Annals Agric. Sci., Ain Shams Univ., Cairo, 50(1), 229-245, 2005

PERFORMANCE OF DIFFERENT SESAME (*SESAMUM INDICUM* L.) VARIETIES UNDER VARIABLE ENVIRONMENTS

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ABSTRACT

Two field experiments were carried out during two successive seasons (parent and progeny) in two locations : Kanater (clay soil) and Nubaria (Sandy soil) to study the effect of genotype environmental interaction on yield and yield components of three sesame *(Sesamum indicum* L.) varieties: Cairo 2, Shandaweel and Toshki. Genotypic and phenotypic coefficients of variation, broad and narrow sense heritabilities as well as parent/progeny regression were computed for seven quantitative traits of varieties. Highly significant differences were found between parent and progeny in all traits except plant height and branches number. Highly significant differences were observed also among varieties, locations and their interactions through all studied characters except for seed index. Parents at the first season had the higher genotypic and phenotypic coefficients of variation for plant height, branches and capsules numbers as well as seed index, while progenies were higher for capsules weight and seed yield per feddan for all varieties. Shandaweel variety had the lowest genotypic and phenotypic coefficients of variation for most of the traits followed by Toshki and Cairo 2 varieties. Seeds of Cairo 2 variety produced high oil content followed by Shandaweel and Toshki. Three saturated and two unsaturated fatty acids were measured for all varieties. Oleic acid was the major component for Shandaweel and Toshki oils, while linoleic was the major one for Cairo 2 variety.

Key words: Sesame (*Sesamum indicum* L.), Varieties, Locations, Genotype environmental interaction, Heritability

INTRODUCTION

Sesame, *Sesamum indicum* L. is one of the world's most important and oldest oilseed crop known to man (**Sonntag, 1981**). Sesame has long been cultivated in countries, particularly in Asia and Africa, for its high content of edible oil and pro-

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(Received March 2, 2005)
(Accepted April 11, 2005)

tein (**Salunkhe,** ***et al*** **1991**). Most of Sesame seeds are used for extraction and production of oil. The oil is used as a cooking oil, in margarine and pharmaceuticals (**Abou-Gharbia** ***et al*** **2000**). It also contains natural antioxidants that lend its stability and long shelf life (**Ashri, 1998**).

Breeding for high yielding and stable varieties has always been an important objective of all plant breeding programs. Seed yield is a complex character and sensitive to environmental changes (**Awaad and Aly, 2002**). Genotype-environmental interactions are often described as inconsistent differences among genotypes from one environment to another, especially when varieties are compared over a number of environments (**Comstock and Moll, 1963**). Moreover, significant differences due to environment, genotypes and their interactions with years (Seasons), location and genotype x year x location with a major importance of linear component for seed yield, its components and oil percentage have been reported by **Mahdy** ***et al*** **(1988), Suresh** ***et al*** **(1991)** and **Ragab and Kassem (2002)**.

The main objective of the majority of sesame breeding programs is to select varieties which perform consistently over a wide range of environments or specific environment. It is important for the breeders to quantify and estimate the genotype x environment component and to characterize each variety according to its environmental response. Also, the seed oil content in various locations and varieties varied according to environmental and genotypic factors (**Yarmanos** ***et al*** **1972** and **Lee** ***et al*** **1991**).

Sesame oil contains mainly 4 fatty acids : palmitic (16 : 0), Stearic (18 : 0), oleic (18 : 1) and lenoleic acids (18 : 2). Other Fatty acids appear occasionally in very small amounts (**Ashri, 1998**). Some differences between sesame genotypes in fatty acids composition were reported by **Brigham and Khan (1989).** Variability for fatty acid content that may facilitate breeding for modified oil quality is desired, but its genetic control is unknown (**Yermanos, 1984**).

The present investigation was conducted to evaluate seed yield and its contributed characters of three Egyptian sesame varieties; Cairo 2, Shandaweel and Toshki under two locations; Kanater (old land) and Nubaria (new reclaimed land) in two successive years (seasons) and determine genotype environmental interaction. Also, to quantify the oil content and its fatty acid composition as well as hydrocarbon composition of each variety.

MATERIAL AND METHODS

Seeds of two introduced sesame (*Sesamum indicum* L.) varieties Shandaweel and Toshki were obtained from Agricultural Research Centre, Giza, Egypt, in addition to Cairo 2 (mutant 48) variety seeds which were obtained from Faculty of Agriculture, Cairo University, Egypt. Seeds were sown on April during two successive summer seasons of 2002 and 2003. Two repeated field experiments were conducted under two different environments : the experimental Station of National Research Centre at Kanater representing clay soil and Nubaria region representing sandy soil.

Soil samples were taken at 30 cm depth from the surface of each location for mechanical and chemical analysis which are presented in the following table:

Soil composition	Kanater	Nubaria	Soil chemical analysis	Kanater	Nubaria
Clay %	35.5	6.5	pH	7.60	8.30
Siltt %	22.5	26.4	Ec mmh/cm	0.30	1.05
Sand %	45.0	80.1	$CaCO_3$ %	2.06	29.80

A randomized complete block design with three replications was used. Each replicate had ten lines of 4 m long. Plants were thinned to secure only one plant per hill (40 cm space) after full emergence of the seedlings. All cultural practices were carried out whenever they were required. At maturity, 30 plants were separately harvested for each replicate of each variety. Seven quantitative characters: plant height (cm), number of branches per plant, number of capsules per plant, capsules weight per plant (g), seed index (1000 seeds weight g), seed yield per plant (g) and arithmetic seed yield per feddan (kg) were determined and recorded. The obtained data were subjected to factorial statistical analysis with least significant differences (L.S.D.) test for each season and combined seasons according to **Steel and Torrie, (1980)**. The broad sense heritability (h^2_b) estimates of sesame traits were calculated by using the method of **Johnson *et al* (1955)**. Genotypic and phenotypic coefficients of variation were computed according to the method described by **Burton (1952)**. Narrow sense heritability was also computed using parent/progeny regression, correlation adjusting mating system ($h^2_n = \frac{b_{xy}}{2r_{xy}}$) according to **Smith and Kinmann (1965)**.

Seed oil was extracted using Soxhlet Apparatus according to **A.O.A.C. (1990)**, then the percentage of oil content was estimated for each variety. The fatty acid methyl esters were extracted from oil of each variety by the method described by **Vogel, (1975)**. Qualitative and quantitative analysis of the fatty acid esters of each variety were performed by Gas chromatography with Mass Spectrum (GC/MS). Fatty acid fractions were accomplished on a Varian Gas Chromatography (Walnut Creek, California, USA) equipped with Finnigeum mat SSQ 7000 (Thermo Inst., USA) mass spectrometer and a 30 m × 0.25 mm. DB-5 Capillary column film thickness (J & W Scientific, USA). The column temperature was programmed from 50 C° (constant for 3 min.), at a rate of 7°C /min to 250°C with 10 min. isothermal hold. The injector temperature was 220°C and the transition line temperature was 250°C. The carrier gas was helium and the column head pressure was 10-15 psi. Comparison with on-line computer library (NIST software package-National Institute for Standards and Technology, USA) was done. Comparisons were carried out with published literature in accordance with the procedure used by NRC laboratory.

RESULTS

Genotype – Environment Interactions Analysis

Data presented in Table (1) showed the analysis of variance through seven quantitative characters of three sesame varieties (Cairo 2 mutant 48, Shandaweel and Toshki) grown at two locations (Kanater and Nubaria) for two summer seasons (2002 and 2003) as well as combined analysis. Highly significant differences were observed between varieties in the two seasons and combined analysis for all studied characters except for seed index in the second season which showed non significant difference. Also, highly significant differences were noted between locations in all characters except for seed index which was found to have non significant differences either for each season or the combined data. While non significant differences were found between seasons in plant height and branches number but highly significant variations in the remained five characters. Interaction between varieties (V) and locations (L) showed highly significant differences for the combined data for branches number, capsules number, capsules weight, seed yield per plant and seed yield per feddan. But it had significant differences for seed index and insignificant for plant height. Moreover, the interaction between seasons and varieties had highly significant variations among combined analysis for all studied characters, while season location interactions represented highly significant variation for seed yield per plant and per feddan only significant for branches number and non significant for the remained characters. The tri-interaction (S×V×L) had highly significant differences for the combined analysis of plant height, branches number, capsules number, seed yield per plant and seed yield per feddan, but insignificant for capsules weight and seed index.

Data in Table (2) showed that Shandaweel variety had the highest means of all traits among the first, second seasons and combined analysis except for plant height (it had the lowest values) and seed index (it had moderate values). On the contrary, Cairo 2 variety had the lowest mean for all characters, except for plant height which was the highest. Toshki variety was the medium variety among others.

On the other hand, Nubaria location was better for plant height, number of branches, number of capsules and capsules weight than Kanater. Meanwhile, Kanater location gave the higher values of seed index, seed yield per plant and seed yield per feddan than Nubaria at both seasons and combined analysis.

Concerning the interaction between varieties and locations, Shandaweel variety gave the highest values at Nubaria locality of branches number, capsules number as well as capsules weight. However, Cairo 2 variety had the lowest values of the same three characters through the first, second seasons and combined analysis at Kanater location. Moreover, the highest seed yield per plant and per feddan were given by Shandaweel at Kanater. While Cairo 2 at Nubaria had the lowest seed yield per plant and per feddan at the first, second seasons as well as combined analysis.

Table 1. Analysis of variance (MSS) of seven quantitative traits for three sesame varieties grown at two locations through two successive seasons 2002 and 2003

		Seasons (S)	Varieties (V)	Locations (L)	Interactions				Replicates	Error
					S × V	S × L	V × L	S × V × L		
d.f. (seasons)		-	2	1	-	-	2	-	2	10
d.f. (combined)		1	2	1	2	1	2	2	4	22
plant height (cm)	1st	-	2404.5**	1643.56**	-	-	51.72	-	12.67	32.87
	2nd	-	211.72**	1027.55**	-	-	15.06*	-	0.06	2.78
	Comb	2.78	2020.86**	2635.11**	1190.72**	36.0	6.69	120.17**	6.36	17.82
Branches number/plant	1st	-	28.82**	20.69**	-	-	1.62**	-	0.02	0.03
	2nd	-	13.36**	9.10**	-	-	0.57	-	0.11	0.27
	Comb	0.02	40.60**	28.62**	3.16**	1.17*	1.81**	0.77**	0.06	0.15
Capsules number/plant	1st	-	33310.27**	3190.30**	-	-	2176.16**	-	39.83	37.17
	2nd	-	5763.4**	4349.37**	-	-	589.52	-	82.01	195.50
	Comb	74620.04**	33268.72**	8130.04**	11609.87**	9.60	2459.51**	612.31**	60.92	116.09
Capsules weight (g)/plant	1st	-	1106.84**	2112.5**	-	-	375.38**	-	19.66	6.24
	2nd	-	2728.66**	2189.01**	-	-	340.60**	-	12.62	49.67
	Comb	8839.13**	3624.05**	4301.17**	422.91**	0.34	709.62**	12.72	16.14	27.96
Seed index (g)	1st	-	3.24**	0.03	-	-	0.16	-	0.004	0.06
	2nd	-	0.11	0.03	-	-	0.14	-	0.01	0.10
	Comb	5.14**	1.07**	0.05	4.57**	0.004	0.30*	0.02	0.01	0.08
Seed yield/plant (g)	1st	-	266.59**	150.22**	-	-	19.5**	-	1.33	1.10
	2nd	-	395.36**	412.80**	-	-	59.10**	-	0.32	1.87
	Comb	294.69**	621.99**	530.53**	79.92**	32.49**	24.71**	72.68**	0.83	1.48
Seed yield/feddan (kg)	1st	-	7611.19**	43414.26**	-	-	995.27	-	385.51	318.05
	2nd	-	14259.67**	119299.81**	-	-	17080.56**	-	92.63	539.83
	Comb	85166.30**	179755.15**	153324.06**	22231.39**	9390.0**	7140.03**	21871.59**	956.27	428.94

Table 2. Averages, standared errors, coefficient of variability as well as least significant difference at 5% of seven quantitative characters for three sesame varieties grown at two localities among two seasons 2002 and 2003

Items	Plant height			Branches number/plant			Capsules number/plant			Capsules weight (g)/plant		
	1st	2nd	Comb.	1st	2nd	Comb.	1st	2nd	Comb.	1st	2nd	Comb.
Varieties (V)												
Cairo 2	166.9	152.0	159.4	1.8	2.4	2.1	124.7	252.6	188.6	91.2	112.9	102.0
Shandaweel	126.9	140.2	133.5	6.2	5.4	4.1	272.2	314.5	293.3	118.3	155.2	136.7
Toshki	145.4	145.2	145.2	4.0	4.2	5.8	180.0	283.0	231.5	103.1	138.5	120.8
X¯	146.4	145.8	146.1	4.0	4.0	4.0	192.3	283.4	237.8	104.2	135.5	119.8
S.E.	11.6	3.4	7.5	1.3	0.9	1.1	43.0	17.9	30.4	7.8	12.3	10.0
C.V.%	13.7	4.1	8.9	55.0	37.7	46.3	38.7	10.9	22.1	13.0	15.7	14.5
L.S.D. $_{0.05}$	7.38	2.15	3.6	0.23	0.66	0.33	7.85	18	9.11	3.22	9.70	4.47
Locations (L)												
Kanater	136.8	138.2	137.5	2.9	3.2	3.1	177.8	267.8	222.8	93.3	124.5	108.9
Nubaria	155.9	153.3	154.6	5.1	4.7	4.9	206.8	298.9	252.9	115.0	146.5	130.8
X¯	146.4	145.8	146.1	4.0	4.0	4.0	192.3	283.4	237.9	104.2	135.5	119.9
S.E.	9.6	7.6	8.6	1.1	0.8	0.9	14.5	15.6	15.1	10.9	11.0	11.0
C.V.%	9.2	7.3	8.3	38.9	26.9	31.8	10.7	7.8	8.9	14.7	11.5	12.9
L.S.D. $_{0.05}$	6.03	1.75	6.24	0.19	0.54	0.27	6.41	14.7	7.43	2.63	7.41	3.65
Interaction L × V												
Kanater												
Cairo 2	154.0	146.0	150.0	1.3	1.8	1.6	129.8	245.1	187.5	84.9	107.5	96.2
Shandaweel	119.7	131.0	125.3	4.7	4.3	4.5	239.2	287.9	263.0	98.3	135.6	117.0
Toshki	136.7	137.7	137.2	2.8	3.6	3.2	164.3	270.4	217.4	96.8	130.4	113.6
Nubaria												
Cairo 2	179.7	158.0	168.8	2.3	2.9	2.6	119.6	260.0	189.8	97.4	118.2	107.8
Shandaweel	154.0	149.3	141.7	7.7	6.4	7.1	305.1	341.1	323.1	138.2	174.8	156.5
Toshki	134.0	152.7	153.3	5.2	4.7	5.0	195.7	295.6	245.7	109.4	146.6	128.0
X¯	146.4	145.8	146.1	4.0	4.0	4.0	192.3	283.4	237.9	104.2	135.5	119.9
S.E.	8.5	4.1	6.1	1.0	0.6	0.8	28.8	13.8	21.0	7.5	9.6	8.5
C.V.%	14.3	6.8	10.2	58.4	40.1	49.0	36.7	11.9	21.6	17.7	17.4	17.3
L.S.D. $_{0.05}$	-	-	5.09	0.33	-	0.47	11.10	-	12.88	4.55	12.83	6.32

Table 2. Cont.

Items		Seed index			Seed yield/plant			Seed yield/feddan		
		1st	2nd	Comb.	1st	2nd	Comb.	1st	2nd	Comb.
Varieties (V)										
	Cairo 2	3.5	3.7	3.6	23.9	26.6	25.2	405.8	455.1	430.4
	Shandaweel	4.5	3.4	3.9	37.2	41.7	39.4	631.6	708.3	669.9
	Toshki	4.9	3.4	4.1	30.1	39.8	34.9	510.9	676.6	593.7
	X⁻	4.3	3.5	3.9	30.4	36.0	33.2	516.1	613.3	564.7
	S.E.	0.4	0.1	0.2	3.8	4.7	4.2	65.2	79.6	70.6
	C.V.%	16.8	4.9	6.5	21.9	22.8	21.9	21.9	22.5	21.7
	L.S.D. $_{0.05}$	0.22	-	0.24	1.35	1.76	1.03	22.96	29.91	17.50
Locations (L)										
	Kanater	4.3	3.5	3.9	33.2	40.7	37.0	565.2	694.7	630.0
	Nubaria	4.2	3.4	3.8	27.5	31.3	29.4	466.9	531.9	499.4
	X⁻	4.3	3.5	3.9	30.4	36.0	33.2	516.1	613.3	564.7
	S.E.	0.1	0.1	0.1	2.9	4.7	3.8	49.2	81.4	65.3
	C.V.%	1.7	2.0	1.8	13.3	18.5	16.2	13.5	18.8	16.4
	L.S.D. $_{0.05}$	-	-	-	1.10	1.44	0.84	18.75	24.42	14.29
Interaction L × V										
Kanater	Cairo 2	3.3	3.5	3.4	27.1	27.5	27.3	461.3	474.9	468.1
	Shandaweel	4.6	3.6	4.1	39.2	48.4	43.8	665.8	822.2	744.0
	Toshki	5.0	3.4	4.2	33.4	46.3	40.0	568.4	787.1	677.8
Nubaria	Cairo 2	3.6	3.8	3.7	20.6	25.6	23.1	350.2	435.2	392.7
	Shandaweel	4.3	3.2	3.8	35.1	35.0	35.1	597.3	594.4	595.9
	Toshki	4.8	3.3	4.1	26.7	33.3	30.0	453.3	566.1	509.7
	X⁻	4.3	3.5	3.9	30.4	36.0	33.2	516.1	613.3	564.7
	S.E.	0.3	0.1	0.1	2.8	3.9	3.2	47.0	65.1	54.1
	C.V.%	15.9	6.2	7.9	22.3	26.3	23.7	22.3	26.0	23.5
	L.S.D. $_{0.05}$	-	-	0.34	-	2.49	1.46	-	42.30	24.75

Comb. Combined

Genotypic, Phenotypic Variations and Broad Sense Heritability

Data presented in Table (3) showed that both genotypic and phenotypic coefficients of variation were higher in the first season for plant height, branches number and capsules number per plant and seed index than these in the second season for all varieties, Cairo 2, Shandaweel and Toshki in both locations, Kanater and Nubaria. On the contrary, capsules weight and seed yield per feddan were higher in the second season. While seed yield per plant genotypic and phenotypic coefficients of variation were found to be higher in the first season at Nubaria location for Cairo 2 and Toshki varieties and at Kanater for Shandaweel and Toshki varieties, but lower at Kanater for Cairo 2 variety and Nubaria for Shandaweel variety.

On the other side, Cairo 2 variety had the highest genotypic and phenotypic coefficients of variability for branches number, capsules number, capsules weight, seed yield per plant and per feddan followed by Toshki followed by Shandaweel variety in both seasons and locations. Meanwhile, genotypic and phenotypic coefficients of variation for plant height and seed index were disruptive between varieties.

Concerning sesame traits, the highest levels of genotypic and phenotypic coefficients of variance were noted for number of branches followed by number of capsules and seed yield per plant for all studied varieties at both locations in the first season. While, seed yield per feddan had the lowest coefficients of variability at both locations for all varieties in the same season. Branches number had the highest genotypic and phenotypic coefficients of variation in the second season followed by seed yield per plant followed by capsules weight of all varieties at both locations. Plant height of all varieties in the second season had the lowest phenotypic variations at Kanater and Nubaria locations. While, the lowest levels of genotypic variations were noted in plant height for Toshki at both locations and for Shandaweel at Nubaria, but noted in seed index for Cairo 2 at both locations and for Shandaweel at Kanater location.

Broad sense heritability was estimated for each trait of sesame in the first and second seasons and presented in Table (3). The highest broad sense heritability was recorded for branches number (0.9938), capsules number (0.9933) and seed yield per plant (0.9757) in the first season. Estimates of heritability in the second season were less than that in the first one for all varieties. The highest broad sense heritability values were recorded for seed yield per plant (0.9723), plant height (0.9260) and Capsules weight (0.8999) in the second season. Seed yield per feddan had the lowest heritabilities in both the first and second seasons where it was 0.7926 and 0.8090, respectively.

Parent/Progeny Regression and Narrow Sense Heritability

Estimates of parent/progeny regression and narrow sense heritability of sesame varieties traits at Kanater and Nubaria locations were shown in Table (4). All parent/progeny regression estimates were positive. Shandaweel variety presented the highest parent/progeny regression and narrow sense heritability values for seed yield per plant (0.8398 and 0.4819) respectively, seed yield per

Table 3.Genotypic coefficient of variation (G.C.V.), phenotypic coefficient of variation (P.C.V.), genotypic and phenotypic variance (σ^2G and σ^2p) and broad sense heritability (h^2_b) for seven quantitative characters of three sesame varieties Cairo 2, Shandaweel and Toshki grown at two different localities Kanater and Nubaria for two generations as well as combind generations

Varieties	Genetic c.v. %	Locations	Plant height			Branches number/plant			Capsules number/plant			Capsules weight (g)/plant		
			1st	2nd	Comb.	1st	2nd	Comb.	1st	2nd	Comb.	1st	2nd	Comb.
Cairo 2 mutant 48	G.C.V. %	Kanater	12.91	4.04	12.18	168.53	82.03	162.26	57.37	12.43	39.64	15.95	19.66	25.45
		Nubaria	11.06	3.73	10.82	95.26	50.91	99.85	62.26	11.72	39.16	13.91	17.88	22.71
		General	11.91	3.88	11.46	121.72	61.52	123.63	59.72	12.06	39.41	14.85	18.72	24.00
	P.C.V. %	Kanater	13.44	4.20	12.50	169.06	86.96	164.06	57.56	13.68	40.06	16.22	20.72	26.04
		Nubaria	11.51	3.88	11.11	95.55	53.97	100.96	62.47	12.89	39.57	14.14	18.85	23.23
		General	12.40	4.03	11.76	122.10	65.22	124.99	59.92	13.27	39.83	15.10	19.73	24.56
Shandaweel	G.C.V. %	Kanater	16.61	4.50	14.58	46.61	34.34	57.69	31.13	10.58	28.26	13.78	15.58	20.92
		Nubaria	12.91	3.95	12.89	28.45	23.07	36.57	24.41	8.93	23.01	9.80	12.09	15.64
		General	15.67	4.21	13.69	35.34	27.34	63.32	27.36	9.69	25.34	11.45	13.62	17.91
	P.C.V. %	Kanater	17.29	4.68	14.97	46.76	36.4	58.33	31.24	11.64	28.56	14.01	16.43	21.41
		Nubaria	13.44	4.11	13.23	28.54	24.46	36.97	24.49	9.83	23.25	9.97	12.74	16.00
		General	16.31	4.37	14.05	35.45	28.99	64.02	27.45	10.66	25.61	11.64	14.35	18.32
Toshki	G.C.V. %	Kanater	14.54	4.29	13.32	78.25	41.01	81.13	45.32	11.27	34.19	13.99	16.20	21.55
		Nubaria	14.84	3.86	11.92	42.13	31.41	51.92	38.05	10.31	30.25	12.38	14.41	19.13
		General	13.67	4.06	12.58	54.77	35.15	44.76	41.37	10.76	32.11	13.14	15.26	20.27
	P.C.V. %	Kanater	15.14	4.45	13.67	78.49	43.48	82.03	45.48	12.40	34.55	14.23	17.08	22.05
		Nubaria	15.44	4.02	12.23	42.26	33.3	52.50	38.18	11.34	30.57	12.59	15.19	19.57
		General	14.23	4.22	12.92	54.94	37.27	45.26	41.51	11.84	32.44	13.36	16.08	20.73
	Varieties σ^2 G		395.27	34.82	333.84	4.80	2.18	6.74	5545.52	927.98	5525.44	183.43	446.50	599.35
	Varieties σ^2 p		428.14	37.60	351.66	4.83	2.45	6.89	5582.69	1123.48	5641.53	189.67	496.17	627.31
	Varieties h^2_b		0.923	0.926	0.9493	0.9938	0.8899	0.9782	0.9933	0.8260	0.9794	0.9671	0.8999	0.9554

Table 3. cont.

Varieties	Genetic c.v. %	Locations	Seed index			Seed yield/plant			Seed yield/feddan		
			1st	2nd	Comb.	1st	2nd	Comb.	1st	2nd	Comb.
Cairo 2 mutant 48	G.C.V. %	Kanater	22.06	2.20	12.13	24.55	29.45	37.25	7.56	10.07	36.93
		Nubaria	20.22	2.06	11.14	32.29	31.63	44.02	9.96	10.99	44.02
		General	20.80	2.10	11.45	27.83	30.44	40.36	8.59	10.51	40.17
	P.C.V. %	Kanater	23.28	6.14	14.71	24.85	29.86	37.52	8.49	11.19	37.20
		Nubaria	21.34	5.68	13.51	32.69	32.08	44.34	11.18	12.22	44.34
		General	21.95	5.07	13.89	28.18	30.88	40.64	9.65	11.68	40.45
Shandaweel	G.C.V. %	Kanater	15.83	4.29	10.06	16.97	16.73	23.22	5.24	5.82	23.24
		Nubaria	16.93	4.77	10.85	18.95	23.14	28.97	5.84	8.04	29.01
		General	16.18	4.96	10.57	17.88	19.42	25.81	5.52	6.75	25.81
	P.C.V. %	Kanater	16.70	7.70	12.20	17.18	16.97	23.38	5.88	6.47	23.40
		Nubaria	17.86	8.46	13.16	19.19	23.47	29.18	6.56	8.94	29.22
		General	17.07	8.57	12.82	18.10	19.69	26.00	6.20	7.51	25.99
Toshki	G.C.V. %	Kanater	14.56	5.08	9.82	19.92	17.49	25.42	6.13	6.08	25.51
		Nubaria	15.17	4.95	10.06	24.91	24.32	33.90	7.69	8.45	33.92
		General	14.86	5.26	10.06	22.10	20.35	29.14	6.82	7.07	29.12
	P.C.V. %	Kanater	15.36	8.44	11.90	20.16	17.74	25.61	6.89	6.75	25.69
		Nubaria	16.00	8.40	12.20	25.22	24.66	34.14	8.64	9.39	34.16
		General	15.68	8.72	12.20	22.37	20.64	29.35	7.67	7.86	29.23
	Varieties σ^2 G		0.53	-	0.17	44.25	65.58	103.42	1215.52	2286.64	29887.70
	Varieties σ^2 p		0.59	-	0.25	45.35	67.45	104.90	1533.57	2826.47	30316.64
	Varieties h^2_b		0.8983	-	0.6735	0.9757	0.9723	0.9859	0.7926	0.8090	0.9859

Comb. Combined

Table 4. Parent/progeny regession and narrow sense heritability % estimates for seven quantitative characters of three sesame varieties Cairo 2, Shandaweel and Toshki, grown at different locations, Kanater and Nubaria

Items	Varieties	Locations	Plant height	Branches number /plant	Capsules number /plant	Capsules weight (g)/plant	Seed index	Seed yield /plant	Seed yield /feddan
Parent/progeny regression	Cairo 2	Kanater	0.2105	0.1811	0.0453	0.2173	0.7273	0.5847	0.5847
		Nubaria	0.2484	0.5000	0.3366	0.5548	0.4286	0.8333	0.8333
	Shandaweel	Kanater	0.2835	0.4343	0.61.47	0.3816	0.4286	0.8398	0.8398
		Nubaria	0.2500	0.1164	0.8001	0.2530	0.8571	0.2933	0.2933
	Toshki	Kanater	0.5429	0.3000	0.1751	0.3536	0.8846	0.6303	0.6303
		Nubaria	0.2500	0.4267	0.5127	0.4486	0.4733	0.2256	0.2256
Narrow sense heritability %	Cairo 2	Kanater	0.1147	0.0907	0.0375	0.1094	0.4264	0.3216	0.3216
		Nubaria	0.1287	0.2500	0.2149	0.2991	0.3273	0.4409	0.4409
	Shandaweel	Kanater	0.1423	0.2190	0.3956	0.2014	0.3273	0.4819	0.4819
		Nubaria	0.1456	0.0585	0.4224	0.1301	0.4771	0.1705	0.1705
	Toshki	Kanater	0.2803	0.1732	0.1122	0.1821	0.4467	0.3253	0.3253
		Nubaria	0.1466	0.2329	0.2148	0.2559	0.2621	0.1252	0.1252

feddan (0.8398 and 0.4819), capsules number (0.6147 and 0.3958), branches number (0.4343 and 0.2190) and capsules weight (0.3816 and 0.2014, respectively) at Kanater location. While, the highest regression and narrow sense heritability values were recorded for seed index and plant height (0.8846 & 0.4467 and 0.5429 & 0.2803, respectively) of Toshki variety at the same locality. Meanwhile, sandy soil at Nubaria location presented the highest parent/progeny regression and narrow sense heritability for seed yield per plant (0.8333 and 0.4409), seed yield per feddan (0.8333 and 0.4409), capsules weight (0.5548 and 0.2991) and branches number (0.50 and 0.25, respectively) for Cairo 2 compared with other varieties. While, seed index (0.8571 and 0.4771) and capsules number (0.8001 and 0.4224) for parent progeny regression and narrow sense heritability, respectively had the highest values for Shandaweel variety in Nubaria location.

Comparison of the different characters showed that Cairo 2 variety had the highest regression as well as narrow sense heritability for seed index at Kanater (0.7273 and 0.4264), and seed yield at Nubaria (0.8333 and 0.4409). Contradictly with Shandaweel variety which had the highest regression and heritability values for seed yield (0.8398 and 0.4819) at Kanater and for seed index (0.8571 and 0.4771) at Nubaria location. Seed index at Kanater and capsules number at Nubaria had the highest values of parent/progeny regression and narrow sense heritability for Toshki variety.

Fixed Oil and Its Main Fatty Acids

The percentage of fixed oil isolated from the dried seeds of the three studied sesame varieties Cairo 2, Shandaweel and Toshki was shown in Table (5). Cairo 2 variety had the highest percent of oil averaged with 37.94 %. The oil contents of Shandaweel and Toshki were approximately equal in their fixed oil contents (34.68 and 34.37 %, respectively).

Gas Chromatography with Mass Spectrum (GC/MS) was used in the identification and quantitation of fatty acids and hydrocarbons composition isolated from the fixed oil of the three sesame varieties. The identified saturated and unsaturated fatty acids as well as hydrocarbons are shown in Table (5). Three saturated fatty acids: palmitic (C_{16}), stearic (C_{18}) and arachidic (C_{20}) acids were detected in all different varieties. Although, stearic acid was the first major saturated fatty acid in Cairo 2 and Shandaweel varieties with relative percent of 6.46% and 15.97%, respectively and average of 9.69%, palmitic acid was found to be the major in Toshki variety with 7.74 % relative percentage. On the other hand, two unsaturated fatty acids were detected in all studied varieties. Oleic acid was found to be the major unsaturated fatty acid in Toshki and Shandaweel (66.52 and 51.77%, respectively). While linoleic acid had the majority relative percent 48.5% in Cairo 2 variety. Moreover, five hydrocarbon compounds were detected in the varieties of Cairo 2 and Shandaweel, but only three were found at Toshki variety. Ergosto,4,6,22,tri-3-ol was the major hydrocarbon compound in all varieties with relative percentage of 8.63, 5.5 and 3.2 % in Cairo 2, Toshki and Shandaweel, respectively. Coefficient of variability (C.V. %) estimates were so high in all compounds to reveal the wide range variation between varieties in their fatty acid and hydrocarbon compositions.

Table 5. Mean values and coefficient of variabilities (c.v. %) of the main saturated and unsaturated fatty acids as well as hydrocarbons of three sesame varieties

Components	RRT*	Varieties			Mean	C.V. %
		Cairo 2	Toshki	Shandaweel		
Percentage of fixed oil content		37.94	34.37	34.68	35.66 ± 1.14	5.55
Palmatic (16:0)	0.90 ± 0.02	3.16	7.74	6.61	5.84 ± 0.58	40.88
Stearic (18 : 0)	1.16 ± 0.03	6.46	6.64	15.97	9.69 ± 3.14	56.13
Archidic (20 : 0)	1.27 ± 0.03	2.13	1.28	4.04	2.48 ± 0.82	56.92
Total saturated fatty acids		11.75	15.66	26.62	18.01 ± 4.45	42.80
Oleic (18 : 1)	0.98 ± 0.02	24.86	66.52	51.77	47.72 ±12.20	44.27
Linoleic (18 : 2)	1.05 ± 0.03	48.50	9.68	14.93	24.37 ± 12.16	86.42
Total unsaturated fatty acids		73.36	76.20	66.70	72.09 ± 2.82	6.76
Eicosane	1.37 ± 0.05	1.26	-	0.77	0.68 ± 0.37	93.87
Docosane	1.47 ± 0.05	3.09	-	1.77	1.62 ± 0.90	95.71
Tetracosane	1.58 ± 0.04	0.89	1.24	0.34	0.82 ± 0.26	55.10
Hexacosane	1.72 ± 0.06	1.02	1.39	0.60	1.00 ± 0.23	39.40
Ergosto,4,6,22,tri-3-ol	1.93 ± 0.05	8.63	5.50	3.20	5.78 ± 1.57	47.18
Total hydrocarbons		14.89	8.13	6.68	9.90 ± 2.53	44.26
Total known components		100.00	99.99	100.00	99.997 ± 0.003	0.006

*RRT = Relative retention time

DISCUSSION

Results of genotype-environmental interactions analysis cleared that significant differences were obtained for varieties(V) in respect with the studied characters, in addition to the significant effects of locations (L) on yield and its contributing characters obtained which are in agreement with those detected by **El-Serogy *et al* (1997), Basha (1998) Awaad & Basha (2000)** and **Ragab & Kassem (2002).** Also, the interactions between varieties with both seasons (V×S) and locations (V×L) in all characters as well as the tri-interaction (S×V×L) in most of the studied characters were highly significant, implying different response of varieties over seasons and/or locations. These results are providing evidence for the necessity of testing varieties in multiple environments to determine the suitable variety to the suitable location. A similar conclusion was reported by **Ragab *et al* (1995); Awaad and Basha (2000)** and **Awaad & Aly (2002).**

Concerning genotypic and phenotypic variations as well as broad sense heritability, it was concluded that branches number, Capsules number and seed yield per plant showed high genotypic and phenotypic coefficients of variation and high broad sense heritability. Therefore, these traits are the most suitable for improvement of sesame through selection. This finding was in agreement with **Kamala (1990); John and Nair (1993), Shanmugavalli and Vanniarajan (1998)** and **Sheeba *et al* (2003).**

It is evident that parent/progeny regression and narrow sense heritability indicated that Shandaweel was the best variety to inherit its progeny according to narrow sense heritability comparing with other varieties.

The highest narrow sense heritability for seed index and capsules number confirmed that these characters are the most suitable for improvement of sesame through selection. This finding is in agreement with **Shanmugavalli and Vanniarajan (1998)** and **Sheeba *et al* (2003)**, but contradicted with **Ranganatha *et al* (1994),** who found low narrow sense heritability for seed yield, primary branches, capsules number and oil percentage of sesame.

On the other hand, **Weiss, (1983)** decided that the oil content mean is near 50% with a range from 34.4 to 59.8% in sesame which were generally higher than our results. **Ashri, (1998)** reported that the variation in oil content is due to both genotype and environment. While **Yermanos *et al* (1972)** suggested that the oil content is governed by quantitative genes in addition to some factors such as seed maturity period and seed color which play a role in oil content variation (**Tashiro *et al* 1990; Lee *et al* 1991** and **Namiki, 1995**).

The results of oil fatty acids and hydrocarbon compounds are in good agreement with those of **Yermanos, *et al* (1972); Brigham and Khan (1989); Raheja *et al* (1989); Ashri, (1998)** and **Abou-Gharbia *et al* (2000).** Seed maturity and capsule position affect the relative proportions of the fatty acids (**Kang *et al* 1985** and **Gupta, 1990**). Also, climatic conditions affect the production of fatty acids (**Lee *et al* 1981**).

As a general conclusion, Shandaweel variety had the highest seed yield per plant and per feddan as well as the lowest genotypic and phenotypic coefficient of variation for seed yield during the first and second seasons in both old and new reclaimed lands (Kanater and Nubaria). Therefore, it is be recommended to use this variety for sesame cultivation in Egypt.

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مجلة حوليات العلوم الزراعية ، كلية الزراعة ، جامعة عين شمس ، القاهرة ، م٥٠ ، ع(١)، ٢٢٩ - ٢٤٥ ، ٢٠٠٥

أداء أصناف السمسم المختلفة تحت ظروف بيئات مختلفة

[١٧]

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أقيمت تجربتان فى الحقل فى موسمين متتاليين (الآباء والأبناء) فى موقعين أحدهما بالقناطر (تربة طمية) والآخر بالنوبارية (تربة رملية) لدراسة تأثير التفاعل الوراثى البيئى على المحصول ومكوناته فى ثلاثة أصناف من السمسم هى (القاهرة ٢ ، شندويل ، توشكى) . وقد تم تقدير كل من معامل الاختلاف الوراثى والمظهرى ودرجة التوريث سواءاً بالمدى الواسع أو المدى الضيق بالإضافة إلى انحدار الأبناء على الآباء وذلك خلال دراسة سبعة صفات كمية. لوحظت اختلافات عالية المعنوية بين الآباء والأبناء فى جميع الصفات المدروسة ماعدا صفتى ارتفاع النبات وعدد الفروع على النبات . إضافة إلى وجود اختلافات عالية المعنوية بين الأصناف والمواقع وكذلك التفاعل بينهما فى جميع الصفات ماعدا دليل البذرة. وكان معامل الاختلاف الوراثى والمظهرى عاليا فى الآباء عن الأبناء فى صفات ارتفاع النبات وعدد الفروع وعدد الكبسولات على النبات ودليل البذرة ، بينما كان الأبناء أعلى فى وزن الكبسولات ومحصول البذور للنبات وكذلك للفدان فى كل الأصناف . كما كان الصنف شندويل هو الأقل فى معاملى الاختلاف الوراثى والمظهرى فى معظم الصفات يليه الصنف توشكى ثم الصنف القاهرة ٢. وأنتجت بذور الصنف القاهرة ٢ أعلى محتوى زيت يليه شندويل ثم توشكى . وقد تم تعريف خمسة أحماض دهنية معزولة من الزيت فى كل الأصناف . إلا أن الحمض Oleic كان الحمض الرئيسى فى زيت كل من الصنفين شندويل وتوشكى بينما كان الحمض Linoleic هو الحمض الرئيسى فى زيت الصنف القاهرة ٢.

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