugar content was approximately 10.9 % - 12.9 %.

The objective of this investigation was to develop and evaluate the performance and heterosis of new watermelon F_1 hybrids.

MATERIALS AND METHODS

This study was conducted during the period from 2001 to 2005. Selfing and crossing were carried out in the greenhouse of Kaha Vegetable Research Farm (KVRF), Kalubia Governorate from 2001 to 2003, while evaluations were conducted for the two successive seasons 2004 and 2005 under low tunnels at El-Borollous Location (BL), Kafr El-Shikh Governorate using drip-irrigation system.

The genetic materials used in the present investigation included ten different genotypes of watermelon, viz., Crimson Sweet (Veronsa Semillas, Spain), Giza 1 and the local variety Mehesny (Horticulture Researche Institute, Egypt), Kodhi and the inbred line 7150 (Biotecnologia Genetica, Valencia, Spain), Sugar Baby and Klondike (Rocalba Semillas, Barcelona, Spain), Congo (Castle Seed Company, USA), Charleston Gray 133 (Atlas Seeds Company, USA) and Peacock WR 60 (Ferry – Morse Seed Company, USA). The F_1 hybrid Aswan (Sakata, Japan) was also included as a check. These genotypes were chosen according to their performance in previous trials.

Individual plants from each genotype were selfed for 5 successive generations. After that, the homogenous inbred lines were selected and used as parents for this study. These inbred lines were crossed in a diallel mating without reciprocals producing 45 F_1 hybrids. Out of these hybrids, seeds of 5 F_1's were insufficient and were therefore excluded from the evaluation.

Selfing and hybridization were usually practiced between 6 and 10 a.m. For selfing technique, the hermaphrodite, pistillate and male flower buds at the suitable stage, which are expected to open on the following morning on the same plant, were tied by a cotton filament in the afternoon. Next morning, the filament was untied and after pollinating with pollen grains

from the same plant, the flowers were tagged and bagged. For crossing, male and female flowers were tied by a cotton filament to keep the corolla closed to prevent contamination caused by foreign pollen. In the next morning, the male flower was picked. Pollination was made by rubbing the anthers against the stigma. The pollinated flower was tagged and bagged.

The selfed and hybrid fruits were harvested soon after maturity. They were cut crosswise and the seeds were scrabbed out and cleaned under running tap water. Seeds, after being dried under indirect sunlight, were used for planting.

The ten parental inbred lines, their 40 F_1 hybrids and the commercial F_1 hybrid Aswan (check) were evaluated in the field for two successive seasons during the 2004 and 2005 under low tunnels at the experimental farm, at –Borollous location, Kafr El-Shikh Governorate using a drip-irrigation system. Rows were covered with black plastic mulch of 0.2-0.3mm thickness. Seed were directly sown on January 10th, 2004 (the first season) and on January 15th, 2005 (the second season).

In each evaluation trial, the evaluated genotypes were arranged in a randomized complete block design (RCBD) with three replicates. Each plot was one row of 3m wide and 5m long and contained 10 plants spaced at 0.5m. All agricultural practices were carried out according to the recommendations of the Ministry of Agriculture, Egypt.

Data were recorded for the following characters:

1. **Yield**
   - Early fruit yield.
   - Total fruit yield.

   Data on yield were recorded in kg per plot then were transformed to tons per feddan.
2. **Fruit characteristics**

   Data on average fruit weight, rind thickness, total soluble solids (TSS) and fruit shape index were recorded on 5 random fruits / plot.

Statistical analysis

Data obtained were statistically analyzed using combined analysis after testing the homogeneity of the data of the two seasons (Gomez and Gomez, 1984) and mean comparisons were based on the Duncan's multiple range test (Duncan, 1955).

Heterosis

Heterosis was estimated according the following equations:

$$\text{Higher-parent heterosis} = \frac{\overline{F_1} - \overline{HP}}{\overline{HP}} \times 100$$

(according to Sinha and Khanna, 1975)

where: $\overline{HP}$: Mean of the higher or better parent.
$\overline{F_1}$: Mean of the first hybrid generation.

RESULTS AND DISCUSSION

Early yield

Data obtained on early yield (EY) of watermelon genotypes evaluated in the two seasons 2004 and 2005, are presented in Table (1). In every season, there were significant differences among the evaluated genotypes in EY.

Concerning parental evaluation,the inbred line Sugar Baby produced a high EY in both seasons followed by the inbred line Kodhi without significant differences between them and the check hybrid Aswan. Regarding the evaluated hybrids, the hybrids Giza 1 × Sugar Baby, Sugar Baby × Klondike, Sugar Baby × Peacock and Charleston Gray × Klondike produced high EY which were not significantly different from the check hybrid Aswan and also from the parental lines Kodhi and Sugar Baby. Only one hybrid, i.e., Charleston Gray × Klondike exhibited significant positive higher-parent heterosis for EY in the two seasons. Meanwhile, most of the evaluated hybrids showed negative higher-parent heterosis for this trait in the two seasons.

As for early yield relative to the check variety, none of the evaluated hybrids showed significant superiority in EY.

Total yield

Data obtained on total yield (TY) of watermelon genotypes evaluated in 2004 and 2005 seasons are presented in Table (2).

Combined analysis of both seasons showed significant differences among genotypes for TY. Concerning parents, the line 7150 produced the highest TY (28.7 tons/fed.), without significant differences from the control and also from the inbred lines Congo, Klondike, Mehesny and Peacock.

The two hybrids Charleston Gray × Klondike and Charleston Gray × Congo produced, significantly, the highest TY of 36.54 and 36.49 tons/fed., respectively, without significant differences form the check cultivar which produced TY of 33.46 tons/fed. and also without significant differences from the crosses Crimson Sweet × Congo, Crimson Sweet × Klondike, Crimson Sweet × Mehesny, Crimson Sweet × Peacock, Giza 1 × Sugar Baby and Sugar Baby × Peacock.

Three out of the 40 evaluated hybrids showed significant positive better–parent heterosis for this trait of 31.4 %, 28.2 % and 24.3 % for the crosses Charleston Gray × Congo, Charleston Gray × Klondike and Kodhi × Sugar Baby, respectively.

These results coincided with those of Sachan and Nath (1976) who reported that the yield of promising hybrids increased 87% over the yield of

Table 1. Mean performance of some watermelon genotypes and their hybrids and heterosis estimates for early yield in the 2004 and 2005 seasons

Genotype	Early yield (ton / feddan)		High parent heterosis (%)		F_1 relative to the check (%)	
	2004	2005	2004	2005	2004	2005
Check						
Aswan (F_1 hybrid)	9.71 ab	9.99 a	-	-	-	-
Parents						
Crimson Sweet (P_1)	6.91 c-g	7.28 e-i	-	-	-	-
Giza 1 (P_2)	7.84 cd	8.59 a-f	-	-	-	-
Kodhi (P_3)	8.40 bc	8.87 a-e	-	-	-	-
Sugar Baby (P_4)	9.33 ab	9.52 a-d	-	-	-	-
7150 (P_5)	6.44 d-g	7.18 e-i	-	-	-	-
Charleston Gray (P_6)	6.25 d-g	5.88 i	-	-	-	-
Congo (P_7)	5.88 fg	6.53 g-i	-	-	-	-
Klondike (P_8)	7.27 c-g	7.65 e-i	-	-	-	-
Mehesny (P_9)	6.44 d-g	6.25 g-i	-	-	-	-
Peacock (P_{10})	6.35 d-g	7.09 e-i	-	-	-	-
Hybrids developed						
$P_1 \times P_2$	6.81 c-g	7.00 e-i	-31.28	-18.51	-29.87	-29.93
$P_1 \times P_3$	6.53 d-g	7.03 e-i	-34.11	-20.74	-32.75	-29.63
$P_1 \times P_4$	6.16 d-g	7.09 e-i	-37.84	-25.53	-36.56	-29.03
$P_1 \times P_5$	7.28 c-g	8.03 b-h	-26.54	10.30	-25.03	-19.62
$P_1 \times P_6$	6.44 d-g	6.91 f-i	-35.02	-5.08	-33.68	-30.83
$P_1 \times P_7$	7.37 c-g	7.75 d-i	-25.63	6.46	-24.10	-22.42
$P_1 \times P_8$	7.09 c-g	7.00 e-i	-28.46	-8.50	-26.98	-29.93
$P_1 \times P_9$	7.09 c-g	6.81 f-i	-28.46	-6.46	-26.98	-31.83
$P_1 \times P_{10}$	7.18 c-g	7.93 c-h	-27.55	11.85	-26.06	-20.62
$P_2 \times P_3$	5.79 g	6.53 g-I	-31.07	-26.38	-40.37	-34.63
$P_2 \times P_4$	10.08 a	9.71 a-c	8.04	2.80	3.81	-2.80
$P_2 \times P_5$	6.53 d-g	7.00 e-i	-16.71	-18.51	-32.75	-29.93
$P_2 \times P_6$	7.37 c-g	7.65 e-i	-5.99	-13.85	-24.10	-23.42
$P_2 \times P_7$	6.07 e-g	7.19 e-i	-22.58	-16.30	-37.49	-28.03
$P_2 \times P_8$	5.97 fg	7.28 e-i	-23.85	-15.25	-38.52	-27.13

Table 1. Cont.

Genotype	Early yield (ton / feddan)		High parent heterosis (%)		F_1 relative to the check (%)	
	2004	2005	2004	2005	2004	2005
$P_2 \times P_9$	6.53 d-g	6.63 g-i	-16.71	-22.82	-32.75	-33.63
$P_2 \times P_{10}$	7.28 c-g	7.65 c-i	-7.14	-10.94	-25.03	-23.42
$P_3 \times P_4$	7.56 c-f	8.22 a-g	-18.97	-13.66	-22.14	-17.72
$P_3 \times P_5$	7.47 c-g	7.56 c-i	-11.07	-14.77	-23.07	-24.32
$P_3 \times P_6$	5.88 fg	7.09 c-i	-30.00	-20.07	-39.44	-29.03
$P_3 \times P_7$	6.25 d-g	6.07 hi	-25.60	-31.57	-35.63	-39.24
$P_3 \times P_8$	5.88 fg	6.63 g-i	-30.00	-25.25	-39.44	-33.63
$P_3 \times P_9$	6.87 c-g	7.09 c-i	-27.74	-20.07	-37.49	-29.03
$P_3 \times P_{10}$	6.44 d-g	6.16 hi	-23.33	-30.55	-33.68	-38.34
$P_4 \times P_5$	7.72 c-e	7.37 e-i	-17.26	-22.58	-20.49	-26.23
$P_4 \times P_6$	6.53 d-g	6.91 f-i	-30.01	-27.42	-32.75	-30.83
$P_4 \times P_7$	6.87 c-g	6.53 g-i	-34.94	-31.41	-37.49	-34.63
$P_4 \times P_8$	9.61 ab	9.71 a-c	3.00	2.00	-1.03	-2.80
$P_4 \times P_9$	6.63 d-g	6.53 g-i	-28.94	-31.41	-31.72	-34.63
$P_4 \times P_{10}$	9.61 ab	9.80 ab	3.00	2.94	-1.03	-1.90
$P_5 \times P_6$	5.97 fg	6.63 g-i	-7.30	-7.66	-38.52	-33.63
$P_5 \times P_7$	6.35 d-g	6.44 g-i	-1.40	-10.31	-34.60	-35.54
$P_5 \times P_8$	6.53 d-g	6.72 f-i	-10.18	-12.16	-32.75	-32.73
$P_5 \times P_9$	6.72 d-g	6.91 f-i	4.35	-3.76	-30.79	-30.83
$P_5 \times P_{10}$	6.87 c-g	6.81 f-i	-5.75	-5.15	-37.49	-31.83
$P_6 \times P_7$	6.25 d-g	6.16 hi	0.00	-5.67	-35.63	-38.34
$P_6 \times P_8$	9.89 ab	9.71 a-c	36.04*	26.93*	1.85	-2.80
$P_6 \times P_9$	6.87 eg	6.63 g-i	-5.75	6.08	-37.49	-33.63
$P_7 \times P_{10}$	6.16 d-g	6.63 g-i	-2.99	-6.49	-36.56	-33.63
$P_9 \times P_{10}$	5.97 fg	6.63 g-i	-7.30	-6.49	-38.52	-33.63

Table 2. Mean performance of some watermelon genotypes and their hybrids and heterosis estimates for total yield in the 2004 and 2005 seasons.

Genotype	Total yield (ton/feddan)			High parent heterosis (%)	F_1 relative to the check (%)
	2004	2005	*Mean*		
Check					
Aswan (F_1 hybrid)	35.09 a-c	31.83 a-c	33.46 ab	-	-
Parents					
Crimson Sweet (P_1)	23.52 o-p	25.76 d-h	24.64 f-i	-	-
Giza 1 (P_2)	27.44 g-o	27.63 c-h	27.53 c-i	-	-
Kodhi (P_3)	21.84 p	25.39 e-h	23.61 hi	-	-
Sugar Baby (P_4)	22.03 p	24.73 gh	23.38 i	-	-
7150 (P_5)	28.75 d-n	28.65 b-h	28.70 b-i	-	-
Charleston Gray (P_6)	25.29 k-p	25.67 d-h	25.48 e-i	-	-
Congo (P_7)	27.25 h-o	28.28 c-h	27.77 b-i	-	-
Klondike (P_8)	27.63 g-o	29.40 a-g	28.51 b-i	-	-
Mehesny (P_9)	27.63 g-o	28.47 b-h	28.05 b-i	-	-
Peacock (P_{10})	26.79 h-p	28.65 b-h	27.72 b-i	-	-
Hybrids developed					
$P_1 \times P_2$	30.52 c-k	29.58 a-g	30.05 b-f	9.15	-10.19
$P_1 \times P_3$	25.95 i-p	25.01 f-h	25.48 e-i	3.41	-23.85
$P_1 \times P_4$	25.57 j-p	22.96 h	24.27 g-i	-1.50	-27.47
$P_1 \times P_5$	30.71 c-j	29.12 a-g	29.91 b-f	4.22	-10.61
$P_1 \times P_6$	31.27 c-h	30.61 a-g	30.94 b-e	21.43	-7.53
$P_1 \times P_7$	31.83 c-h	31.36 a-e	31.59 a-d	13.76	-5.59
$P_1 \times P_8$	33.32 c-e	31.83 a-c	32.57 a-c	14.24	-2.66
$P_1 \times P_9$	32.67 c-g	32.29 a-c	32.48 a-c	15.79	-2.93
$P_1 \times P_{10}$	31.55 c-h	31.45 a-d	31.50 a-d	13.64	-5.86
$P_2 \times P_3$	24.68 m-p	26.6 c-h	25.64 e-i	-6.87	-23.37
$P_2 \times P_4$	33.97 b-d	32.29 a-c	33.13 a-c	20.34	-0.99
$P_2 \times P_5$	28.09 e-o	27.63 c-h	27.86 b-i	-2.93	-16.74
$P_2 \times P_6$	29.49 d-n	28.84 b-h	29.17 b-h	5.96	-12.82
$P_2 \times P_7$	28.09 e-o	28.28 c-h	28.19 b-i	1.51	-15.75
$P_2 \times P_8$	31.17 c-i	30.24 a-g	30.71 b-e	7.72	-8.22

Table 2. Cont.

Genotype	Total yield (ton/feddan)			High parent heterosis (%)	F_1 relative to the check (%)
	2004	2005	*Mean*		
$P_2 \times P_9$	30.99 c-i	29.68 a-g	30.33 b-e	8.13	-9.35
$P_2 \times P_{10}$	31.64 c-h	29.77 a-g	30.71 b-e	10.79	-8.22
$P_3 \times P_4$	29.49 d-n	29.21 a-g	29.35 b-g	24.31*	-12.28
$P_3 \times P_5$	29.31 d-n	30.89 a-f	30.10 b-f	4.88	-10.04
$P_3 \times P_6$	24.45 n-p	27.72 e-h	26.09 d-i	2.39	-22.83
$P_3 \times P_7$	29.59 d-n	28.84 b-h	29.21 b-g	5.19	-12.70
$P_3 \times P_8$	31.64 c-h	29.68 a-g	30.66 b-e	7.54	-8.37
$P_3 \times P_9$	31.64 c-h	29.40 a-g	30.52 b-e	8.81	-8.79
$P_3 \times P_{10}$	28.47 e-o	30.71 a-g	29.59 b-g	6.75	-11.57
$P_4 \times P_5$	29.40 d-n	29.96 a-g	29.68 b-g	3.41	-11.30
$P_4 \times P_6$	28.56 e-o	30.51 a-g	29.53 b-g	15.89	-11.75
$P_4 \times P_7$	30.05 c-l	29.21 a-g	29.63 b-g	6.70	-11.45
$P_4 \times P_8$	30.99 c-i	30.61 a-g	30.80 b-e	8.83	-7.95
$P_4 \times P_9$	31.73 c-h	30.24 a-g	30.99 b-e	10.48	-7.38
$P_4 \times P_{10}$	33.23 c-f	31.92 a-c	32.57 a-c	17.50	-2.66
$P_5 \times P_6$	28.19 e-o	28.28 c-h	28.23 b-i	-1.64	-15.63
$P_5 \times P_7$	27.81 g-o	28.37 c-h	28.09 b-i	-2.13	-16.05
$P_5 \times P_8$	29.21 d-n	31.27 a-e	30.24 b-f	5.37	-9.62
$P_5 \times P_9$	24.83 l-p	27.16 e-h	25.99 d-i	-9.44	-22.33
$P_5 \times P_{10}$	29.77 d-m	27.72 e-h	28.75 b-i	0.17	-14.08
$P_6 \times P_7$	37.99 ab	35.00 a	36.49 a	31.40*	9.06
$P_6 \times P_8$	38.64 a	34.44 ab	36.54 a	28.17*	9.21
$P_6 \times P_9$	31.27 e-h	30.15 a-g	30.71 b-e	9.48	-8.22
$P_7 \times P_{10}$	31.36 e-h	28.84 b-h	30.10 b-f	8.39	-10.04
$P_9 \times P_{10}$	28.00 f-o	28.56 b-h	28.28 b-i	0.82	-15.48

the better parent. In the same direction, Sidhu and Brar (1977) found that heterosis was the highest in the cross Sugar Baby × Shipper for yield. Also, Hussain *et al* (1977) reported that heterosis over superior-parent for yield was the greatest in the cross Sugar Baby × Sugar Surika. Also, Sidhu and Brar (1985) found that the crosses Sugar Baby × Shipper and Shipper × Black Diamond exhibited the highest values of heterosis for fruit yield relative to the better parent of 28.87% and 21.55%, respectively. In the same direction, Rajendran and Thamburaj (1993) found significant heterosis for fruit yield per vine. Also, Rajan Bansal *et al* (2002) reported that the maximum heterosis for fruit yield / plant was recorded in the cross Sel- B × Shipper (47.55%) followed by the crosses Hw-1 × A.M. (46.22%) and DM × Shipper (45.48%).

Average fruit weight

Data obtained on average fruit weight (AFW) of watermelon genotypes evaluated in 2004 and 2005 season are presented in Table (3).

Combined analysis of both seasons showed significant differences among the evaluated genotypes for AFW. The parent, Klondike produced the heaviest fruit among all evaluated parental genotypes but without significant differences from the inbred lines Crimson Sweet, Charleston Gray, Congo , Mehesny and Peacock. The inbred lines Charleston Gray, Klondike, Mehesny and Peacock significantly surpassed the check variety in AFW.

Regarding the evaluated hybrids, the crosses Charleston Gray × Klondike and Charleston Gray × Mehesny, significantly, produced the heaviest fruits compared with all evaluated genotypes and had an AFW of 8.5 and 8.3 kg, respectively.

Relative to control, 10 out of 40 evaluated hybrids surpassed the check hybrid ranging from 21.2 % to 66.1 %. The highest value (66.1%) was shown by the cross Charleston Gray × Klondike, followed by the cross Charleston Gray × Mehesny (62.4 %).

Only four hybrids, viz., Crimson Sweet × Mehesny, Charleston Gray × Klondike, Charleston Gray × Mehesny and Mehesny × Peacock exhibited significant positive better-parent heterosis for this trait ranging from 17.8 % to 23.7 %.

These results coincided with those of Sachan and Nath (1976) who found that fruit weight increased to a maximum of 16% over that of the better parent. Sidhu and Brar (1977) and Hussain *et al* (1977) reported that heterosis was the highest in one cross and ten crosses for fruit weight, respectively. Also, Salim (1989) reported that the hybrid vigour of the heavy fruits was observed in five crosses, with an average degree of heterosis ranging from 14.33% in the cross Crimson Sweet × Giza 21 to 40.21% in the cross Sun Shady × Crimson Sweet.

Table 3. Mean performance of some watermelon genotypes and their hybrids and heterosis estimates for average fruit weight in the 2004 and 2005 seasons

Genotype	Average fruit weight (kg)			High parent heterosis (%)	F_1 relative to the check (%)
	2004	2005	*Mean*		
Check					
Aswan (F_1 hybrid)	4.73 o-v	5.47 g-o	5.10 j-q	-	-
Parents					
Crimson Sweet (P_1)	6.80 f-m	6.23 d-i	6.12 e-j	-	-
Giza 1 (P_2)	5.37 h-u	5.2 j-q	5.28 h-q	-	-
Kodhi (P_3)	3.40 x	3.53 t-u	3.47 rs	-	-
Sugar Baby (P_4)	3.43 wx	3.37 u	3.40 s	-	-
7150 (P_5)	4.80 n-v	4.87 r-u	4.43 n-r	-	-
Charleston Gray (P_6)	7.27 b-e	6.4 e-f	6.83 d-f	-	-
Congo (P_7)	6.13 e-i	6.13 d-i	6.13 e-j	-	-
Klondike (P_8)	7.83 c-f	7.13 c	7.88 c-e	-	-
Mehesny (P_9)	6.50 d-h	6.87 d-j	6.28 e-i	-	-
Peacock (P_{10})	6.33 e-i	6.83 e-j	6.18 e-i	-	-
Hybrids developed					
$P_1 \times P_2$	4.57 q-v	4.73 n-r	4.65 l-q	-24.82	-8.82
$P_1 \times P_3$	4.80 v-x	4.50 p-s	4.25 q-s	-30.56	-16.67
$P_1 \times P_4$	5.80 l-v	5.65 f-m	5.33 h-p	-12.91	4.51
$P_1 \times P_5$	5.10 j-v	5.73 f-m	5.42 h-n	-11.44	6.27
$P_1 \times P_6$	5.87 k-v	5.43 h-o	5.25 i-q	-23.13	2.94
$P_1 \times P_7$	6.87 e-g	6.77 c-e	6.82 d-f	11.26	33.73*
$P_1 \times P_8$	5.80 g-p	5.97 e-k	5.88 f-k	-16.95	15.29
$P_1 \times P_9$	7.87 a-c	6.93 cd	7.40 b-d	17.83*	45.10*
$P_1 \times P_{10}$	6.20 e-k	6.80 e-k	6.10 e-j	-1.29	19.61
$P_2 \times P_3$	4.37 u-x	4.33 q-t	4.35 o-s	-17.61	-14.71
$P_2 \times P_4$	4.97 l-v	5.10 k-q	5.03 k-q	-4.73	-1.37
$P_2 \times P_5$	4.70 o-v	3.87 s-u	4.28 p-s	-18.94	-16.08
$P_2 \times P_6$	4.93 m-v	6.23 d-i	5.58 g-m	-18.30	9.41
$P_2 \times P_7$	5.97 f-n	6.33 e-h	6.15 e-j	0.33	20.59
$P_2 \times P_8$	5.93 f-n	5.6 f-n	5.77 g-k	-18.50	13.14

Table 3. Cont.

Genotype	Average fruit weight (kg)			High parent heterosis (%)	F_1 relative to the check (%)
	2004	2005	*Mean*		
$P_2 \times P_9$	6.20 e-k	6.17 d-i	6.18 e-i	-1.59	21.18*
$P_2 \times P_{10}$	5.57 h-t	4.93 i-r	5.25 i-q	-15.05	2.94
$P_3 \times P_4$	4.70 o-v	3.87 s-u	4.28 p-s	23.34	-16.08
$P_3 \times P_5$	4.50 r-w	4.47 p-s	4.48 n-q	1.13	-12.16
$P_3 \times P_6$	5.30 i-u	5.33 i-p	5.32 h-p	-22.11	4.31
$P_3 \times P_7$	5.63 h-s	5.47 g-o	5.55 g-m	-9.46	8.82
$P_3 \times P_8$	5.33 h-u	5.50 f-o	5.42 h-n	-23.45	6.27
$P_3 \times P_9$	4.63 p-v	4.60 o-s	4.62 m-q	-26.43	-9.41
$P_3 \times P_{10}$	4.40 t-x	4.40 q-s	4.40 n-r	-28.80	-13.73
$P_4 \times P_5$	5.03 k-v	4.90 m-r	4.97 k-q	12.19	-2.55
$P_4 \times P_6$	5.70 h-q	5.00 i-q	5.35 h-o	-21.67	4.90
$P_4 \times P_7$	5.83 g-o	5.83 f-l	5.83 f-k	-4.89	14.31
$P_4 \times P_8$	5.67 h-r	5.70 f-m	5.68 g-l	-19.77	11.37
$P_4 \times P_9$	5.07 k-v	5.03 i-q	5.05 k-q	-19.59	-0.98
$P_4 \times P_{10}$	5.23 i-u	5.4 i-o	5.32 h-p	-13.92	4.31
$P_5 \times P_6$	6.93 c-g	6.13 d-i	6.53 d-g	-4.39	28.04*
$P_5 \times P_7$	5.83 g-o	5.43 h-o	5.63 g-m	-8.16	10.39
$P_5 \times P_8$	6.07 f-m	6.23 d-i	6.15 e-j	-13.14	20.59
$P_5 \times P_9$	6.30 e-i	6.33 c-h	6.32 e-h	0.64	23.92*
$P_5 \times P_{10}$	6.40 e-i	6.1 d-j	6.25 e-i	1.13	22.55*
$P_6 \times P_7$	6.47 s-x	4.90 m-r	4.68 l-q	-31.48	-8.24
$P_6 \times P_8$	8.10 ab	8.83 a	8.47 a	19.63*	66.08*
$P_6 \times P_9$	8.43 a	8.13 ab	8.28 ab	21.23*	62.35*
$P_7 \times P_{10}$	6.27 e-j	6.37 c-g	6.32 e-h	2.27	23.92*
$P_9 \times P_{10}$	7.57 a-d	7.97 b	7.77 a-c	23.73*	52.35*

Fruit Length

Data obtained on fruit length (FL) of watermelon genotypes evaluated in 2004 and 2005 seasons are presented in Table (4).

Combined analysis for the two seasons showed significant differences among the evaluated genotypes in this trait.

Concerning the evaluated parental genotypes, the inbred line Charleston Gray produced the longest fruit followed by the inbred line Congo without significant differences between them.

Regarding the evaluated hybrids, the cross Congo × Peacock produced, significantly, the longest fruits among all evaluated genotypes followed by the crosses, Charleston Gray × Klondike and Charleston Gray × Congo.

Relative to the standard variety, 17 out of the evaluated 40 hybrids exhibited significant superiority for FL ranging from 11.55% to 56.37% in the crosses 7150 x Klondike and Congo x Peacock, respectively.

As for better-parent heterosis, only two hybrids out of the 40 evaluated hybrids significantly surpassed their better–parents in FL. On the contrary, 17 hybrids showed significant negative better parent heterosis for this trait ranging from –22.86% to -9.91% in the crosses Giza 1 × Klondike and 7150 × Peacock, respectively.

Fruit shape index

Data obtained on fruit shape index (FSI) of watermelon genotypes evaluated in 2004 and 2005 seasons are presented in Table (5).

Combined analysis of both seasons showed significant differences among the evaluated genotypes in FSI. The parental lines Charleston Gray, Congo and Peacock produced elongate fruits and the inbred line Klondike had oval fruits. Meanwhile, other evaluated genotypes had spherical fruits. Twenty one out of the 40 hybrids evaluated had oval fruits, 17 hybrids had spherical fruits, and only two had elongated fruits.

As for better-parent heterosis, 23 hybrids out of the 40 evaluated hybrids exhibited significant negative better parent heterosis for FSI ranging from –30.77% to –8.97% in the crosses Crimson Sweet × Peacock and Mehesny × Peacock, respectively.

Fruit rind thickness

Data obtained on fruit rind thickness (FRT) of watermelon genotypes evaluated in 2004 and 2005 seasons are presented in Table (6).

Concerning evaluation of parental genotypes, the parents Kodhi, Sugar Baby and Peacock produced fruits with the least FRT in the two seasons without significant differences from the check hybrid Aswan.

Regarding FRT of the evaluated hybrids, the hybrid Giza 1 × Sugar Baby produced the least FRT compared with all evaluated hybrids but

Table 4. Mean performance of some watermelon genotypes and their hybrids and heterosis estimates for fruit length in the 2004 and 2005 seasons

Genotype	Fruit length (cm)			High parent heterosis (%)	F_1 relative to the check (%)
	2004	2005	*Mean*		
Check					
Aswan (F_1 hybrid)	22.6 o-t	24.17 l-u	23.38 k-q	-	-
Parents					
Crimson Sweet (P_1)	21.9 p-u	23.97 m-u	22.93 m-s	-	-
Giza 1 (P_2)	22.4 o-t	22.47 t-w	22.43 n-s	-	-
Kodhi (P_3)	19.6 uv	19.5 xy	19.55 uv	-	-
Sugar Baby (P_4)	19.0 v	18.13 y	18.57 v	-	-
7150 (P_5)	19.07 v	20.4 wx	19.73 t-v	-	-
Charleston Gray (P_6)	33.0 b	33.73 bc	33.37 b	-	-
Congo (P_7)	30.83 b-d	32.9 cd	31.87 bc	-	-
Klondike (P_8)	31.33 bc	30.43 ef	30.88 c	-	-
Mehesny (P_9)	24.7 j-o	24.77 k-t	24.73 g-n	-	-
Peacock (P_{10})	29.83 c-e	29.5 e-g	29.67 cd	-	-
Hybrids developed					
$P_1 \times P_2$	23.30 m-r	23.27 q-v	23.28 k-q	1.53	-0.43
$P_1 \times P_3$	21.93 p-u	22.53 t-w	22.23 n-s	-3.05	-4.92
$P_1 \times P_4$	21.90 p-u	23.8 n-u	22.85 n-s	-0.35	-2.27
$P_1 \times P_5$	21.33 q-v	22.63 s-w	21.98 o-t	-4.14	-5.99
$P_1 \times P_6$	28.00 e-g	26.33 h-m	27.17 e-g	-18.58*	16.21*
$P_1 \times P_7$	27.10 f-j	28.10 g-i	27.60 d-f	-13.40*	18.05*
$P_1 \times P_8$	24.40 k-p	23.70 o-u	24.05 i-p	-22.12*	2.87
$P_1 \times P_9$	24.30 l-p	25.10 k-s	24.70 g-n	-0.12	5.65
$P_1 \times P_{10}$	23.97 m-p	22.53 t-w	23.25 k-q	-21.64*	-0.56
$P_2 \times P_3$	20.47 s-v	22.04 u-w	21.25 q-u	-5.26	-9.11
$P_2 \times P_4$	22.47 o-t	23.17 r-v	22.82 n-s	1.74	-2.40
$P_2 \times P_5$	20.10 t-v	20.87 v-x	20.48 s-v	-8.69	-12.40*
$P_2 \times P_6$	25.37 h-m	27.97 g-j	26.67 e-h	-20.08*	14.07*
$P_2 \times P_7$	26.73 f-l	25.57 j-r	26.15 e-j	-17.95*	11.85*
$P_2 \times P_8$	23.67 m-q	23.97 m-u	23.82 j-p	-22.86*	1.88

Table 4. Cont.

Genotype	Fruit length (cm)			High parent heterosis (%)	F_1 relative to the check (%)
	2004	2005	*Mean*		
$P_2 \times P_9$	24.70 j-o	24.67 k-t	24.68 g-n	-0.20	5.56
$P_2 \times P_{10}$	23.93 m-p	23.67 p-u	23.80 j-p	-19.78*	1.80
$P_3 \times P_4$	20.37 s-v	20.67 wx	20.52 r-v	4.96	-12.23*
$P_3 \times P_5$	20.97 r-v	22.40 t-w	21.68 p-u	9.88	-7.27
$P_3 \times P_6$	27.43 f-i	26.53 h-l	26.98 e-g	-19.15*	15.40*
$P_3 \times P_7$	26.97 f-j	25.73 i-q	26.35 e-i	-17.32*	12.70*
$P_3 \times P_8$	25.27 h-n	25.77 i-q	25.52 f-l	-17.36*	9.15
$P_3 \times P_9$	22.70 n-s	23.27 q-v	22.98 l-r	-7.08	-1.71
$P_3 \times P_{10}$	22.47 o-t	24.57 k-t	23.52 k-q	-20.73*	0.60
$P_4 \times P_5$	22.53 o-t	23.50 p-u	23.02 l-q	16.68*	-1.54
$P_4 \times P_6$	27.03 f-j	26.73 h-k	26.88 e-g	-19.45*	14.97*
$P_4 \times P_7$	26.63 f-l	26.20 h-o	26.42 e-i	-17.10*	13.00*
$P_4 \times P_8$	24.97 i-o	26.23 h-n	25.60 e-k	-17.10*	9.50
$P_4 \times P_9$	23.77 m-q	24.83 k-t	24.30 h-o	-1.74	3.93
$P_4 \times P_{10}$	23.77 m-q	25.57 j-r	24.67 g-n	-16.85*	5.52
$P_5 \times P_6$	27.63 e-h	28.53 f-h	28.08 de	-15.85*	20.10*
$P_5 \times P_7$	28.67 d-f	26.80 i-p	27.33 ef	-14.25*	16.89*
$P_5 \times P_8$	25.87 g-m	26.30 h-n	26.08 e-j	-15.54*	11.55*
$P_5 \times P_9$	25.70 g-m	25.23 k-r	25.47 f-m	2.99	8.94
$P_5 \times P_{10}$	26.90 f-k	26.57 h-l	26.73 e-h	-9.91*	14.33*
$P_6 \times P_7$	33.20 b	33.77 bc	33.48 b	-0.56	43.20*
$P_6 \times P_8$	32.03 bc	35.2 0 b	33.62 b	0.75	43.80*
$P_6 \times P_9$	31.93 bc	30.97 de	31.45 bc	-5.75	34.52*
$P_7 \times P_{10}$	35.77 a	37.37 a	36.56 a	14.72*	56.37*
$P_9 \times P_{10}$	31.53 bc	30.53 ef	31.03 c	4.58	32.72*

Table 5. Mean performance of some watermelon genotypes and their hybrids and heterosis estimates for fruit shape index in the 2004 and 2005 seasons

Genotype	Fruit shape index			High parent heterosis (%)	F_1 relative to the check (%)
	2004	2005	*Mean*		
Check					
Aswan (F_1 hybrid)	1.10 j-p	1.09 s-v	1.09 j-m	-	-
Parents					
Crimson Sweet (P_1)	1.11 i-p	1.13 p-v	1.12 j-m	-	-
Giza 1 (P_2)	1.14 i-o	1.15 n-v	1.14 i-m	-	-
Kodhi (P_3)	1.06 j-p	1.09 s-v	1.08 k-m	-	-
Sugar Baby (P_4)	1.06 j-p	1.02 v	1.04 m	-	-
7150 (P_5)	1.03 m-p	1.09 s-v	1.06 l-m	-	-
Charleston Gray (P_6)	1.71 a	1.73 ab	1.72 a	-	-
Congo (P_7)	1.62 ab	1.82 a	1.72 a	-	-
Klondike (P_8)	1.49 c-e	1.37 d-g	1.43 cd	-	-
Mehesny (P_9)	1.07 j-p	1.10 r-v	1.09 j-m	-	-
Peacock (P_{10})	1.57 bc	1.54 c	1.56 b	-	-
Hybrids developed					
$P_1 \times P_2$	1.16 i-l	1.17 m-u	1.16 h-m	1.75	6.42
$P_1 \times P_3$	1.15 i-m	1.13 p-v	1.14 i-m	1.79	4.59
$P_1 \times P_4$	1.02 n-p	1.10 q-v	1.06 k-m	-5.36	-2.75
$P_1 \times P_5$	1.01 op	1.11 p-v	1.06 k-m	-5.36	-2.75
$P_1 \times P_6$	1.45 d-f	1.37 d-g	1.41 c-e	-18.02*	29.36
$P_1 \times P_7$	1.23 hi	1.27 g-n	1.25 f-i	-27.33*	14.68
$P_1 \times P_8$	1.12 i-p	1.14 o-v	1.13 i-m	-20.98*	3.67
$P_1 \times P_9$	1.14 i-n	1.12 p-v	1.13 i-m	0.89	3.67
$P_1 \times P_{10}$	1.05 k-p	1.11 q-v	1.08 j-m	-30.77*	-0.92
$P_2 \times P_3$	1.01 p	1.07 t-v	1.04 m	-8.77	-4.59
$P_2 \times P_4$	1.06 j-p	1.11 q-v	1.09 j-m	-4.39	0.00
$P_2 \times P_5$	1.07 j-p	1.05 uv	1.06 k-m	-7.02	-2.75
$P_2 \times P_6$	1.38 e-g	1.34 e-i	1.36 d-f	-20.93*	24.77
$P_2 \times P_7$	1.31 gh	1.22 i-r	1.27 f-h	-26.16*	16.51
$P_2 \times P_8$	1.17 i-k	1.24 h-p	1.21 g-j	-15.38*	11.01

Table 5. Cont.

Genotype	Fruit shape index			High parent heterosis (%)	F_1 relative to the check (%)
	2004	2005	*Mean*		
$P_2 \times P_9$	1.04 i-p	1.10 q-v	1.07 k-m	-6.14	-1.83
$P_2 \times P_{10}$	1.14 i-o	1.14 o-v	1.14 i-m	-26.92*	4.59
$P_3 \times P_4$	1.07 j-p	1.13 p-v	1.10 j-m	1.85	0.92
$P_3 \times P_5$	1.06 j-p	1.05 uv	1.06 l-m	-2.78	-3.67
$P_3 \times P_6$	1.38 e-g	1.32 e-j	1.35 d-f	-21.51*	23.85
$P_3 \times P_7$	1.36 fg	1.29 f-l	1.33 d-f	-22.67*	22.02
$P_3 \times P_8$	1.18 ij	1.19 k-t	1.19 h-k	-16.78*	19.17
$P_3 \times P_9$	1.10 j-p	1.18 l-u	1.14 i-m	4.59	4.59
$P_3 \times P_{10}$	1.15 i-m	1.26 g-o	1.20 g-j	-23.08*	10.09
$P_4 \times P_5$	1.11 i-p	1.13 p-v	1.12 j-m	5.66	2.75
$P_4 \times P_6$	1.44 d-f	1.36 d-h	1.40 c-e	-18.60*	28.44
$P_4 \times P_7$	1.30 gh	1.31 e-k	1.31 e-g	-24.42*	19.27
$P_4 \times P_8$	1.15 i-m	1.19 k-t	1.17 h-l	-18.18*	7.34
$P_4 \times P_9$	1.12 i-p	1.14 o-v	1.13 i-m	3.67	3.67
$P_4 \times P_{10}$	1.15 i-m	1.19 k-t	1.17 h-l	-25.00*	7.34
$P_5 \times P_6$	1.41 e-g	1.42 de	1.42 c-e	-17.44*	30.28
$P_5 \times P_7$	1.36 fg	1.29 f-m	1.32 d-f	-23.26*	21.10
$P_5 \times P_8$	1.35 fg	1.21 j-s	1.28 f-h	-10.49*	17.43
$P_5 \times P_9$	1.11 j-p	1.11 q-v	1.11 j-m	1.83	1.83
$P_5 \times P_{10}$	1.12 i-p	1.23 i-q	1.18 h-l	-24.36*	8.26
$P_6 \times P_7$	1.65 ab	1.71 ab	1.68 a	-2.33	54.13
$P_6 \times P_8$	1.45 d-f	1.38 d-g	1.42 c-e	-17.44*	30.28
$P_6 \times P_9$	1.55 b-d	1.46 cd	1.51 bc	-12.21*	38.53
$P_7 \times P_{10}$	1.66 ab	1.70 b	1.68 a	-2.33	54.13
$P_9 \times P_{10}$	1.43 d-f	1.40 d-f	1.42 c-e	-8.97*	30.28

Table 6. Mean performance of some watermelon genotypes and their hybrids and heterosis estimates for fruit rind thickness in the 2004 and 2005 seasons

Genotype	Rind thickness (cm)		High parent heterosis (%)		F_1 relative to the check (%)	
	2004	2005	2004	2005	2004	2005
Check						
Aswan (F_1 hybrid)	1.00 g-r	1.02d-i	-	-	-	-
Parents						
Crimson Sweet (P_1)	1.18 b-g	1.22 a-f	-	-	-	-
Giza 1 (P_2)	1.09 e-n	1.08 b-i	-	-	-	-
Kodhi (P_3)	0.85 r	0.95 hi	-	-	-	-
Sugar Baby (P_4)	0.89 o-r	0.89 i	-	-	-	-
7150 (P_5)	1.10 d-l	1.13 b-h	-	-	-	-
Charleston Gray (P_6)	1.08 e-o	1.12 b-h	-	-	-	-
Congo (P_7)	1.09 e-m	1.14 b-h	-	-	-	-
Klondike (P_8)	1.08 e-o	1.10 b-i	-	-	-	-
Mehesmy (P_9)	1.34 ab	1.30 ab	-	-	-	-
Peacock (P_{10})	0.90 n-r	0.98 g-i	-	-	-	-
Hybrids developed						
$P_1 \times P_2$	1.06 e-p	1.16 b-h	-2.8	7.41	6.00	13.73
$P_1 \times P_3$	1.14 c-k	1.11 b-i	43.1*	16.84	14.00	8.82
$P_1 \times P_4$	0.91 m-r	1.12 b-h	2.2	25.8*	-9.00	9.80
$P_1 \times P_5$	1.15 c-j	1.16 b-h	4.5	2.65	15.00	13.73
$P_1 \times P_6$	1.08 e-o	1.14 b-h	0	1.79	8.00	11.76
$P_1 \times P_7$	1.44 a	1.28 a-c	32.1*	12.3	44.00	25.49
$P_1 \times P_8$	1.18 b-h	1.25 a-d	9.3	13.63	18.00	22.55
$P_1 \times P_9$	1.24 b-e	1.17 b-h	5.1	-4.1	24.00	14.71
$P_1 \times P_{10}$	1.10 d-l	1.08 b-i	22.2*	10.2	10.00	5.88
$P_2 \times P_3$	0.90 n-r	1.02 d-i	-5.9	7.4	-10.00	0.00
$P_2 \times P_4$	0.87 p-r	0.89 i	-2.2	0	-13.00	-12.75
$P_2 \times P_5$	1.06 e-p	1.18 a-h	-2.8	9.3	6.00	15.69
$P_2 \times P_6$	1.09 e-m	1.12 b-h	0.9	3.7	9.00	9.80
$P_2 \times P_7$	1.03 g-r	1.14 b-h	-5.5	5.6	3.00	11.76
$P_2 \times P_8$	1.15 c-j	1.21 a-g	6.5	12.03	15.00	18.63

Table 6. Cont.

Genotype	Rind thickness (cm)		High parent heterosis (%)		F_1 relative to the check (%)	
	2004	2005	2004	2005	2004	2005
$P_2 \times P_9$	1.09 c-n	1.08 b-i	0	0.9	9.00	5.88
$P_2 \times P_{10}$	1.03 g-r	1.09 b-i	14.4	11.2	3.00	6.86
$P_3 \times P_4$	0.92 l-r	0.98 g-i	8.2	10.1	-8.00	-3.92
$P_3 \times P_5$	0.98 i-r	0.99 f-i	15.3	4.2	-2.00	-2.94
$P_3 \times P_6$	0.99 h-r	1.06 c-i	16.5	11.6	-1.00	3.92
$P_3 \times P_7$	0.95 k-r	1.00 e-i	11.8	5.3	-5.00	-1.96
$P_3 \times P_8$	1.03 gr	1.16 b-h	21.2	22.1	3.00	13.73
$P_3 \times P_9$	0.98 i-r	1.01 e-i	15.3	6.3	-2.00	-0.98
$P_3 \times P_{10}$	0.88 p-r	1.00 e-i	3.5	5.3	-12.00	-1.96
$P_4 \times P_5$	0.98 j-r	1.06 c-i	10.1	19.1	-2.00	3.92
$P_4 \times P_6$	1.04 f-q	1.17 b-h	16.9	31.5*	4.00	14.71
$P_4 \times P_7$	0.93 l-r	1.03 d-i	4.5	15.7	-7.00	0.98
$P_4 \times P_8$	0.86 qr	1.03 d-i	-3.4	15.7	-14.00	0.98
$P_4 \times P_9$	1.28 a-d	1.21 a-g	43.8*	35.9*	28.00	18.63
$P_4 \times P_{10}$	0.99 h-r	1.00 e-i	11.2	12.4	-1.00	-1.96
$P_5 \times P_6$	1.19 b-g	1.40 a	10.2	25.0*	19.00	37.25
$P_5 \times P_7$	1.14 c-k	1.08 b-i	4.6	-4.4	14.00	5.88
$P_5 \times P_8$	1.14 c-k	1.10 b-i	5.6	0.9	14.00	7.84
$P_5 \times P_9$	1.24 b-e	1.23 a-e	12.7	8.8	24.00	20.59
$P_5 \times P_{10}$	1.09 c-n	1. 09 b-i	21.1	12.2	9.00	7.84
$P_6 \times P_7$	1.17 b-i	1.16 b-h	8.3	3.6	17.00	13.73
$P_6 \times P_8$	1.30 a-c	1.28 a-c	20.4*	16.4	30.00	25.49
$P_6 \times P_9$	1.22 b-f	1.20 a-g	13.0	7.1	22.00	17.65
$P_7 \times P_{10}$	1.05 e-p	1.16 b-h	16.7	18.4	5.00	13.73
$P_9 \times P_{10}$	1.17 b-i	1.16 b-h	30.9*	18.4	17.00	13.73

without significant differences from both the control and most of the evaluated hybrids in the two seasons.

In the two seasons, most of the evaluated hybrids were not significantly different in FRT from their better parents, i..e., the parents having thin rind.

These results partly agree with El-Lithy (1986) who found that hybrid vigour was strongly expressed in rind thickness in the original cross towards the thin rind. Also, Salim (1989) reported that only two crosses significantly decreased in rind of fruit compared to the thin parent by -18.95% in the cross Peacock × Congo and -18.02% in the cross Cong × Crimson Sweet.

Total Soluble Solids

Data obtained on total soluble solids (TSS) of watermelon genotypes evaluated in 2004 and 2005 seasons are presented in Table (7).

Combined analysis of both seasons showed significant differences among the evaluated genotypes in fruit TSS. The parent Klondike produced fruits having the highest TSS content (11.1%) among all evaluated parental genotypes, but was not significantly different from the check hybrid (Aswan) in this trait. This parent and most of the evaluated parental genotypes were not significantly different from the check hybrid (Aswan).

Regarding the evaluated hybrids, the hybrid Giza 1 × Sugar Baby produced fruits with the highest TSS content (11.7%) among all evaluated genotypes with significant differences from the check hybrid (Aswan). At the same time, this hybrid was not significantly different in TSS from other 12 hybrids.

The hybrid Giza 1 × Sugar Baby was the only one which significantly surpassed the standard hybrid Aswan in TSS.

As for better parent heterosis, only 5 out of the 40 evaluated hybrids significantly surpassed their better parents in fruit TSS with a range from 6.1 % to 12.2 % with the hybrid Kodhi × Charleston Gray having the highest estimate.

These results are in agreement with results of Brar and Nandpuri (1976), Sachan and Nath (1976), Hussain *et al* (1977), Rajendran and Thamburaj (1993) who found that TSS showed high heterosis values for some hybrids over their better-parents. Also, Salim (1989) reported that the maximum better-parent heterosis for TSS was recorded in the cross Peacock × Crimson Sweet (19.4%) followed by the crosses Sun Shady × Crimson Sweet (10.33%) and Sun Shady × Giza 21 (9.73). In another study, Rajan Bansal *et al.* (2002) reported that the cross DM × Shipper exhibited the maximum heterosis (18.84%) over the better parent for TSS followed by the cross Sel-B × Shipper (11.77%).

Table 7. Mean performance of some watermelon genotypes and their hybrids and heterosis estimates for TSS in the 2004 and 2005 seasons

Genotype	TSS			High parent heterosis (%)	F_1 relative to the check (%)
	2004	2005	Mean		
Check					
Aswan (F_1 hybrid)	10.90 a-i	10.97 ab	10.93 b-i	-	-
Parents					
Crimson Sweet (P_1)	10.40 e-n	10.47 ab	10.43 g-n	-	-
Giza 1 (P_2)	10.23 g-n	10.30 ab	10.27 h-n	-	-
Kodhi (P_3)	9.77 mn	10.17 ab	9.97 l-n	-	-
Sugar Baby (P_4)	10.80 a-j	10.57 ab	10.68 d-l	-	-
7150 (P_5)	10.17 h-n	10.23 ab	10.20 i-n	-	-
Charleston Gray (P_6)	9.87 l-n	10.13 ab	10.00 l-n	-	-
Congo (P_7)	9.70 n	10.13 ab	9.92 mn	-	-
Klondike (P_8)	11.00 a-h	11.10 ab	11.05 a-g	-	-
Mehesny (P_9)	9.90 k-n	9.83 ab	9.87 n	-	-
Peacock (P_{10})	10.80 a-j	10.83 ab	10.82 d-j	-	-
Hybrids developed					
$P_1 \times P_2$	10.70 b-l	10.93 ab	10.82 d-j	3.74	-1.01
$P_1 \times P_3$	10.20 g-n	10.13 ab	10.17 j-n	-2.49	-6.95
$P_1 \times P_4$	10.10 i-n	10.43 ab	10.27 h-n	-3.84	-6.04
$P_1 \times P_5$	11.00 a-h	11.13 ab	11.07 a-g	6.14*	1.28
$P_1 \times P_6$	10.43 e-n	10.77 ab	10.60 e-n	1.63	-3.02
$P_1 \times P_7$	10.73 b-k	11.00 ab	10.87 c-j	4.22	-0.55
$P_1 \times P_8$	10.53 e-n	10.53 ab	10.53 f-n	-4.71	-3.66
$P_1 \times P_9$	10.27 g-n	10.53 ab	10.40 g-n	-0.29	-4.85
$P_1 \times P_{10}$	11.13 a-f	11.50 ab	11.32 a-e	4.62	3.57
$P_2 \times P_3$	10.77 a-j	10.93 ab	10.85 c-j	5.65	-0.73
$P_2 \times P_4$	11.60 a	11.73 ab	11.67 a	9.27*	6.77*
$P_2 \times P_5$	10.37 f-n	10.87 ab	10.62 e-m	3.41	-2.84
$P_2 \times P_6$	10.57 e-m	10.77 ab	10.67 d-m	3.89	-2.38
$P_2 \times P_7$	10.73 b-k	11.03 ab	10.88 b-j	5.94	-0.46
$P_2 \times P_8$	11.43 ab	11.33 ab	11.38 a-d	2.99	4.12

Table 7. Cont.

Genotype	TSS			High parent heterosis (%)	F_1 relative to the check (%)
	2004	2005	*Mean*		
$P_2 \times P_9$	9.97 j-n	10.03 ab	10.00 i-n	-2.63	-8.51
$P_2 \times P_{10}$	11.00 a-h	11.20 ab	11.10 a-g	2.59	1.56
$P_3 \times P_4$	11.03 a-g	10.90 ab	10.97 a-h	2.72	0.37
$P_3 \times P_5$	10.67 b-l	10.87 ab	10.77 d-k	5.59	-1.46
$P_3 \times P_6$	11.23 a-e	11.20 ab	11.22 a-f	12.20*	2.65
$P_3 \times P_7$	10.57 c-m	10.80 ab	10.68 d-l	7.12	-2.29
$P_3 \times P_8$	11.00 a-h	11.03 ab	11.02 a-h	-0.27	0.82
$P_3 \times P_9$	9.73 mn	10.10 ab	9.92 mn	-0.50	-9.24
$P_3 \times P_{10}$	11.37 a-c	11.43 ab	11.40 a-d	5.36	4.30
$P_4 \times P_5$	10.43 e-n	10.77 ab	10.60 e-n	-0.75	-3.02
$P_4 \times P_6$	10.57 c-m	10.73 ab	10.65 d-m	-0.28	-2.56
$P_4 \times P_7$	10.03 j-n	10.00 ab	10.02 i-n	-6.18	-8.33
$P_4 \times P_8$	11.43 ab	11.80 ab	11.62 ab	5.16	6.31
$P_4 \times P_9$	10.10 i-n	9.73 b	9.92 mn	-7.12	-9.24
$P_4 \times P_{10}$	11.33 a-d	11.83 a	11.58 a-c	7.02*	5.95
$P_5 \times P_6$	11.13 a-f	10.90 ab	11.02 a-h	8.04*	0.82
$P_5 \times P_7$	10.70 b-l	11.13 ab	10.92 b-j	7.06	-0.09
$P_5 \times P_8$	10.77 a-j	11.00 ab	10.88 b-j	-1.54	-0.46
$P_5 \times P_9$	10.70 i-n	9.93 ab	10.00 i-n	-1.96	-8.51
$P_5 \times P_{10}$	10.10 i-n	10.00 ab	10.05 k-n	-7.12	-8.05
$P_6 \times P_7$	10.50 d-n	10.80 ab	10.65 d-m	6.50	-2.56
$P_6 \times P_8$	10.97 a-h	11.67 ab	11.32 a-e	2.44	3.57
$P_6 \times P_9$	10.77 a-j	10.53 ab	10.65 d-m	6.50	-2.56
$P_7 \times P_{10}$	10.47 e-n	10.87 ab	10.67 d-m	-1.39	-2.38
$P_9 \times P_{10}$	10.23 g-n	10.45 ab	10.34 g-n	-4.44	-5.40

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استنباط وتقييم بعض هجن البطيخ الجديدة وحساب قوة الهجين لها

أحمد حسن خريبة[1]، خالد السيد على عبد العاطى[1] ، محمد محمود صالح[2]، ربيع رمضان على الحواجرى[2]

١- قسم الخضر – كلية الزراعة – جامعة القاهرة

٢- أقسام بحوث الخضر – معهد بحوث البساتين – مركز البحوث الزراعية

أجريت هذه الدراسة خلال الفترة من 2001 حتى 2005، وقد أجرى التلقيح الذاتى وكذلك التهجينات فى الصوب بمزرعة بحوث الخضر بقها بمحافظة القليوبية خلال الفترة من 2001 وحتى 2003، بينما تم التقييم خلال موسمين متتاليين عامى 2004 و 2005 تحت الأنفاق البلاستيكية بمنطقة البرلس بكفر الشيخ باستخدام الرى بالتنقيط وتغطية خطوط الزراعة بالبلاستيك الأسود.

استخدم فى هذه الدراسة عشرة آباء عبارة عن سلالات تربية داخلية مستنبطة من الأصناف : بيكوك، جيزة 1، شارلستون جراى، شوجر بيبى، كريمسون سويت، كلوندیك، كودای ، كونجو ، محيسنى ، السلالة 7150. نفذت هذه الآباء فى اتجاه واحد لإنتاج 45 هجين جيل أول، وقد تم إستبعاد 5 هجن منها من التقييم بسبب قلة البذور المنتجة منها. قيمت هذه الهجن (الأربعون) وكذلك آبائها بالإضافة إلى الهجين التجارى أسوان (للمقارنة) خلال موسمى 2004 و 2005 بمنطقة البرلس بمحافظة كفر الشيخ. تمت الزراعة بالبذرة مباشرة فى الموسم الأول فى 10 يناير 2004 وفى 15 يناير 2005 فى الموسم الثانى.

أعطى الأب شوجر بيبى أعلى محصول مبكر فى كلا الموسمين، كما أعطت الهجن جيزة 1 × شوجر بيبى، وشوجر بيبى × كلوندیك، وشوجر بيبى × بيكوك، وشارلستون جراى × كلوندیك محصولا مبكراً عالياً ولكن بدون إختلافات معنوية بالمقارنة بالهجين التجارى أسوان وكذلك بالمقارنة بالأبوين كودای، وشوجر بيبى. أظهر الهجين شارلستون جراى × كلوندیك قوة هجين معنوية موجبة بالمقارنة بالأب الأعلى فى هذه الصفة فى كلا الموسمين.

أعطى كل من الهجينين شارلستون جراى × كلوندیك، وشارلستون جراى × كونجو أعلى محصول كلى وكان 36.54 ، و36.49 طن/ فدان على الترتيب بدون اختلافات معنوية عن الكنترول الذى أعطى محصول 33.46 طن/ فدان، وأيضاً بدون أختلافات معنوية عن الهجن كريمسون سويت × كونجو، وكريمسون سويت× كلوندیك، وكريمسون وسويت × محيسنى، وكريمسون سويت × بيكوك، وجيزة 1× شوجر بيبى، وشوجر بيبى× بيكوك . كذلك أظهرت 3 هجن وهى شارلستون جراى × كونجو، وشارلستون جراى كلوندیك ، وكودای × شوجر بيبى قوة هجين معنوية موجبة بالمقارنة بأحسن الأبوين لصفة المحصول الكلى.

أنتج كل من الهجينين شارلستون جراى × كلوندیك، وشارلستون جراى × محيسنى ثماراً أقل وزناً – معنوياً – بالمقارنة بالطرز الوراثية الأخرى المختبرة.

أظهرت 10 تلوقاً معنوياً بالنسبة للأب الأعلى لصفة وزن الثمرة بالمقارنة بالكنترول بنسب تراوحت ما بين 21.2% إلى 66.1%، بينما أظهرت 4 هجن فقط قوة هجين معنوية موجبة بالمقارنة بأحسن الأبوين تراوحت ما بين 17.8% إلى 23.7%.

أنتج الهجين كونجو × بيكوك أكثر الثمار طولاً بالمقارنة بكل الطرز الوراثية المدروسة تلاه فى ذلك الهجينين شارلستون جراى × كلوندیك، وشارلستون جراى × كونجو. وأظهر 17 هجيناً تلوقاً معنوياً بالنسبة للأب الأعلى لصفة طول الثمرة بالمقارنة بالكنترول تراوحت ما بين 11.55% إلى 56.37%، وقد تفوق هجينان

فقط – معنوياً – على أفضل آبائهما فى هذه الصفة. أنتجت الآباء شارلستون جراى، وكونجو، وبيكوك بالإضافة لهجينين ثمارا مطاولة، وأنتج الأب كلوندیك و21 هجين ثماراً بيضاوية الشكل، بينما أنتجت باقى الأصناف والهجن ثماراً كروية.

أنتجت الأصناف كوداى، وشوجر بيبى، وبيكوك وكذلك الهجين جيزة 1 × شوجر بيبى ثماراً تميزت بأقل سمك لقشرة الثمرة فى كلا الموسمين، ولم تظهر اى من الهجن المدروسة تفوقاً معنوياً لهذه الصفة مقارنة بالكنترول، كذلك معظم الهجن المدروسة فى كلا الموسمين لم تظهر قوة هجين معنوية سالبة بالمقارنة بأحسن آبائها فى هذه الصفة.

أنتج الصنف كلوندیك وكذلك الهجين جيزة 1 × شوجر بيبى ثماراً احتوت على أعلى قيمة لصفة المواد الصلبة الكلية القابلة للذوبان حيث كانت على التوالى 11.1% و 11.7%. وأظهر الهجين جيزة 1 × شوجر بيبى تفوقاً معنوياً على الكنترول أسوان بينما أظهرت خمس هجن فقط قوة هجين معنوية موجبة بالمقارنة بأحسن آبائها فى هذه الصفة تراوحت ما بين 6.1% إلى 12.2%.