Heterosis for yield and yield components in some sesame (*Sesamum indicum* L.) genotypes

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ABSTRACT

The objective of this study was to determine the heterotic effect for yield and yield components in some sesame genotypes. Eight sesame lines were selected as parents from the sesame breeding program, Gedarif Research Station, Agricultural Research Corporation (ARC), Sudan. The parents were crossed in all possible diallel combinations (without reciprocals) to produce 28 single-cross hybrids. The eight parents and 28 F_1 generatins were evaluated under rain for two consecutive seasons (2005 and 2006) at Gedarif Research Station. Four of the parents were released varieties *viz*: Ziraa-9, Kenana-2, Promo and Gedarif-1, and the other four were advanced lines. The experiment was arranged in a randomized complete block design with three replicates to elucidate heterotic effect for yield and yield components among the 36 sesame genotypes. Data were recorded on days to 50% flowering, days to maturity, plant height, number of branches/plant, number of capsules/plant, height to first capsule, capsule length, 1000-seed weight, seed yield/plant and seed yield/ha. Heterosis was calculated as percentage increase or decrease over mid parent, corresponding better parent and standard parent, for the ten characters. Average heterosis, heterobeltiosis and standard heterosis in all characters were detected. The cross Gd2002OBN.103×Promo expressed significant negative heterosis for days to 50% flowering for the three types of heterosis, negative heterosis for days to maturity and positive heterosis for seed yield/ha, hence could be exploited for developing early maturing and high yielding varieties. Significant positive heterotic values of the three types of heterosis for seed yield/ha were shown by Gd2002SPSN.53×Gedarif-1 and Gd2002SPSN.53 ×Promo. It is concluded that further testing is needed to confirm consistency of these crosses in terms of their seed yield and stability.

INTRODUCTION

In the Sudan, sesame is the main cash crop of the rainfed sector and is one of the main agricultural exported commodities. Sesame is an ancient and important oil seed crop, and is often referred to as “the queen of oil seeds”, because it is prized not only for its nutritive value but also for the quality and quantity (50%) of its oil which is rich in vitamin E and has a significant amount of linoleic acid that can control blood cholesterol levels. The protein content of sesame seed is about 20%-30% (Khidir, 2007).

In 2010, the world production amounted to 4.32 million metric tones, obtained from 7.87 million hectares, with an average productivity of 549kg/ha. The Sudan contributed 6% and 16% of production and producing area, respectively. The major producers are India, China, Myanmar and Sudan (FAO, 2011). Averaged from 2002 to 2009, the Sudan production was 295250 tones/year obtained from 1404586 hectares, with a mean yield of 210 kg/ha. Among the Arab countries, the Sudan contribution was 90% to the sesame area and 71% to the production (AOAD, 2010).

The ultimate objective of the sesame breeding program since its inception in the Sudan in the early 1950s has been the development of high yielding, non-shattering varieties for mechanized production. In 1951, a segregating population for indehiscent mutant was introduced from USA, and initial selections were made at the Gezira Research Station and then at the Central Rain-land Research Station at Tozi, till 1954. The selected lines, like the original material, proved to be poor yielders (Walton, 1959). In 1954, crosses were made to transfer the indehiscent trait to the local types. However, the strains resulting from this program were also poor yielders. At the end of the nineteen sixties, a multiple crosses program involving several indehiscent lines and a large number of local types was started, but no success was achieved (Khidir, 2007). It is note worthy that in many parts of the world breeding for indehiscency proved to be a difficult task. Thus, the main and immediate objective of the sesame breeding program in the Sudan was the development of high yielding, dehiscent varieties. The shattering problem could be partially solved by breeding for uniform maturity (Khidir, 1969). In 1975, a joint program between ARC and University of California, financed by UNDP, resulted in the release of two varieties (Kenana-1 and Khidir) (Khidir, 2007).

Hybridization is the most potent technique to enrich the genetic variation and to break yield barriers for producing varieties having built-in high yield potential (Singh and Narayanan, 2000). It is well known that non-related parents tend to yield more vigorous offspring. This phenomenon has been termed hybrid vigor. Hybrid vigor has been successfully used in breeding open-pollinated crops, whereas its use in self-pollinated crops was less successful. In cross-fertilized species, the naturally imposed breeding system assures cross fertilization, while in self-fertilizing species, selfing is favored by floral morphology. It is now well understood that the production of successful hybrids requires suitable parental inbred lines. In cross-pollinated crops, problems arise in the inbreeding phase, while in self-pollinated crops, they arise in the crossing phase. Through the use of male sterility and manipulations of floral morphology, it becomes possible to achieve efficient hybrid seed production in self-pollinated crops. This fact has been recently demonstrated for many self-pollinated crops (Osman, 1980).

The large number of seeds in a single pollination and availability of male sterility in sesame (Rangasamy and Rathinam, 1982 ; Osman, 1980) offer a scope for exploitation of heterosis and hybrid breeding is gaining momentum to achieve quantum jump in the yield of sesame. Hybrid vigor of even a small magnitude for an individual yield component may have an additive or synergistic effect on the end product (yield). Heterosis in sesame has been reported by various workers (Senthil *et al*., 2003 ; Thiyagu *et al*., 2007).

Hybrid vigor is the increase in size or vigor of a hybrid over the average of its parents or the better parent. The terms hybrid vigor and heterosis are synonymous. The principle of hybrid breeding is to find the parents that will combine well to produce superior yielding F_1 plants, hence the exploitation of heterosis mainly depends upon its direction and magnitude. Estimation of heterosis over the better parent (heterobeltiosis) may be useful in identifying the heterotic cross combinations that show superiority over the standard or the best variety of the area. Therefore, this study was conducted to determine the heterotic effect for yield and yield components among 36 sesame genotypes (8 parents and 28 hybrids).

MATERIALS AND METHODS

Eight sesame parents with a wide range of variability were chosen from the sesame breeding program, Gedarif Research Station, Agricultural Research Corporation (ARC), Sudan. These parents were obtained from selfed plants in the previous season to ensure their varietal purity (pure lines). The parents were Gd2002SPSN.29, Gd2002SPSN.14, Ziraa-9, Gd2002SPSN.53, Gd2002OBN2.103, Gedarif-1, Kenana-2 and Promo. Four of these parents were released varieties *viz*: Ziraa-9, Kenana-2, Promo and Gedarif-1. Ziraa-9 resulted from a systematic purification and selection in a local material, on the basis of seed color. It is characterized by profuse branching, late flowering and maturity and white small seeds. Kenana-2, a white-seeded variety, is a selection from an introduced variety from Burkina-Faso and was released in 1991. Promo is a selection from introduced sesame material of temperate origin (Greece), characterized by high branching, medium duration, even maturity and delayed shattering (Ahmed, 1997; Ahmed, 2008). It was released in 1998. Gedarif-1 is a selection from segregating material of crosses between temperate and tropical cultivars. It was released in 2003 and is characterized by non-branching habit, medium to late duration to flowering and good vigorous habit of growth (Ahmed *et al*., 2003). The other four genotypes were advanced promising lines adapted to the Gedarif environment.

In 2004, the eight parents were grown in rows 10 m long and 0.8 m apart for each genotype to ensure maximum potentiality of the genotypes. The area was weeded and irrigated, when necessary, to increase the duration of flowering. In the same season, all parents were crossed in all possible combinations (without reciprocals) to produce 28 single-cross hybrids according to half diallel arrangement. Some flowers in each parent were selfed to maintain the purity of the parents.

The material (parents and hybrids) was sown under rains for two seasons (2005 and 2006) at Gedarif Research Station, Sudan, at latitude 14º 1'N, longitude 35º 21'E and altitude 592 masl. The trial was arranged in a randomized complete block design with three replicates. Each entry was grown in one row of 2 m long and 0.6 m apart. The seeds were sown in holes, spaced 0.2 m apart within the row. After 3 weeks, the seedlings were thinned to 3 plants/hole.

In the first season (2005), the sowing date was on 18^{th} July; the first rain after sowing was on 24^{th} July and the seedlings emerged on 30^{th} July. In the second season (2006), the experiment was sown on 19^{th} July; first rain after sowing was on the same day and seedlings emerged on 22^{ed} July. The experiment was weeded before thinning and then whenever necessary. The data were recorded on days to 50% flowering (DFPF), days to maturity (DTM), plant height (PHT), number of branches/plant

(NBPP), number of capsules/plant (NCPP), height to first capsule (HFC), capsule length (CL), 1000-seeds weight (1000-SW), seed yield/plant (SYPP) and seed yield/ha (SY/ha).

The data were subjected to analysis of variance according to the method described by Gomez and Gomez (1984). Heterosis was calculated as percentage of increase or decrease over mid parent, corresponding better parent and standard parent (Promo), for all characters measured, as described by Singh and Narayanan (2000).

RESULTS AND DISCUSSION

The range of heterosis over mid parent, corresponding better parent (BP) and standard parent (SP) showing a desirable heterotic response for the studied characters are presented in Table 1. The crosses with the highest average heterosis, heterobeltiosis and standard heterosis for the ten characters are presented in Table 2.

The average heterosis, heterobeltiosis and standard heterosis for days to 50% flowering ranged from -8.53% to 8.23%, -6.61% to 14.52% and -9.26% to 11.64%, respectively. Significant negative average heterosis was exhibited by two crosses; namely, Gd2002SPSN.29 × Gd2002SPSN.53 and Gd2002OBN.103 × Promo. Significant negative heterobeltiosis was shown by the cross Gd2002OBN.103× Promo, whereas significant negative standard heterosis for days to 50% flowering was exhibited by Gd2002SPSN.29×Gd2002SPSN.53, Gd2002SPSN.29 × Gd2002 OBN.103, Gd2002SPSN, 29×Kenana-2 and Gd2002OBN.103×Promo (Tables, 3, 4 and 5). Similar results were reported by Deepa and Kumar (2001) and Singh *et al*. (2005). The average heterosis, heterobeltiosis and standard heterosis for days to maturity ranged from -5.18% to 4.43%, -1.45% to 11.50% and -1.87% to 12.33%, respectively (Table 1). Significant negative average heterosis was shown by Gd2002SPSN.29×Gedarif-1 (Table 3). These results are in accordance with the findings of Mishra *et al*. (1994), Mishra and Sikarwar (2001) and Singh *et al*. (2005). Significant negative heterosis for days to 50% flowering and maturity indicate the possibility of obtaining early maturing genotypes. However, at present, sesame is grown mainly under rain-fed conditions in Sudan and planting late maturing varieties is rather risky, because of the short rainy season, and the low or uneven distribution of rainfall, specially in the northern part of the central rainlands. Under such conditions, early maturity is a desirable character.

Table 1. Effect of parameters of heterosis on earliness, vegetative growth and yield components of 28 F_1 sesame hybrids grown at Gedarif, combined over two seasons (2005 and 2006).

	DFPF	DTM	PHT (cm)	NBPP	NCPP	HFC (cm)	CL (cm)	1000-SW (g)	SYPP (g)	SY/ha (kg)
No. of crosses with:										
a- desirable relative heterosis	24	11	23	23	22	16	22	26	27	21
b- heterobeltiosis	7	6	26	10	14	7	8	17	23	16
c- standard heterosis	13	6	13	2	1	17	11	25	19	18
Range of:										
a- relative heterosis (%)	-8.53 to 8.23	-5.18 to 4.43	-6.77 to 23.79	-39.84 to 207.69	-14.5 to 80.19	-22.44 to 17.45	-3.39 to 7.11	-2.18 to 12.83	-11.14 to 109.8	-22.85 to 66.21
b- heterobeltiosis (%)	-6.61 to 14.52	-1.45 to 11.50	-4.62 to 54.91	-87.00 to 96.00	-34.60 to 71.63	-16.33 to 57.14	-16.31 to 14.65	-8.36 to 12.41	-28.07 to 102.67	-38.19 to 73.45
c- standard heterosis (%)	-9.26 to 11.64	-1.87 to 12.33	-18.82 to 16.86	-83.83 to 40.56	-35.31 to 1.18	-29.84 to 24.73	-16.08 to 15.73	-5.28 to 14.44	-19.27 to 62.74	-25.83 to 89.98

DFPF = Days to 50% flowering, DTM = Days to maturity, PHT = Plant height, NBPP = Number of branches/plant, NCPP = Number of capsules/plant, CL = Capsule length, 1000-SW = 1000-seed weight, SYPP = Seed yield per plant and SY/ha = Seed yield per hectare.

The characters that contributed to the vegetative growth, such as plant height and number of branches/plant, exhibited significant positive average heterosis, heterobeltiosis and standard heterosis (Tables 3, 4 and 5). These results are in line with the findings of Thiyagu *et al.* (2007). Vegetative growth is essential for realizing high yield as total dry matter production is the main attribute that determine high seed yield in crops. For plant height, out of the 28 crosses 23 and 26 crosses exhibited positive average heterosis and heterobeltiosis, respectively. The cross Gd2002SPSN.29 × Ziraa-9 and Ziraa-9 × Gd2002SPSN.53 exhibited significant positive average heterosis and heterobeltiosis (Tables 3 and 4).

Average heterosis in number of branches/plant ranged from -39.84% to 207.69%, and the crosses Gd2002SPSN.14×Ziraa-9, Ziraa-9×Gd2002OBN.103 and Gd2002 SPSN.53×Gedarif-1 revealed positive highly significant values (Tables 1 and 3). Heterosis over the best parent ranged from -87.00% to 96.00%, and Ziraa-9×Gd2002OBN.103 revealed the highest significant positive value (96.00%) (Tables1 and 4).

Total number of capsules/plant is an important yield contributing character. Number of capsules/plant, in the hybrids exceeded that of the mid parent and correspondence better parent in 22 and 14 crosses, respectively (Tables 1, 3 and 4). These results are in accordance with the findings of Deepa and Kumar (2001). Many researchers reported positive direct effect of number of capsules/plant on seed yield (Khidir and Osman, 1970 ; Osman and Khidir, 1974). Highly significant positive average heterosis (80.19%) and heterobeltiosis (71.93%) were shown by the cross Ziraa-9×Gd2002SPSN.53 (Tables 3 and 4).

Height to first capsule is a criterion of earliness. Sixteen crosses expressed less height to first capsule than their mid parent. Significant negative average heterosis (-22.44%) was shown by the cross Gd2002SPSN.14×Gd2002SPSN.53. The range of heterobeltiosis in this character varied from -16.33% to 57.14%, whereas the standard heterosis varied from -29.84% to 24.73%; and 17 crosses set the first capsule lower than the standard variety (Promo) (Tables 1, 3, 4 and 5).

Table 2. The best crosses showing high desirable heterotic vigor for yield and yield components in 28 F_1 sesame hybrids grown at Gedarif, combined over two seasons (2005 and 2006).

Character	Hybrids with desirable heterosis		
	Relative heterosis	Heterobeltiosis	Standard heterosis
DFPF	Gd2002SPSN.29× Gd2002SPSN.53 Gd2002OBN2.103×Promo	Gd2002OBN2.103 ×Promo	Gd2002SPSN.29× Gd2002SPSN.53 Gd2002SPSN.29×Gd2002OBN2.103 Gd2002SPSN.29×Kenana-2 Gd2002OBN2.103×Promo
DTM	Gd2002SPSN.29×Gedarif-1	-	-
PHT (cm)	Gd2002SPSN.29×Ziraa-9 Ziraa-9× Gd2002SPSN.53	Gd2002SPSN.29× Gd2002SPSN.14 Gd2002SPSN.29× Ziraa-9 Gd2002SPSN.29× Gd2002SPSN.53 Gd2002SPSN.29× Gd2002OBN2.103 Gd2002SPSN.29× Gedarif-1 Gd2002SPSN.29× Promo Ziraa-9× Gd2002SPSN.53 Gd2002SPSN.53× Gedarif-1	Gd2002SPSN.29× Gd2002SPSN.53 Gd2002SPSN.29×Gd2002OBN2.103 Gd2002SPSN.29×Gedarif-1 Gd2002SPSN.29×Kenana-2 Gd2002SPSN.29× Promo Ziraa-9×Gedarif-1
NBPP	Gd2002SPSN.14×Ziraa-9 Ziraa-9×Gd2002OBN2.103 Gd2002SPSN.53×Gedarif-1 Gd2002OBN2.103×Gedarif-1	Ziraa-9×Gd2002OBN2.103	Gd2002SPSN.29× Gd2002SPSN.14 Gd2002SPSN.29×Gd2002OBN2.103
NCPP	Ziraa-9× Gd2002SPSN.53 Ziraa-9×Gd2002OBN2.103	Ziraa-9× Gd2002SPSN.53	-
HFC (cm)	Gd2002SPSN.14× Gd2002SPSN.53	-	Gd2002SPSN.29×Gedarif-1

Table 2. Continued.

CL (cm)	-	Gd2002SPSN.14× Ziraa-9	Gd2002SPSN.14×Gd2002OBN2.103 Gd2002SPSN.14× Kenana-2 Gd2002OBN2.103×Kenana-2
1000-SW (g)	Gd2002SPSN.29×Gd2002OBN2.103 Gd2002SPSN.14×Gedarif-1 Ziraa-9×Gd2002OBN2.103 Gd2002OBN2.103×Gedarif-1 Gedarif-1 ×Kenana-2	Gd2002OBN2.103 ×Gedarif-1 Ziraa-9×Gd2002OBN2.103	Gd2002SPSN.29× Gd2002SPSN.14 Gd2002SPSN.29× Ziraa-9 Gd2002SPSN.29× Gd2002SPSN.53 Gd2002SPSN.29×Gd2002OBN2.103 Gd2002SPSN.29×Gedarif-1 Gd2002SPSN.29×Kenana-2
SYPP (g)	Ziraa-9× Gd2002SPSN.53 Gd2002SPSN.53×Gd2002OBN2.103	Ziraa-9× Gd2002SPSN.53 Gd2002SPSN.14× Ziraa-9 Gd2002SPSN.53× Gd2002OBN2.103	Ziraa-9× Gd2002SPSN.53
SY/ha (kg)	Gd2002SPSN.53×Gedarif-1 Gd2002SPSN.14× Ziraa-9 Gd2002SPSN.53×Promo	Gd2002SPSN.14× Ziraa-9 Gd2002SPSN.53× Gedarif-1 Gd2002SPSN.53× Promo	Gd2002SPSN.53×Gedarif-1 Gedarif-1 ×Kenana-2

DFPF = Days to 50% flowering, DTM = Days to maturity, PHT = Plant height, NBPP = Number of branches/plant, NCPP = Number of capsules/plant, CL = Capsule length, 1000-SW = 1000-seed weight, SYPP = Seed yield per plant and SY/ha = Seed yield per hectare.

The capsule length influences the number of seeds/capsule. None of the crosses had significant positive heterotic values for this character in the three types of heterosis (average heterosis, heterobeltiosis and standard heterosis). However, Gd2002SPSN.14×Gd2002OBN.103 and Gd2002SPSN.14×Kenana-2 expressed significant positive standard heterosis, and Gd2002SPSN.14×Ziraa-9 showed significant positive heterobeltiosis (Tables 3, 4 and 5).

Table 3. Estimates of average heterosis (%) in 28 F_1 sesame hybrids grown at Gedarif, combined over two seasons (2005 and 2006).

Cross	DFPF	DTM	PHT (cm)	NBPP	NCPP
Gd2002SPSN.29 x Gd2002SPSN.14	-3.07	-0.57	15.67	165.71	28.05
Gd2002SPSN.29 x Ziraa-9	-5.24	0.06	23.97**	-3.75	45.79
Gd2002SPSN.29 x Gd2002SPSN.53	-8.53**	1.32	8.76	54.00	21.32
Gd2002SPSN.29xGd2002OBN2.103	-3.95	0.25	8.79	-39.84	23.27
Gd2002SPSN.29 x Gedarif-1	-5.93	-5.18*	-1.49	50.00	27.27
Gd2002SPSN.29 x Kenana-2	-1.81	0.00	2.68	33.33	-2.15
Gd2002SPSN.29 x Promo	-0.81	0.38	2.02	31.15	-7.38
Gd2002SPSN.14 x Ziraa-9	-4.37	2.65	13.33	96.43**	44.83
Gd2002SPSN.14 x Gd2002SPSN.53	-1.38	1.62	5.04	30.49	8.93
Gd2002SPSN.14xGd2002OBN2.103	-3.85	-0.55	4.44	10.16	16.64
Gd2002SPSN.14 x Gedarif-1	2.74	4.15*	1.07	135.14	12.67
Gd2002SPSN.14 x Kenana-2	-3.41	-2.52	3.71	11.68	1.84
Gd2002SPSN.14 x Promo	-1.16	1.68	5.15	15.79	-2.03
Ziraa-9 x Gd2002SPSN.53	-2.83	4.43*	17.40*	51.97	80.19**
Ziraa-9 x Gd2002OBN2.103	-2.76	2.42	12.65	82.67**	44.35*
Ziraa-9 x Gedarif-1	-1.52	-0.17	13.51	67.07	30.38
Ziraa-9 x Kenana-2	-1.35	-0.30	10.93	-4.95	17.56
Ziraa-9 x Promo	-0.24	2.22	-6.43	-5.05	-14.50
Gd2002SPSN.53xGd2002OBN2.103	-3.20	3.10	5.59	38.25	18.84
Gd2002SPSN.53 x Gedarif-1	-0.12	2.38	11.67	207.69**	39.32
Gd2002SPSN.53 x Kenana-2	-4.85	1.53	5.86	26.97	17.59
Gd2002SPSN.53 x Promo	-5.41	-0.81	7.34	17.69	0.71
Gd2002OBN2.103 x Gedarif-1	-0.51	1.49	4.94	125.20*	27.24
Gd2002OBN2.103 x Kenana-2	-1.07	-2.05	2.04	5.81	-1.02
Gd2002OBN2.103 x Promo	-7.23*	-2.08	-2.89	11.33	8.69
Gedarif-1 x Kenana-2	8.29**	3.80*	4.67	12.15	8.66
Gedarif-1 x Promo	5.22	0.00	-0.64	35.83	1.06
Kenana-2 x Promo	0.40	-2.33	-6.77	-18.86	-21.34
SE±	1.19	1.46	6.40	0.35	6.32

*, ** Significant at 0.05 and 0.01 probability levels, respectively.
DFPF = Days to 50% flowering, DTM .= Days to maturity, PHT = Plant height, NBPP = Number of branches/plant and NCPP = Number of capsules/plant.

Table 3. Continued.

Cross	HFC (cm)	CL (cm)	1000-S W (g)	SYPP (g)	SY/ha (kg)
Gd2002SPSN.29 x Gd2002SPSN.14	14.33	6.94	2.40	66.67	46.14
Gd2002SPSN.29 x Ziraa-9	3.29	6.87	7.79	72.85	66.21
Gd2002SPSN.29 x Gd2002SPSN.53	-3.79	4.31	1.92	24.63	46.53
Gd2002SPSN.29xGd2002OBN2.103	-5.92	-2.74	8.51*	37.19	14.88
Gd2002SPSN.29 x Gedarif-1	-13.58	1.48	4.49	1.16	-12.71
Gd2002SPSN.29 x Kenana-2	-0.34	5.93	3.02	15.52	4.11
Gd2002SPSN.29 x Promo	4.48	2.05	-0.81	21.95	15.31
Gd2002SPSN.14 x Ziraa-9	10.34	4.68	5.73	56.62	58.67*
Gd2002SPSN.14 x Gd2002SPSN.53	-22.44*	-0.34	3.27	11.47	-17.95
Gd2002SPSN.14xGd2002OBN2.103	-3.67	0.61	3.25	16.34	15.22
Gd2002SPSN.14 x Gedarif-1	-1.93	-0.55	10.43*	13.19	6.36
Gd2002SPSN.14 x Kenana-2	-4.81	5.53	4.80	0.23	5.65
Gd2002SPSN.14 x Promo	0.52	-0.82	5.92	21.36	-0.09
Ziraa-9 x Gd2002SPSN.53	10.69	5.64	3.76	109.8**	23.18
Ziraa-9 x Gd2002OBN2.103	1.13	-0.66	10.53*	53.07	46.64
Ziraa-9 x Gedarif-1	7.16	6.67	4.49	50.95	35.84
Ziraa-9 x Kenana-2	-1.75	1.28	4.98	38.89	28.63
Ziraa-9 x Promo	-6.06	0.54	3.26	17.95	-7.92
Gd2002SPSN.53xGd2002OBN2.103	-6.07	1.01	5.95	70.24**	42.71
Gd2002SPSN.53 x Gedarif-1	17.45	4.37	7.72	39.13	63.66**
Gd2002SPSN.53 x Kenana-2	1.40	5.84	4.27	31.29	38.66
Gd2002SPSN.53 x Promo	7.07	3.85	3.65	42.52	51.94*
Gd2002OBN2.103 x Gedarif-1	-4.50	1.26	12.83**	26.26	9.45
Gd2002OBN2.103 x Kenana-2	-8.41	7.11	6.81	1.69	-2.07
Gd2002OBN2.103 x Promo	-13.66	-3.39	2.91	21.71	6.81
Gedarif-1 x Kenana-2	13.55	4.86	8.57*	22.84	32.11
Gedarif-1 x Promo	-2.55	1.18	-2.18	10.08	-20.27
Kenana-2 x Promo	-6.11	6.81	3.11	11.14	-22.85
SE±	3.66	0.15	0.13	1.23	147.58

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

HFC = Height to first capsule, CL = Capsule length, 1000-SW = 1000 seed weight, SYPP = Seed yield per plant and SY/ha = Seed yield per hectare.

Seed mass is one of the important characters that have positive association with seed yield (Khidir and Osman, 1970 ; Osman and Khidir, 1974 ; Ali *et al.*, 2003). The 1000-seed weight showed positive heterosis (average heterosis, heterobeltiosis and standard heterosis in 26, 17 and 25 crosses, respectively). Average heterosis varied from -2.18% to 12.83%, whereas heterobeltiosis and standard heterosis ranged from -8.36% to 12.41% and -5.28% to 14.44%, respectively (Table 1). Senthil *et al.* (2003) reported a range of -25.02% - 56.30% relative heterosis for 1000-seed weight.

The great number of crosses showing positive heterosis indicates the usefulness of this trait in hybrid breeding.

Table 4. Estimates of heterobiltiosis (%) in 28 F_1 sesame hybrids grown at Gedarif, combined over two seasons (2005 and 2006).

Cross	DFPF	DTM	PH)	P	NCPP
Gd2002SPSN.29 x Gd2002SPSN.14	3.13	0.38	41.55**	26.00	5.60
Gd2002SPSN.29 x Ziraa-9	7.95*	4.84**	54.91**	-80.00*	22.83
Gd2002SPSN.29 x Gd2002SPSN.53	-2.56	2.93	31.88**	-20.00	-1.78
Gd2002SPSN.29xGd2002OBN2.103	0.28	3.44	33.49**	-83.00**	-2.97
Gd2002SPSN.29 x Gedarif-1	1.42	2.55	33.33**	23.00	-3.01
Gd2002SPSN.29 x Kenana-2	0.00	2.55	26.41*	-67.00	-28.91
Gd2002SPSN.29 x Promo	2.84	1.53	30.43**	-60.00	-34.60*
Gd2002SPSN.14 x Ziraa-9	2.02	6.50**	15.35*	63.00	41.04
Gd2002SPSN.14 x Gd2002SPSN.53	-1.26	2.25	5.88	10.00	0.06
Gd2002SPSN.14xGd2002OBN2.103	-5.54	1.63	4.67	-17.00	9.90
Gd2002SPSN.14 x Gedarif-1	4.03	11.50**	10.12	20.00	1.81
Gd2002SPSN.14 x Kenana-2	0.82	-1.00	4.23	-54.00	-13.54
Gd2002SPSN.14 x Promo	1.32	1.88	9.12	-37.00	-19.91
Ziraa-9 x Gd2002SPSN.53	3.52	7.65**	20.45**	36.00	71.93**
Ziraa-9 x Gd2002OBN2.103	5.74	3.95*	14.40*	96.00**	32.67
Ziraa-9 x Gedarif-1	3.69	2.91	6.60	-20.00	15.06
Ziraa-9 x Kenana-2	10.14**	1.82	12.33	-34.00	-2.34
Ziraa-9 x Promo	9.26**	5.85**	-4.62	-20.00	-31.52*
Gd2002SPSN.53xGd2002OBN2.103	-1.31	4.69**	6.67	30.00	14.52
Gd2002SPSN.53 x Gedarif-1	1.01	8.89**	22.60**	63.00	28.61
Gd2002SPSN.53 x Kenana-2	-0.55	-0.62	7.23	-14.00	1.82
Gd2002SPSN.53 x Promo	-2.91	-0.37	12.32	-17.00	-16.11
Gd2002OBN2.103 x Gedarif-1	2.61	6.23**	14.06*	23.00	21.69
Gd2002OBN2.103 x Kenana-2	1.37	-1.45	2.33	-34.00	-11.46
Gd2002OBN2.103 x Promo	-6.61*	-0.12	0.55	-13.00	-6.64
Gedarif-1 x Kenana-2	14.52**	9.33**	13.33	-87.00	1.30
Gedarif-1 x Promo	9.26**	6.85**	4.14	-53.00	-9.72
Kenana-2 x Promo	2.19	-1.00	-3.74	-50.00	-24.88
SE±	1.19	1.46	6.40	0.35	6.32

*, ** Significant at 0.05 and 0.01 probability levels, respectively.
DFPF = Days to 50% flowering, DTM = Days to maturity, PHT = Plant height, NBPP = Number of branches/plant and NCPP = Number of capsules/plant.

Table 4. Continued.

Cross	HFC (cm)	CL (cm)	1000-S W (g)	SYPP (g)	SY/ha (kg)
Gd2002SPSN.29 x Gd2002SPSN.14	57.14**	-5.23	-4.48	29.19	16.06
Gd2002SPSN.29 x Ziraa-9	49.35**	2.56	-2.98	42.90	41.11
Gd2002SPSN.29 x Gd2002SPSN.53	20.78	2.70	-4.78	0.53	17.66
Gd2002SPSN.29xGd2002OBN2.103	20.34	-14.77**	-2.99	4.04	-13.07
Gd2002SPSN.29 x Gedarif-1	12.99	-4.38	-6.27	-28.07	-38.19*
Gd2002SPSN.29 x Kenana-2	28.57	1.84	-3.28	-12.05	-15.62
Gd2002SPSN.29 x Promo	36.36*	-4.20	-8.36*	-8.99	-9.31
Gd2002SPSN.14 x Ziraa-9	14.85	14.65**	1.72	60.05*	73.45*
Gd2002SPSN.14 xGd2002SPSN.53	-16.33	-10.46*	3.09	16.03	-19.13
Gd2002SPSN.14xGd2002OBN2.103	2.22	-0.60	-1.38	12.81	7.87
Gd2002SPSN.14 x Gedarif-1	2.14	-16.31**	5.86	0.00	-9.20
Gd2002SPSN.14 x Kenana-2	0.24	-3.08	4.08	-2.27	2.89
Gd2002SPSN.14 x Promo	4.84	-6.77	4.83	14.99	-1.41
Ziraa-9 x Gd2002SPSN.53	24.64*	2.93	-0.34	102.67**	15.06
Ziraa-9 x Gd2002OBN2.103	11.94	-9.61*	9.70*	37.08	27.24
Ziraa-9 x Gedarif-1	16.35	-3.30	4.10	24.22	8.43
Ziraa-9 x Kenana-2	7.95	1.10	0.34	25.00	21.52
Ziraa-9 x Promo	2.15	-1.75	5.35	3.43	-16.17
Gd2002SPSN.53xGd2002OBN2.103	-4.58	-10.21*	1.03	56.85*	31.81
Gd2002SPSN.53 x Gedarif-1	21.49*	-3.09	3.09	17.43	38.06*
Gd2002SPSN.53 x Kenana-2	3.72	3.31	3.74	21.59	36.99
Gd2002SPSN.53 x Promo	10.60	-1.05	2.41	28.48	47.80*
Gd2002OBN2.103 x Gedarif-1	-2.78	-15.62**	12.41**	14.68	-0.89
Gd2002OBN2.103 x Kenana-2	-7.78	-2.70	1.36	1.12	-10.55
Gd2002OBN2.103 x Promo	-12.22	-10.21*	-0.70	18.84	1.26
Gedarif-1 x Kenana-2	14.79	-4.78	3.40	11.01	10.34
Gedarif-1 x Promo	-2.42	-10.14*	-5.28	19.27	-31.16
Kenana-2 x Promo	-5.21	4.20	1.36	-13.70	-25.83
SE±	3.66	0.15	0.13	1.23	147.58

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

HFC = Height to first capsule, CL = Capsule length, 1000-SW = 1000 seed weight, SYPP = Seed yield per plant and SY/ha = Seed yield per hectare.

Table 5. Estimates of standard heterosis (%) in 28 F_1 sesame hybrids grown at Gedarif, combined over two seasons (2005 and 2006).

Cross	DFPF	DTM	PHT (cm)	NBPP	NCPP
Gd2002SPSN.29 x Gd2002SPSN.14	-3.97	-1.87	-9.10	48.33*	-32.94*
Gd2002SPSN.29 x Ziraa-9	0.53	2.49	-0.52	-57.22**	-26.07
Gd2002SPSN.29 x Gd2002SPSN.53	-9.26**	0.62	-15.31*	-57.22**	-34.60*
Gd2002SPSN.29xGd2002OBN2.103	-6.61*	1.12	-14.27*	-79.44**	-30.33*
Gd2002SPSN.29 x Gedarif-1	-5.56	0.25	-14.37*	-83.33**	-23.70
Gd2002SPSN.29 x Kenana-2	-6.87*	0.25	-18.82**	-22.22	-35.31*
Gd2002SPSN.29 x Promo	-4.23	-0.72	-16.24*	-33.33	-34.60*
Gd2002SPSN.14 x Ziraa-9	7.14*	6.10**	7.23	22.22	-10.43
Gd2002SPSN.14 x Gd2002SPSN.53	3.70	1.87	-3.10	-40.56*	-29.15
Gd2002SPSN.14xGd2002OBN2.103	-0.79	1.25	-2.69	-42.78*	-21.09
Gd2002SPSN.14 x Gedarif-1	9.26**	11.08**	2.38	-51.67**	-19.91
Gd2002SPSN.14 x Kenana-2	-2.65	-1.37	-3.10	-15.00	-21.23
Gd2002SPSN.14 x Promo	1.32	1.49	1.45	-20.56	-19.91
Ziraa-9 x Gd2002SPSN.53	9.00**	8.59**	10.24	7.22	14.22
Ziraa-9 x Gd2002OBN2.103	7.14*	8.09**	6.83	40.56*	-4.74
Ziraa-9 x Gedarif-1	11.64**	10.21**	16.86*	-23.89	-9.48
Ziraa-9 x Kenana-2	6.35*	4.61*	5.48	-3.89	-11.14
Ziraa-9 x Promo	9.26**	5.85**	-8.17	-11.11	-31.52*
Gd2002SPSN.53xGd2002OBN2.103	0.00	5.60**	-2.38	-16.67	-17.77
Gd2002SPSN.53 x Gedarif-1	6.35*	9.84**	12.20	-11.11	-1.18
Gd2002SPSN.53 x Kenana-2	-3.97	0.25	-1.86	-7.22	-7.35
Gd2002SPSN.53 x Promo	-2.91	-0.37	2.79	-9.44	-16.11
Gd2002OBN2.103 x Gedarif-1	3.97	10.46**	6.51	-20.56	-4.27
Gd2002OBN2.103 x Kenana-2	-2.12	1.25	-4.45	-3.89	-19.43
Gd2002OBN2.103 x Promo	-6.61*	-0.13	-6.10	-7.22	-6.63
Gedarif-1 x Kenana-2	10.58**	12.33**	6.52	-33.33	-7.82
Gedarif-1 x Promo	9.26**	6.85**	4.14	-29.44	-9.72
Kenana-2 x Promo	-1.32	-1.00	-9.62	-12.78	-24.88
SE±	1.19	1.46	6.40	0.35	6.32

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

DFPF = Days to 50% flowering, DTM = Days to maturity, PHT = Plant height, NBPP = Number of branches/plant and NCPP = Number of capsules/plant.

Table 5. Continued.

	HFC (cm)	CL (cm)	000-S W (g)	SYPP (g)	SY/ha (kg)
Gd2002SPSN.29 x Gd2002SPSN.14	-2.42	7.69	12.68**	15.63	13.00
Gd2002SPSN.29 x Ziraa-9	-7.26	-2.10	14.44**	7.71	15.82
Gd2002SPSN.29 x Gd2002SPSN.53	-25.00*	-7.00	12.32**	-19.27	11.25
Gd2002SPSN.29xGd2002OBN2.103	-25.27*	-0.70	14.44**	-0.86	-2.99
Gd2002SPSN.29 x Gedarif-1	-29.84**	-16.08**	10.56*	-16.06	-14.94
Gd2002SPSN.29 x Kenana-2	-20.16*	-3.18	14.08**	-17.13	-22.14
Gd2002SPSN.29 x Promo	-15.32	-4.20	8.10	-8.99	-9.31
Gd2002SPSN.14 x Ziraa-9	24.73*	9.44	3.87	29.12	42.36
Gd2002SPSN.14 x Gd2002SPSN.53	-21.51*	1.75	5.63	-5.35	-21.27
Gd2002SPSN.14xGd2002OBN2.103	-1.08	15.73**	0.70	7.50	20.39
Gd2002SPSN.14 x Gedarif-1	2.42	-4.90	8.10	16.70	24.96
Gd2002SPSN.14 x Kenana-2	-1.61	10.14*	7.75	-7.92	0.18
Gd2002SPSN.14 x Promo	4.84	5.94	7.04	14.99	-1.41
Ziraa-9 x Gd2002SPSN.53	16.94	-1.75	2.11	62.74*	8.79
Ziraa-9 x Gd2002OBN2.103	8.33	5.24	3.52	30.62	42.00
Ziraa-9 x Gedarif-1	16.67	-7.69	-1.76	44.97	49.21
Ziraa-9 x Kenana-2	5.91	-3.50	3.87	17.77	12.13
Ziraa-9 x Promo	2.15	-1.75	0.35	3.43	-16.17
Gd2002SPSN.53xGd2002OBN2.103	-10.48	4.55	3.52	49.46	47.10
Gd2002SPSN.53 x Gedarif-1	13.98	-12.24*	5.63	37.04	89.98**
Gd2002SPSN.53 x Kenana-2	-2.67	-1.75	7.39	14.56	29.53
Gd2002SPSN.53 x Promo	3.76	-1.05	4.93	28.48	47.80*
Gd2002OBN2.103 x Gedarif-1	-5.91	-1.75	5.28	33.83	36.38
Gd2002OBN2.103 x Kenana-2	-10.75	13.29*	4.93	-3.64	-0.18
Gd2002OBN2.103 x Promo	-15.05	4.55	-0.70	18.84	13.01
Gedarif-1 x Kenana-2	12.63	-9.44	7.04	29.55	51.85*
Gedarif-1 x Promo	-2.42	-10.14*	-5.28	19.27	-5.27
Kenana-2 x Promo	-6.99	4.20	4.93	-13.70	-25.83
SE±	3.66	0.15	0.13	1.23	147.58

*, ** Significant at 0.05 and 0.01 probability levels, respectively.
HFC = Height to first capsule, CL = Capsule length, 1000-SW = 1000-seed weight, SYPP = Seed yield per plant and SY/ha = Seed yield per hectare.

Table 6. Seed yield (kg/ha) for 36 sesame genotypes grown at Gedarif Research Station, season 2005, 2006 and when combined over the two seasons.

Genotype	2005		2006		Combined	
	Rank	Mean	Rank	Mean	Rank	Mean
Gd2002SPSN.29	36	237f	35	416fg	36	326b
Gd2002SPSN.29 x Gd2002SPSN.14.	18	611bcdef	14	675abcdefg	15	643ab
Gd2002SPSN.29 x Ziraa-9.	16	645bcdef	15	672abcdefg	13	659ab
Gd2002SPSN.29 x Gd2002SPSN.53.	10	694bcdef	22	572abcdefg	18	633ab
Gd2002SPSN.29xGd2002OBN2.103.	26	492cdef	17	612abcdefg	25	552ab
Gd2002SPSN.29 x Gedarif-1.	27	491cdef	28	477defg	30	484b
Gd2002SPSN.29 x Kenana-2.	24	525cdef	36	362g	34	443b
Gd2002SPSN.29 x Promo	29	469cdef	24	563bcdefg	29	516b
Gd2002SPSN.14	14	651bcdef	31	457defg	24	554ab
Gd2002SPSN.14 x Ziraa-9	9	722bcdef	7	897abcde	6	810ab
Gd2002SPSN.14 x Gd2002SPSN.53	32	438def	30	458defg	33	448b
Gd2002SPSN.14 xGd2002OBN2.103	5	796bcde	21	574abcdefg	12	685ab
Gd2002SPSN.14 x Gedarif-1	3	984abc	34	438fg	11	711ab
Gd2002SPSN.14 x Kenana-2	31	440def	13	699abcdefg	20	570ab
Gd2002SPSN.14 x Promo	17	643bcdef	27	479defg	23	561ab
Ziraa-9	25	496cdef	33	439fg	32	467b
Ziraa-9 x Gd2002SPSN.53	15	646bcdef	20	591abcdefg	19	619ab
Ziraa-9 x Gd2002OBN2.103	12	674bcdef	4	941abc	7	808ab
Ziraa-9 x Gedarif-1	4	878abcd	8	821abcdef	3	849ab
Ziraa-9 x Kenana-2	13	669bcdef	19	606abcdefg	16	638ab
Ziraa-9 x Promo	34	386def	23	568bcdefg	31	477b
Gd2002SPSN.53	23	539bcdef	25	536cdefg	27	538ab
Gd2002SPSN.53 xGd2002OBN2.103	6	753bcdef	6	900abcd	5	837ab
Gd2002SPSN.53 x Gedarif-1	1	1263a	5	900abcd	1	1081a
Gd2002SPSN.53 x Kenana-2	7	741bcdef	10	733abcdefg	10	737ab
Gd2002SPSN.53 x Promo	11	687bcdef	3	995ab	4	841ab
Gd2002OBN2.103	21	548bcdef	11	723abcdefg	17	635ab
Gd2002OBN2.103 x Gedarif-1	22	541bcdef	1	1012a	9	776ab
Gd2002OBN2.103 x Kenana-2	35	343ef	9	792abcdefg	22	568ab
Gd2002OBN2.103 x Promo	20	582bcdef	12	705abcdefg	14	643ab
Gedarif-1	2	1039ab	26	528cdefg	8	783ab
Gedarif-1 x Kenana-2	8	726bcdef	2	1003ab	2	864ab
Gedarif-1 x Promo	19	607bcdef	29	472defg	26	539ab
Kenana-2	30	443def	18	608abcdefg	28	525b
Kenana-2 x Promo	33	390def	32	454efg	35	422b
Promo	28	480cdef	16	657abcdefg	21	569ab
Mean		618.657		648.12		633.389
SE±		112.79		126.9		85.21
C.V%		32		34		33
Level of significance		***		***		***

Means followed by the same letter(s) in columns are not significantly different at 0.05 probability level, according to the Duncan's Multiple Range Test.

*** Significant at P≤ 0.001.

The average heterosis, heterobeltiosis and standard heterosis for seed yield/plant ranged from -11.14% to 109.08%, -28.07% to 102.67% and -19.27% to 62.74%, respectively (Table 1). Significant positive average heterosis was exhibited by Ziraa-9×Gd2002SPSN.53 and Gd2002SPSN.53×Gd2002OBN.103 (Table 3). Significant positive heterobeltiosis was shown by Gd2002SPSN.14×Ziraa-9, Ziraa-9×Gd2002SPSN.53 and Gd2002SPSN.53×Gd2002OBN.103 (Table 4), whereas significant positive standard heterosis for seed yield/plant was given by Ziraa-9×Gd2002SPSN.53 (Table 5). The results were in line with that reported by Thiyagu *et al.* (2007).

Seed yield per unit area is the major objective in any plant breeding program. Very highly significant differences (P≤0.001) were found among the genotypes in both seasons and when combined over two seasons. Such results are expected since these genotypes were based on inbred lines with different genetic background. The seed yield/ha varied from 237 to 1263, 362 to 1012 and 326 to 1081 kg/ha in season 2005, 2006 and when combined over two seasons, respectively. The highest yielder when combined over two seasons was the cross Gd2002SPSN53x Gedarif-1 (1081 kg/ha) followed by Gedarif-1 x Kenana-2 (864 kg/ha), Ziraa-9 x Gedarif-1 (849 kg/ha), Gd2002SPSN53 x Promo (841 kg/ha), Gd2002SPSN53 x Gd2002OBN2,103 (837 kg/ha) and Gd2002SPSN14 x Ziraa-9 (810 kg/ha) (Table 6).

Out of the 28 crosses, 21, 16 and 18 exhibited positive heterosis (average heterosis, heterobeltiosis and standard heterosis) for seed yield/ha, respecti-vely (Table 1). Significant positive average heterosis was shown by Gd2002SPSN.14 x Ziraa-9, Gd2002SPSN.53×Gedarif-1, and Gd2002SPSN. 53×Promo (Table 3). Significant positive heterobeltiosis was exhibited by Gd2002SPSN.14×Ziraa-9, Gd2002 SPSN.53×Gedarif-1 and Gd2002SPSN. 53×Promo (Table 4) whereas significant positive standard heterosis was shown by Gd2002SPSN.53×Gedarif-1, Gd2002SPSN.53×Promo and Gedarif-1×Kenana-2 (Table 5). Significant positive heterotic values for the three types of heterosis were shown by Gd2002 SPSN.53×Gedarif-1 (1081 kg/ha), and Gd2002SPSN.53×Promo (841 kg/ha). Further testing would be needed to confirm consistency of these crosses in term of their seed yield and stability.

CONCLUSION

The cross Gd2002OBN.103×Promo which expressed significant negative heterosis for days to 50% flowering for the three types of heterosis, negative heterosis for days to maturity and positive heterosis for seed yield/ha., could be used for developing early maturing and high yielding varieties. However, at present, sesame is grown extensively under rain-fed conditions in Sudan and planting late maturing varieties is rather risky. The crosses Gd2002SPSN.14xZiraa-9, Gd2002SPSN.53×Gedarif-1, Gd2002SPSN .53×Promo and Gedarif-1×Kenana-2, which exhibited significant positive heterobeltiosis or standard heterosis for seed yieldl/ha., could be of useful value in hybrid breeding for seed yield improvement.

REFERENCES

Ahmed, M. E. 1997. Adaptability of new varieties of sesame to the central rainlands of the Sudan. A paper submitted to the Variety Release Committee, Khartoum, Sudan.

Ahmed, M. E. 2008. Evaluation of new sesame (*Sesamum indicum* L.) genotypes for yield, yield components and stability. University of Khartoum Journal of Agricultural Sciences 16: 380-394.

Ahmed, M. E., M. B. Taha and A. A. Khalafalla. 2003. Assessment of new promising sesame cultivars for the central rainlands and irrigated systems. A paper submitted to the Variety Release Committee, Khartoum, Sudan.

Ali, K. A., A. E. S. Ibrahim, M. B. Taha and M. E. Ahmed. 2003. Performance, interrelationship and path analysis of some yield components in sesame. University of Khartoum Journal of Agricultural Sciences 11: 305-321.

AOAD. 2010. Arab Agricultural Statistics Year Book, 30. Arab Organization for Agricultural Development (AOAD), Khartoum, Sudan.

Deepa, S. P. and C. R. A. Kumar. 2001. Heterosis for yield and yield components in sesame (*Sesamum indicum* L.). Sesame and Safflower Newsletter 16: 6-8.

FAO. 2011. Production Year Book, Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.

Gomez, K. A. and K. A. Gomez. 1984. Statistical Procedures for Agricultural Research. 2nd ed. John Wiley and Sons, Inc., New York.

Khidir, M. O. 1969. Indehiscent sesame (*Sesamum orientale* L.). Sudan Agricultural Journal 4: 30-36.

Khidir, M. O. 2007. Oilseed Crops in the Sudan (in Arabic). Second revised edition, Khartoum University Press, Sudan.

Khidir, M. O. and H. E. Osman, 1970. Correlation studies of some agronomic characters in sesame. Experimental Agriculture 6: 27-31.

Mishra, A. K. and R. S. Sikarwar. 2001. Heterosis and combining ability analysis in sesame. Sesame and Safflower Newsletter 16: 1-5.

Mishra, A. K., L. N. Yadav, R. K. S. Tomar and I. S. Raghu. 1994. Heterosis and combining ability in genetically diverse lines in sesame. Sesame and Safflower Newsletter 9: 21-29.

Osman, H. E. 1980. Genetic male sterility in sesame (*Sesamum indicum* L.): Reproductive characteristics and possible use in hybrid vigor. Ph.D. Dissertation, University of California, Riverside.

Osman, H. E. and M. O. Khidir. 1974. Relation of yield components in sesame. Experimental Agriculture 10: 97-103.

Rangasamy, M. and M. Rathinam. 1982. Mutagen induced male sterile line in sesame. Indian Journal of Genetics 42: 142.

Senthil, K. P., R. Pushpa and J. Ganesan. 2003. Heterosis for yield and yield components in sesame (*Sesamum indicum* L.). Sesame and Safflower Newsletter 18: 12-14.

Singh, A. K., J. P. Lal and H. Kumar. 2005. Identification of certain heterotic crosses for their exploitation in the improvement of sesame (*Sesamum indicum* L.). Sesame and Safflower Newsletter 20:34-37.

Singh, P. and S. S. Narayanan. 2000. Biometrical Techniques in Plant Breeding. Second edition. Kalyani Publisher, New Delhi.

Thiyagu, K., G. Kandasamy, N. Manivannan and V. Muralidharan. 2007. Studies on heterosis in genetically diverse lines of cultivated sesame (*Sesamum indicum* L.). Madras Agricultural Journal 94:162-167.

Walton, P.D. 1959. Plant breeding in the central rainlands of the Sudan. 1951-56. Empire Journal of Experimental Agriculture 27: 79-85.

قوة الهجين للانتاجية ومكوناتها فى بعض الطرز الوراثية للسمسم

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محطة البحوث الزراعية القضارف، القضارف، السودان.

الخلاصة

هدفت هذه الدراسة لتحديد تأثير قوة الهجين على انتاجية السمسم ومكوناتها. اختيرت ثمانية اباء من برنامج تربية السمسم، محطة بحوث القضارف، السودان. هجنت الاباء الثمانية من جهة واحدة مع بعضها للحصول على 28 هجينا. تم تقويم الاباء الثمانية وثمانية وعشرين هجيناً فى موسمين مطريين متتاليين (2005 و2006) بمحطة بحوث القضارف. أربعة من الاباء (زراعة-9، كنانة-2، برومو, قضارف-1) هى أصناف مجازة, أما الأربعة أباء الاخرى فهى طرز متقدمة. نفذت التجربة باستخدام القطاعات العشوائية الكاملة بثلاث مكررات لتفسير قوة الهجين عى الانتاجية ومكوناتها فى 36 طرارا وراثيا من السمسم. جمعت بيانات عن الصفات التالية: عدد الأيام حتى 50% ازهار، عدد الأيام حتى النضج، طول النبات، عدد الفروع فى النبات، عدد الكبسولات (الثمار) فى النبات، ارتفاع أول كبسولة، طول الكبسولة، وزن ال 1000 بذرة، الانتاجية للنبات, الانتاجية للهكتار. حسبت قوة الهجين لكل الصفات كنسبة زيادة أو نقصان من متوسط الأبوين أو أفضل الأبوين أو الأب القياسى (أكثر زراعة). أوضح التحليل قوة الهجين لكل الصفات. أظهر الهجين Gd2002OBN.103×Promo قوة هجين معنوية سالبة لصفة عدد الأيام حتى 50% ازهار على كل المستويات, كما أظهر قوة هجين سالبة لصفة عدد الأيام حتى النضج وقوة هجين موجبة لصفة الانتاجية للهكتار وبالتالى يمكن استغلاله فى الحصول على أصناف مبكرة وعالية الانتاجية وكان للهجين Gd2002SPSN.53xGedarif-1 والهجين Gd2002SPSN.53×Promo قوة هجين معنوية فى الانتاجية للهكتار على كل المستويات. خلصت الدراسة الى الحاجة لمزيد من الاختبارات لتأكيد ثبات انتاجية هذه الهجن فى المواسم والمواقع المختلفة.