GENETIC ANALYSIS OF SESAME YIELD VIA QUADRALLEL MATING SYSTEM (*Sesamum indicum* L.)

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Sesame (*Sesamum indicum* L.) is recognized as one of the oldest crop in the world. Sesame has the highest oil content (50 - 60%) among oil crops. The sesame oil is very stable due to the presence of a number of antioxidant such as sesamin, sesamolin and sesamol. Therefore, the production of this important oil seed crop has to be stepped up by evolving high yielding cultivars. Additive gene action plays a major role in selecting superior segregates from crosses. However, Allared proved that favorable epistatic combination have a great role in yield superiority in self- as well as in cross-pollinated crops. He reported that the results of marker-assisted dissections of quantitative traits have clearly established that epistasis played a major role in the inheritance of quantitative traits and in the genetic basis of heterosis. In the context, Rawlings and Cockerham (1962) stated that quadrallel mating design provides additional information about the components of epistatic variances, besides additive and dominance genetic variance. Besides, it provides information about the order in which parents should be crossed to obtain superior segregates. It should be taken into consideration, however that this mating system requires one additional crop season for generating of experimental material as compared to diallel and partial diallel designs, which adds to the experimental cost. Quadrallel model has eight covariance of relatives and seven orthogonal partitions of double crosses sums of squares. Many researchers investigated genetic components of variance using different mating designs. Kamala (1999) indicated that non-additive affects in the from of dominance was more important than additive in plant height, number of branches/pl., number of capsules/pl., number of seeds/capsules, seed index and seed yield/pl. Sumathi and Kalaimani (2000), Manivannan and Ganesan (2001) and Arulmozhi *et al.* (2001) studied gene action using line x tester method. They found that non-additive gene actions including additive x additive interaction control days to 50% flowering, days to maturity, plant height, length of fruiting zone, number of capsules/pl. and seed yield/pl. Bakheit *et al*. (2001) estimated the additive, dominance and epistatic components of genetic variation for yield and yield components by triple test cross. They reported that mean squares from the genetic analysis of variance and the over all epistatic gene effects were highly significant difference for all studied characters. El-Shakhess

(2003) studied gene action for yield and yield components by using fifteen half diallel crosses in F_1 and F_2 generations. She reported that the dominance genetic variance was more important than additive genetic variance for plant height, height of first capsules, length of fruiting zone, number of capsules/pl. and seed yield/pl. in both F_1 and F_2 generations. Attia *et al*. (2004) investigated nature and magnitude of different gene effects of yield and yield components via parents (P_1, P_2), hybrids (F_1, F_2) and backcrosses (Bc_1 and Bc_2). Their results revealed the importance of dominance gene action for plant height, length of fruiting zone, number of branches/pl., number of capsules/pl. and seed yield/pl. Also, they indicated that all combinations of epistatic gene effects were of significant magnitude reflecting their importance in the inheritance of studied traits. In India, Kumar *et al*. (2006) revealed that seed yield determined by dominance x dominance type of genetic system and over dominance was associated with duplicate dominant epistasis of yield and its components. Kim *et al*. (2007) reported that overdominance was exhibited by number of capsules/pl. While, partial dominance by plant height, capsule setting stem length and seed yield/pl.

The present study was undertaken to study epistasis beside additive and dominance effects and genetic components of variance for yield and its components using quadrallel analysis. The ultimate goal of these crosses is to be utilized in enhancing favorable combinations of the weblike type in order to improve sesame characters.

MATERIALS AND METHODS

The experiments were carried out during three successive seasons 2005, 2006 and 2007. Six different lines, viz Shandweel3, line 102-25-2, line 55-6-7, N.A542, local 164 and RH6F6 were utilized. The parents used in the present study were unrelated and completely homozygous. Their origin and some of their characteristics are presented in Table (1). In 2005 season, at the Experiment Station of Agriculture Center (ARC) Shandweel, Sohage. All fifteen possible cross - combination (excluding reciprocals) among these lines were made to obtain single crosses. In 2006 season, at the Experiment Station of Agriculture Center (ARC) Shandweel, Sohage, the 15 F_1 crosses were again mated in a diallel fashion to produce double cross hybrid with the restriction that parent should not appear more than once in the same double cross combinations. The number of all possible double crosses among a group of six parents, excluding reciprocals, was determined by the following formula

Number of double crosses = n (n-1)(n-2)(n-3)/8

In this study n = 6, the number of all possible double crosses was 45. The evaluation trial was carried out during 2007 season at Shandweel Station and the Experiment Station of Agriculture Center (ARC) El-Matana, Quna involving six parents and forty-five double crosses, using RCBD with three replications. Each entry was grown in a plot consisting of two rows, 4 meters long, distance between rows was50 cm and distance between plants within row was 20 cm, with one plant left per hill after thinning. The cultural practices were done according to the recommended methods. Data were recorded on ten guarded plants per plot for each entry for: days to first flowers, plant height (cm), length of fruiting zone (cm), number of branches/pl., number of capsules/pl., seed yield/pl. and seed index. The quadrallel analysis was carried out according to Singh and Chaudhary (1985). Heterosis was determined as the percent of deviation of quadrallel crosses over its better parent (heterobeltiosis) as described by Meredith and Bridge (1972) or the commercial variety Shandweel3 (useful heterosis) according to Fonesca and Patterson (1968). A test of significance for the quadrallel crosses mean from the higher-parent or commercial variety values was conducted by the following appropriate "t" value as described and applied by Wynne *et al.* (1970). Expected genetic gain for yield was computed according to Jenkins (1934) method B i.e. average of the four non - parental single cross.

RESULTS AND DISCUSSION

Data in Table (2) shows mean ± standard error, range and genetic coefficient of variability for the studied characters for quadrallel crosses compared to average value of the six parents in Shandweel (Sh) and El-Matana (Em) location.

In Sh, days to flowering ranged for crosses from 43.7 - 67.0 with a mean of 54.7 and from 45.0 - 56.7 with mean of 49.5 for parents. Means for days to flowering for parents was earlier than crosses by 10.5%. Meanwhile, means for length of fruiting zone, number of branches/pl., number of capsules/pl., seed yield/pl. and seed index were higher than the average of the six parents by 4.7, 2.9, 48.6, 57.7 and 4.7%, respectively. With respect to the plant height and capsules length, means of crosses were lower than means of parents by 1.8 and 5.0%, respectively. Moreover, variability as measured via g.c.v. was less in crosses than in parents for all studied characters except for number of capsules/pl.

In EM, Table (2) revealed that means for days to flowering in crosses and in parents were nearly equal. Means for number of capsules/pl., seed yield/pl. and seed index for crosses were higher by 6.7, 25.1 and 10.3%, respectively, over means of parents. In the context, ranges of these characters for crosses were high both in the lower and higher limits as compared to range of the six parents. Crosses were 1.2, 1.6 and 1.1 fold of the higher parents for number of capsules/pl., seed yield/pl. and seed index, respectively. The g.c.v was less in crosses than in parents.

Analysis of genetic components of variances for studied characters in Sh and

Em are presented in Table (3). Results indicated highly significant mean squares for all epistatic effects types in all studied characters in both location except for capsule length and seed index. This indicated that all types of epistatic components (i.e, Dominance x Dominance (T_2), Additive x Additive x Additive (T_3) and Dominance x Dominance x Dominance (T_4)) were involved in the expression of these characters. These results are in harmony with those reported by Sumathi and Kalamani (2000), Manivannan and Ganesan (2001) and Arulmozhi *et al*. (2001).

The values of additive, dominance and all types of epistasis for all studied characters in Sh and Em are summarized in Table (4). In Sh, the type of gene action (additive x dominance) played a great role over all epistatic effects in all studied characters, except for seed yield/pl. where additive x additive played the greatest role. In Em, the (additive x additive) type of gene action accounted for a greater part of the over all epistasis effects for days to flowering, number of capsules /pl., seed yield /pl. and seed index. Meanwhile, the (additive x dominance) type played a great role in plant height, length of fruiting zone and number of branches/pl. Dominance x dominance played a great role in capsules length. This implies that improvement of these traits will be possible using any breeding procedure which emphasizes epistatic gene effect such as selection in latter generations and /or by using reciprocal recurrent selection in the present of made sterile parents. Ya *et al*. (1997) presented a leading experiment in the analysis of gene action and its relation to qualitative trait loci (QTLs) in rice. They stated that heterozygosity made very little contribution to trait expression. However, various levels of negative dominance were observed for many QTLs which suggested that cancellation between positive and negative dominance may cause overdominance reactions. Besides, the epistasis had two pronounced features. First, for larger number of loci contributed to trait expression in a two locus analysis than single locus analysis. Second, all four types of interactions, AA, AD, DA and DD were found. Their results revealed the likelihood of higher - order interactions (multilocus epistasis), especially for the most trait (yield). These results are in harmony those reported by Bakheit *et al*. (2001), Krishnaiath *et al*. (2002), Sankar and kumar (2003), Mothilal and Manoharan (2005), Vidhyavathi *et al*. (2005), Anbanandan *et al*. (2007) and Gawade *et al*. (2007). However, Kim-Donghwi *et al.* (2007) stated that additive gene effects played greater roll than other non - additive gene effects on inheritance of these traits.

Heterosis was calculated in two forms: Heterobeltiosis and useful heterosis in the 45 sesame quadrallel crosses in Shandweel as presented in Table (5).

With respect to days to flowering, eight crosses exhibited a highly significant negative deviation from the better parent and one cross showed highly significant negative deviation from check variety. The cross 40 showed the maximum desirable heterotic effects.

The superiority of hybrids over the better parent and or the check variety was maximum, positive and highly significant in crosses 14 and 42 for plant height. Thus, these two crosses showed the most beneficial weblike epistatic combination for this trait.

For length of fruiting zone, only cross 14 showed maximum, Positive and highly significant heterobeltiosis and useful heterosis 23.0 and 17.5, respectively.

With regard to number of branches/pl., either negative (non-branched) or positive (more branches), selection could be practiced. Ten crosses revealed highly significant and positive heterobeltiosis. On the other hand, thirty crosses showed significant or highly significant positive useful heterosis.

Seventeen crosses revealed a highly significant positive heterobeliosis and useful heterosis for number of capsules/pl. The positive and highly significant heterobeltiosis and useful heterosis were shown in crosses 18 and 37 with respect capsule length.

For seed yield/pl., ten crosses exhibited highly significant and positive heterobeltiosis and useful heterosis. The highest heterotic value in seed yield was obtained from cross 14. This cross outyielded their higher parent and check variety by 129.0 and 109.5, respectively.

With respect to seed index, two crosses (32 and 45) revealed positive and highly significant heterobeltiosis and useful heterosis.

Heterobeltiosis and useful heterosisdata in El-Matana are presented in Table (6). Only one cross (31) showed maximum, negative deviation from both better parent and check variety and these favorable deviations were highly significant for days to flowering.

For plant height, the crosses (1, 2, 7, 10, 11, 12 and 36) showed maximum positive and highly significant desirable heterotic effect over the better parent and check variety.

Cross number (2) exhibited the maximum, positive and significant heterobeltiosis 14.8. Meanwhile, cross (1) showed the highest useful heterosis 26.2 for length of fruiting zone.

For number of branches/pl., three crosses revealed highly significant positive heterobeltiosis. Meanwhile, twenty crosses showed significant or highly significant and positive useful heterosis.

With respect to number of capsules/pl., one cross (No. 11) showed maximum, highly significant, positive heterobeltiosis and useful heterosis.

The positive and highly significant heteobeltiosis and useful heterosis were showed in cross (36) for capsule length.

For seed yield/pl., the seven crosses (1, 11, 17, 21, 27, 36 and 39) showed positive and highly significant heterobeltiosis and useful heterosis. The highest heterotic effect was obtained from the cross (11).

Twelve crosses exhibited positive and highly significant heterobeltiosis and useful heterosis for seed index. The highest heterotic value in seed index was obtained by cross (26).

From the previous data, cross 14 exhibited the maximum, positive and highly significant heterobeltiosis and useful heterosis in Shandweel for plant height, length of fruiting zone, number of branches/ pl., number of capsules/ pl. and seed yield/pl. Meanwhile, cross 11 showed the maximum, positive and highly significant heterobeltiosis and useful heterosis in El-Matana for plant height, number of capsules/pl., capsules length and seed yield /pl. Thus, these two double crosses (cross no. 14 and cross no. 11) might have a weblike epistatic interactions that would be continued in the next segregating generations leading to unique lines in the equilibrium phase with high contributions to yield traits expressions.

Although the quadrallel crosses tested were not superior to the higher parent or check variety in all characteristic, testing more lines and single crosses may reveal superior materials. These results were in harmony with those obtained by Athare *et al*. (2007). in Brazil, Emygdio *et al*. (2007) indicated that some double crosses outyielded some single and three-way maize cross hybrids, indicating that it was unsuitable to generalize inference about yield potential of different maize hybrids based on the type of cross. In contrast, James Weatherspoon (1970) reported that the range in yield for singles was 12.7q/ha more than for three-ways and 24.2q/ha greater than for doubles. Hybrids x environments mean square for singles was more than twice that for double and the mean square for three- way was intermediate between that for double and singles.

Expected and actual seed yields for the 45 quadrallel crosses in Shandweel and El-Matana are shown in Table (7). The ten top yielder crosses were (1, 9, 10, 11, 14, 15, 16, 23, 28 and 40) in Shandweel. On the other hand, the crosses (1, 11, 17, 21, 27, 30, 33, 36, 39 and 45) showed superiority in El-Matana. Thus, two hybrids (1 and 11) showed common superiority in both environments. The twenty - two out of the forty - five hybrids showed 1 - 2 folds more seed yield per plant than the expected when grown in Shandweel. Besides, the top ten hybrids showed twice to trice actual genetic for seed yield as compared to the expected genetic advance. Eighteen out of the forty-five crosses in El-Matana exhibited higher actual than the expected by 10.7-50.6%. All the ten top hybrids showed 1 - 1.5 folds more seed yield per plant than the expected when grown in El-Matana. The hybrids (1, 2, 16 and 29) showed similarity between the actual and expected genetic advance in El-Matana. These conflicts between the expected and actual may be due to the nature of the soil. These results suggested that the epistatic type (additive x additive) effect conditioned the top - yielder hybrids in this study. Similar results were obtained by Zuber *et al*. (1973) and Bakheit *et al*. (2001). Meanwhile, Kumar *et al*. (2006) stated that seed yield is determined by dominance x dominance type of genetic system and overdominance was associated with duplicate dominant epistasis of yield and its components.

SUMMARY

Six sesame lines were mated using a quadrallel mating design to provide estimates of additive and non- additive (dominance an epistatic gene actions) on yield and its components and hetrosis. This investigation was carried out during three successive summer seasons, 2005, 2006 and 2007 at Shandweel and El-Mtana Research Stations. Results exhibited all types of epistatic type of gene action for all studied characters except for capsule length and seed index in both environments. The cross 14 in Shandweel and the cross 11 in El- Matana showed the maximum, positive and highly significant hetrobeltiosis and useful heterosis for most studied characters. Twenty two crosses in Shandweel and eighteen crosses in El- Matana showed actual genetic advance that was higher than expected genetic advance by 1-2 folds.

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Table (1): Origin, pedigree and characteristics of the six parental sesame lines.

Parental line	Origin	Pedigree	Characteristics
Shandweel 3	Egypt 1987	Selected line from Giza32 x N. A130	Medium tall, non-branched, white seed, long capsule, 3 capsules/aix.
Line55-6-7	Egypt 1971	Selected line from N. A114 x S18/6	Short, branched, brown seed, short capsule, 1 capsule/aix.
Line 102-25-2	Egypt 1976	Selected line from N. A217 x Giza 25	Tall, branched, brown seed, long capsule, 1 capsule/aix.
N. A542	F.A.O 1981		Tall, non-branched, yellow seed, medium capsule, 1 capsule/aix.
Local 164	Unknown		Short, branched, creamy seed, short capsule, 3 capsules/aix.
RH6F6	Egypt 1996	Selected line from N. A413 x N. A777	Tall, branched, creamy seed, long capsule, 1 capsule/aix.

Table (2): Means (X ± S.E), ranges (R) and genetic coefficient of variability (g.c.v) for the studied characters for quadrallel crosses compared to mean values of six parents in Shandweel (Sh) and El-Matana (Em).

Statistics	Days to flowering	Plant height (cm)	Length of fruiting zone (cm)	Number of branches/pl.	Number of capsules/pl.	Capsules length (m)	Seed yield/pl. (gm)	Seed index
Crosses in Sh								
X ± S.E	54.7 ± 0.66	228.2 ± 4.3	169.7 ± 2.9	3.6 ± 0.29	266.8 ± 11.6	3.8 ± 0.09	44.3 ± 2.6	4.5 ± 0.03
R	43.7 - 67.0	151.7 - 293.3	120.3 - 201.7	1.0 - 8.6	96.7 - 688.0	2.7 - 5.0	18.6 - 101.9	3.9 - 5.6
g.c.v%	5.2	7.4	5.3	33.1	40.8	7.9	27.4	5.9
Parents in Em								
X ± S.E	49.5 ± 1.6	232.4 ± 16.0	162.1± 10.0	3.5 ± 0.62	179.6 ± 29.9	4.0 ± 0.29	28.1 ± 4.4	4.2 ± 3.0-
R	45.0 - 56.7	184.0 - 296.7	123.3 - 198.3	1.0 - 5.3	87.3 - 294.0	3.1 - 5.0	17.8 - 45.0	3.6 - 5.6
g.c.v%	7.5	16.5	14.7	41.8	40.6	16.7	37.7	17.2
Crosses in Em								
X ± S.E	4602 ± 0.53	179.7 ± 3.5	103.5 ± 2.6	2.3 ± 0.23	158.5 ± 3.22	3.5 ± 0.06	25.9 ± 0.64	4.3 ± 0.06
R	41.0 - 55.0	137.0 - 245.0	71.7 - 155.0	1.0 - 8.0	126.3 - 236.3	3.0 - 4.8	20.4 - 41.4	3.7 - 5.2
g.c.v%	4.5	8.5	10.2	44.0	8.6	7.0	9.9	6.3
Parents in Em								
X ± S.E	45.9 ± 0.69	214.5 ± 17.7	137.8 ± 11.6	3.7 ± 0.64	148.5 ± 20.8	3.7 ± 0.37	20.7 ± 4.2	3.9 ± 0.22
R	43.0 - 48.0	166.0 - 281.7	105.3 - 180.0	1.0 - 5.4	68.0 - 202.7	2.7 - 5.2	15.6 - 25.9	3.2 - 4.6
g.c.v%	12.4	19.6	20.1	39.3	34.1	24.0	15.9	12.4

Table (3): Analysis of variance for genetic components for the studied characters in the two stations.

S.O.V	d.f	Days to flowering	Plant height	Length of fruiting zone	No. of branches/pl	No. of capsules/pl	Capsule length	Seed yield/pl.	Seed index
Sh									
Rep.	2	10.56**	832.91**	182.83**	3.48*	4035.80**	0.02	193.99**	0.15
Crosses (H)	44	58.02**	2541.41**	11.636**	11.30**	71329.55**	1.01	901.86**	0.52
Error (E)	88	34.13	1675.87	865.29	7.05	35861.71**	0.74	458.85	0.31
Line general (G)	5	65.01**	2798.70**	2220.86**	29.61**	70386.99**	2.05	939.14**	0.17
Line specific (S_2)	9	32.21**	1900.94**	587.40**	7.66**	29685.57**	0.10	731.44**	0.66
Line arrangement (T_2)	9	120.69**	2070.82**	1374.71**	15.45**	75335.69**	1.37	962.09**	0.37
Line arrangement (T_3)	16	30.34**	2070.82**	1166.26**	8.31**	96648.84**	0.75	1082.77**	0.55
Line arrangement (T_4)	5	73.11**	696.70**	248.34**	1.63	58852.00	0.17	480.35**	0.78
Em									
Rep.	2	5.69**	1015.87**	359.83**	2.96	57.65**	0.02	4.40**	0.10
Crosses (H)	44	37.55**	1652.49**	877.86**	7.04**	1401.05**	0.53	55.19**	0.55
Error (E)	88	24.44	949.32	543.57	3.95	840.64	0.35	35.31	0.33
Line general (G)	5	19.57**	892.73**	450.55**	20.11**	2686.72**	0.23	29.85**	0.73
Line specific (S_2)	9	48.82**	2266.57**	762.96**	7.20**	1697.37**	0.45	77.57**	0.68
Line arrangement (T_2)	9	2.70	3062.12**	976.52**	4.76**	736.77**	0.18	8.62	0.43
Line arrangement (T_3)	16	56.78**	1178.77**	1242.48**	5.31**	1299.28**	0.80	78.06**	0.51
Line arrangement (T_4)	5	35.88**	275.92**	163.80**	3.27**	1095.03**	0.69	50.49**	0.47

Table (4): Types of gene action for all studied characters in forty-five quadrallel crosses in the two locations.

Genetic components	Days to flowering.	Plant height	. Length of fruiting zone.	No. of branches/pl.	No. of capsules/pl.	Capsules length.	Seed yield /pl.	Seed index
Sh ♀								
σ^2 A	25.31	5085.26	1741.43	18.02	71019	2.56	1922.63	1.32
σ^2 D	391.84	10607.5	7941.54	57.98	157653.50	5.58	3516.80	2.49
σ^2 AA	298.86	19512.19	11139.87	95.48	241845.14	10.21	11368.15	0.62
σ^2 AD	1197.45	52338.18	32365.20	260.58	301920.06	25.58	6260.70	11.29
σ^2 DD	589.18	32795.27	19310.29	165.65	235634.95	17.37	2800.33	7.95
σ^2 AAA	797.51	34935.30	21594.91	173.96	202048.18	17.08	7594.91	7.51
Em ♀								
σ^2 A	127.98	6032.84	2523.26	15.05	3720.05	1.06	200.49	1.51
σ^2 D	132.03	6861.71	7729.42	18.44	1550.04	0.15	176.67	0.15
σ^2 AA	294.37	16321.77	11023.27	46.56	7582.80	1.39	439.31	2.52
σ^2 AD	226.57	33939.10	27304.48	71.73	3446.06	3.16	319.15	0.08
σ^2 DD	70.65	21105.76	11963.28	42.65	541.15	4.77	72.99	0.67
σ^2 AAA	151.98	22668.98	18217.96	48.02	2336.59	2.10	214.24	0.04

♀ Sh and Em are the location Shandweel and El-Matana.

Table (5): Heterobeltiosis (BP) and useful heterosis (CV) of studied character for quadrallel crosses in Shandweel.

No. of crosses	Quadrallel crosses	Days to flowering.		Plant height		. Length of fruiting zone.		No. of branches/pl.	
		BP	CV	BP	CV	BP	CV	BP	CV
1	(1x2)(3x4)	25.4**	30.6**	3.1	16.8*	1.3	2.6	-46.5*	130
2	(1x2)(3x5)	3.0	20.2**	-8.8	11.7**	6.6	10.2	14.0	390**
3	(1x2)(3x6)	2.3	19.4**	3.8	29.1*	-6.8	0.41	-2.0	390**
4	(1x2)(4x5)	-5.9*	9.8**	10.7	19.8*	2.3	3.1	18.4	420**
5	(1x2)(4x6)	7.3**	22.3**	5.5	24.3**	8.4	0.64	-11.4	290**
6	(1x2)(5x6)	-3.9	3.5	13.4	23.3**	-0.50	4.5	-18.6	250**
7	(1x3)(2x4)	8.0**	13.1**	0.0	24.1**-	0.52	0.76	-42.1**	230*
8	(1x3)(2x5)	-1.11	14.0**	-39.5**	24.9**	-30.5**	-30.2**	-38.6*	250**
9	(1x3)(2x6)	11.9**	23.5**	2.5	27.2**	-3.9	-3.2	1.8	480**
10	(1x3)(4x5)	-4.7	9.8**	-14.3*	6.3	15.7**	-16.1**	-19.3	360**
11	(1x3)(4x6)	0.0	11.0**	1.4	25.9**	2.4	11.1	7.0	510**
12	(1x3)(5x6)	-3.3	2.7	-1.4	22.4**	-1.2	3.8	-38.6*	250**
13	(1x4)(2x3)	6.3*	15.2**	-0.12	19.2*	4.9	0.0	-12.5	250**
14	(1x4)(2x5)	-3.6	1.0	19.4**	29.9**	23.0**	17.5**	86.2**	440**
15	(1x4)(2x6)	1.9	12.5**	11.1	24.9**	6.8	-0.82	67.7*	420**
16	(1x4)(3x5)	-3.6	10.4**	1.0	23.8**	-2.9	0.35	55.2**	350**
17	(1x4)(3x6)	0.55	15.2**	-13.9*	0.35	-21.1**	-15.0**	4.0	420**
18	(1x4)(5x6)	14.7**	23.5**	1.9	15.0	-3.5	1.3	69.0*	390**
19	(1x5)(2x3)	4.0	9.0**	-35.0**	-22.4**	28.7**	-29.7**	65.4**	760**
20	(1x5)(2x4)	11.9**	17.3**	-31.7**	-15.8*	-21.8**	-20.8**	-19.2	320**
21	(1x5)(2x6)	17.9**	23.5**	6.5	19.7*	0.47	-0.99	38.5*	620**
22	(1x5)(3x4)	10.0**	14.6*8	-0.31	13.0	-11.3	-10.1	27.0	560**
23	(1x5)(3x6)	33.2**	39.6**	-1.6	-2.5	-15.8**	-9.3	25.0	550**
24	(1x5)(4x6)	11.3**	16.7**	-15.1*	0.15	-8.9	-1.2	-420**	0
25	(1x6)(2x3)	9.0**	18.1**	-2.1	-3.5	-1.2	-2.9	-510**	0
26	(1x6)(2x4)	5.4*	10.4**	-20.4**	-1.8	-2.2	0.99	-55.7**	170
27	(1x6)(2x5)	-1.8	14.6**	2.7	24.6**	12.9**	13.8**	42.6**	250**
28	(1x6)(3x4)	4.6	9.0**	-2.4	18.5*	6.3	7.7	510**	0
29	(1x6)(3x5)	-7.1**	8.3**	-1.0	21.3**	4.2	7.7	-31.1*	320**
30	(1x6)(4x5)	-7.7**	7.7**	-5.4	14.9	2.4	0.35	510**	0
31	(2x3)(4x5)	2.5	11.0**	-2.1	16.8*	-4.8	-4.1	5.0	320**
32	(2x3)(4x6)	-6.3*	1.5	-1.8	17.2*	1.1	9.7	-340**	0
33	(2x3)(5x6)	2.5	10.4**	-15.3*	2.8	-6.1	-1.6	300**	0
34	(2x4)(3x5)	-7.2**	-2.7	-29.4**	-13.0	23.9**	-21.4**	-290**	0
35	(2x4)(3x6)	7.4**	12.5**	-11.6	8.9	4.5	13.4*	-76.0**	20
36	(2x4)(5x6)	-13.1**	-9.0**	-18.8**	0.0	-10.9*	-6.4	-290**	0
37	(2x5)(3x4)	8.0**	12.5**	-15.4*	-4.1	-24.0**	-22.9**	-210*	0
38	(2x5)(3x6)	1.2	20.2**	2.9	19.3*	-8.3	-1.2	-34.0	230*
39	(2x5)(4x6)	-12.8**	-0.63	0.0	18.0*	-9.3	-1.6	-40.9	160
40	(2x6)(3x4)	30.0**	35.4**	1.9	15.5	-3.4	-2.2	-210*	0
41	(2x6)(3x5)	20.0**	25.0**	0.0	22.4**	1.0	4.4	35.5	310**
42	(2x6)(4x5)	7.5**	18.7**	29.2**	45.2**	22.8**	14.9**	35.5	310**
43	(3x4)(5x6)	2.5	10.4**	3.6	17.5*	3.2	8.2	35.5	310**
44	(3x5)(4x6)	1.8	16.0**	-6.1	15.0	1.8	6.6	-4.5	310**
45	(3x6)(4x5)	-4.0**	14.0**	3.1	12.4	1.1	8.9	-56.0**	120

*,** significant at 0.05 and 1.01 levels of probability, respectively.

cont.

No. of crosses	Quadrallel crosses	No. of capsules/pl		Capsule length		Seed yield/pl.		Seed index	
		BP	CV	BP	CV	BP	CV	BP	CV
1	(1x2)(3x4)	50.5**	305.2**	18.4*	17.5	27.5**	105.3**	-17.3**	2.4
2	(1x2)(3x5)	-81.9**	-0.17	-7.0	0.0	-44.3**	10.6	-5.8	16.7**
3	(1x2)(3x6)	-74.2**	-45.6**	0.0	-7.5	-53.1**	-52.4**	-23.1**	-4.8
4	(1x2)(4x5)	210.3**	67.3**	0.0	0.0	98.7**	18.0**	1.4	26.2**
5	(1x2)(4x6)	218.0**	71.8**	7.5	7.5	120.3**	46.7**	-17.3**	2.4
6	(1x2)(5x6)	19.7**	-54.4**	7.5	7.5	-3.1	-42.2**	-15.4**	4.8
7	(1x3)(2x4)	-11.3**	13.7**	0.0	5.0	-36.6**	3.2	-15.1**	7.1
8	(1x3)(2x5)	146.7**	216.0**	-33.3**	-25.0*	-18.1**	33.4**	-9.4*	14.3**
9	(1x3)(2x6)	8.6**	39.2**	-21.4*	17.5	-40.9**	-3.7	-5.7	19.0**
10	(1x3)(4x5)	73.6**	122.5**	-4.8	0.0	10.6**	80.1**	18.9**	2.4
11	(1x3)(4x6)	99.3**	155.5**	-11.9	7.5	-4.1	56.2**	-13.2**	9.5
12	(1x3)(5x6)	-42.8**	-26.8**	2.4	7.5	-52.1**	-22.1**	0.0	26.2**
13	(1x4)(2x3)	13.9**	-24.8**	16.2	7.5	-11.1	-23.3**	-11.5**	9.5
14	(1x4)(2x5)	264.8**	230.5**	11.1	0.0	129.0**	170.3**	13.5**	7.1
15	(1x4)(2x6)	110.6**	84.0**	20.0	5.0	88.0**	62.1**	-17.3**	2.4
16	(1x4)(3x5)	-67.2**	80.8**	-23.3*	-17.5	-49.9**	55.2**	-25.0**	-7.1
17	(1x4)(3x6)	-62.3**	-20.6**	-5.4	--12.5	-31.2**	-10.6	-13.5**	7.1
18	(1x4)(5x6)	55.4**	35.8**	25.0*	25.0*	23.4**	6.4	-7.7	14.3**
19	(1x5)(2x3)	-52.3**	-27.2**	-18.9	-25.0*	-29.8**	-4.5	11.4*	16.7**
20	(1x5)(2x4)	-0.22	52.4**	-16.7	-15.5	-10.5**	21.8**	6.8	11.9*
21	(1x5)(2x6)	8.7**	66.0**	5.6	-7.5	6.6	45.1**	4.3	14.3**
22	(1x5)(3x4)	-53.2**	5.6	-7.5	-12.5	-45.0**	-11.4*	9.1	14.3**
23	(1x5)(3x6)	83.9**	219.6**	-5.4	-12.5	98.6**	129.5**	-11.1*	-4.8
24	(1x5)(4x6)	46.1**	115.3**	20.0	20.0	6.0	44.3**	-2.1	11.9*
25	(1x6)(2x3)	-5.1	-3.8	16.2	7.5	-65.5**	-22.8**	-11.1*	-4.8
26	(1x6)(2x4)	-24.1**	50.4**	-11.9	-7.5	-50.1**	11.7	8.9	16.7**
27	(1x6)(2x5)	-28.6**	41.5**	0.0	12.5	-48.5**	15.1	6.5	16.7**
28	(1x6)(3x4)	21.4**	143.7**	0.0	20.0	-12.3**	96.0**	0.0	7.1
29	(1x6)(3x5)	-81.4**	2.3	4.7	12.5	-63.6**	12.7*	2.2	9.5
30	(1x6)(4x5)	-53.8**	-8.4*	12.5	12.5	-65.1	-22.0**	-6.7	0.0
31	(2x3)(4x5)	58.9**	28.7**	0.0	0.0	60.3**	15.6**	15.0**	9.5
32	(2x3)(4x6)	-28.1**	-41.8**	20.0	20.0	0.74	-27.3**	16.7**	33.3**
33	(2x3)(5x6)	16.1**	-6.6	17.5	17.5	22.4**	-11.7*	-2.1	9.5
34	(2x4)(3x5)	-72.0**	54.6**	-18.6	-20.0	-59.4**	25.7**	-2.3	2.4
35	(2x4)(3x6)	-55.2**	-5.7	-4.8	0.0	-25.7**	-3.4	4.4	11.9**
36	(2x4)(5x6)	-12.66**	-53.3**	-4.8	0.0	-29.3**	-50.7**	-14.9**	-4.8
37	(2x5)(3x4)	58.8**	17.3**	40.0**	-32.5**	-39.9**	-3.2	-6.5	4.8
38	(2x5)(3x6)	-63.1**	-22.4**	-22.2	-12.5	-34.5**	-14.9**	6.5	16.7**
39	(2x5)(4x6)	-21.3**	-28.8**	-22.2*	-12.5	102.6**	85.4**	-14.6**	-2.4
40	(2x6)(3x4)	33.7**	168.3**	-7.9	-12.5	9.6**	76.4**	-12.8**	-2.4
41	(2x6)(3x5)	-64.2**	97.5**	-37.2**	-62.5**	-49.7**	55.7**	-14.9**	4.8
42	(2x6)(4x5)	130.9**	10.5**	-20.0	-20.0	83.1**	0.53	-21.3**	-9.5
43	(3x4)(5x6)	-50.2**	-0.06	-12.5	-12.5	-45.8**	-12.7*	-8.5	2.4
44	(3x5)(4x6)	-73.9**	43.9**	-25.6**	-20.0	-65.8**	9.0	-12.5**	0.0
45	(3x6)(4x5)	-30.2**	47.0**	5.0	5.0	-8.8*	18.6**	17.8**	26.2**

*,** significant at 0.05 and 1.01 levels of probability, respectively.

Table (6): Heterobeltiosis (BP) and useful heterosis (CV) of studied character for quadrallel crosses in El-Matana.

No. of crosses	Quadrallel crosses	Days to flowering.		Plant height		. Length of fruiting zone.		No. of branches/pl.	
		BP	CV	BP	CV	BP	CV	BP	CV
1	(1x2)(3x4)	22.5**	15.3**	23.9**	29.8**	9.5	26.2**	33.3	300.0**
2	(1x2)(3x5)	10.9**	4.4	14.9**	20.3**	14.8	-2.1	30.3	330.0**
3	(1x2)(3x6)	10.0**	3.5	-2.0	14.0*-	-24.8**	-13.6	-66.7**	0.0
4	(1x2)(4x5)	-9.4	-0.88	-10.6	6.3	-37.8**	-28.5**	-66.7**	70.0
5	(1x2)(4x6)	0.0	-7.4*	10.9	16.2*	-27.8**	-17.1*	-66.7**	0.0
6	(1x2)(5x6)	0.0	-5.3	9.2	14.4*	-13.5*	-0.56	0.0	200.0**
7	(1x3)(2x4)	-5.3	-5.3	21.0**	26.2**	-17.4**	10.3	-50.0**	300.0**
8	(1x3)(2x5)	-0.68	-3.1	2.8	4.6	-38.4**	-17.7*	0.0	200.0**
9	(1x3)(2x6)	6.3	0.0	5.3	9.9	-22.1**	4.1	-43.3*	70.0
10	(1x3)(4x5)	3.5	3.5	33.9**	39.6**	-2.3	30.5**	-10.0	170.0**
11	(1x3)(4x6)	27.0**	17.5**	39.0**	45.0**	8.2	28.0**	10.0	200.0**
12	(1x3)(5x6)	7.9*	2.2	22.5**	27.8**	-25.4**	-0.28	10.0	200.0**
13	(1x4)(2x3)	8.2*	3.5	2.4	16.2**	-36.9**	-0.13	-65.5**	200.0**
14	(1x4)(2x5)	2.3	-2.2	-10.1	2.0	-15.6**	15.8*	-75.0**	0.0
15	(1x4)(2x6)	8.6*	2.2	-6.1	6.5	-28.7**	-2.1	-75.0**	0.0
16	(1x4)(3x5)	5.3	0.66	-9.4	2.8	-40.9**	-18.9*	-75.0**	0.0
17	(1x4)(3x6)	12.8**	7.9*	-7.8	7.3	-29.2**	-2.8	-75.0**	0.0
18	(1x4)(5x6)	1.6	-3.7	-16.7**	-6.1	-37.7**	-14.5	-67.5**	30.0
19	(1x5)(2x3)	7.5*	3.5	-20.4**	-7.1	-32.8**	-4.0	-85.1**	30.0
20	(1x5)(2x4)	3.9	0.0	-22.8**	-9.9	-27.1**	4.1	-83.8**	30.0
21	(1x5)(2x6)	24.0**	16.6**-	-4.9	11.1	-29.7**	0.37	-76.4**	70.0
22	(1x5)(3x4)	2.3	1.5	0.51	17.3**	-17.4**	18.1*	-81.9**	30.0
23	(1x5)(3x6)	-5.2	-8.8*	-22.8**	-9.9	-27.6**	3.4	-86.1**	0.0
24	(1x5)(4x6)	4.7	-3.1	-10.1*	4.9	-26.1**	5.6	-81.9**	30.0
25	(1x6)(2x3)	2.3	-2.2	-23.8**	-1.2	-37.5**	-8.7	-85.1**	30.0
26	(1x6)(2x4)	3.0	-1.5	-20.1**	3.6	-33.2**	-2.4	-87.5**	0.0
27	(1x6)(2x5)	24.3**	18.8**	-4.4	24.1**	-18.3**	19.3*	-25.0	200.0**
28	(1x6)(3x4)	4.6	0.0	-33.4**	-13.7*	-44.7**	-19.2*	30.0	30.0
29	(1x6)(3x5)	3.7	-0.88	-32.5**	-12.4*	-52.1**	-30.1**	-60.6**	30.0
30	(1x6)(4x5)	10.5**	5.7	-32.8**	-12.8*	-51.1**	-28.5**	-66.7**	0.0
31	(2x3)(4x5)	-18..0**	-10.3**	-27.9**-	-18.9**	-26.3**	19.6*	-73.6**	130.0*
32	(2x3)(4x6)	-0.71	-8.1*	30	9.1	-20.1**	-13.0	8.0	700.0**
33	(2x3)(5x6)	15.5**	-.9.4**	2.6	15.4*	-0.86	7.8	-65.5**	200.0**
34	(2x4)(3x5)	-7.0*	-3.7	9.8	11.1	-7.3	-9.3	-50.0**	300.0**
35	(2x4)(3x6)	-6.5	-5.3	-1.2	15.0*	-11.4	-7.7	-87.5**	0.0
36	(2x4)(5x6)	27.0**	20.3**	20.4**	19.3**	4.8	2.5	-71.3	130.0*
37	(2x5)(3x4)	-2.3	-5.9	-2.2	5.1	-11.4	-5.9	50.0**	500.0**
38	(2x5)(3x6)	-6.1	-9.6**	-13.4*	0.77	-35.8**	-33.2**	-25.0	200.0**
39	(2x5)(4x6)	14.2**	5.7	11.0*	19.3**	-5.1	3.2	-42.5**	130*
40	(2x6)(3x4)	7.0	0.66	10.2	10.2	-5.0	0.93	40.0	400.0**
41	(2x6)(3x5)	7.0	0.66	1.5	12.8*	1.7	-6.8	0.0	200.0**
42	(2x6)(4x5)	-4.7	-10.3**	-0.77	-0.77	13.6	-1.2	-66.7**	0.0
43	(3x4)(5x6)	-0.70	-6.6	2.1	1.4	-19.0**	-20.8**	63.0**	0.0
44	(3x5)(4x6)	7.1	-0.88	17.8**	20.1**	-11.7	-4.0	-69.7**	0.0
45	(3x6)(4x5)	7.3*	8.8*	-9.0	5.9	-12.3	-8.4	0.0	200.0**

, significant at 0.05 and 1.01 levels of probability, respectively.

cont.

No. of crosses	Quadrallel crosses	No. of capsules/pl		Capsule length		Seed yield/pl.		Seed index	
		BP	CV	BP	CV	BP	CV	BP	CV
1	(1x2)(3x4)	11.8	27.7**	25.0**	8.1	35.9**	54.1**	19.5**	19.5**
2	(1x2)(3x5)	-5.1	19.7**	-5.4	-5.4	-0.75	28.7**	4.8	7.3
3	(1x2)(3x6)	3.3	21.0**	-5.4	-5.4	0.03	25.3**	-2.4	-2.4
4	(1x2)(4x5)	-16.4**	4.1	-13.2**	-10.8	-17.7**	15.3*	-7.0	-2.4
5	(1x2)(4x6)	-2.4	-2.6	0.0	-13.5**	-0.46	2.9	-2.4	-2.4
6	(1x2)(5x6)	-7.8	1.8	-6.3	-18.9**	0.44	8.1	0.0	0.0
7	(1x3)(2x4)	-5.4	-4.7	-13.5**	-13.5**	-17.5**	8.6	-7.1	-4.9
8	(1x3)(2x5)	-2.0	6.9	0.0	-10.8*	-4.9	12.4	0.0	2.4
9	(1x3)(2x6)	11.6	12.3	0.0	-10.1*	2.0	20.6**	2.4	4.9
10	(1x3)(4x5)	-11.7*	9.9	-2.6	0.0	-8.5	28.2**	4.7	9.8**
11	(1x3)(4x6)	52.5**	53.4**	45.5**	29.7**	67.6**	98.1**	21.4**	24.4**
12	(1x3)(5x6)	1.8	12.3	15.6**	0.0	6.9	26.3**	9.5**	12.2**
13	(1x4)(2x3)	-27.6**	9.1	-16.6**	-5.4	-20.9**	32.5**	-6.1	12.2**
14	(1x4)(2x5)	-6.5	1.9	0.0	-10.8*	4.7	16.7*	10.0**	7.3
15	(1x4)(2x6)	0.0	0.65	12.1*	0.0	13.8*	26.3**	12.5**	9.8**
16	(1x4)(3x5)	4.9	19.9**	-10.8*	-10.8*	-4.1	22.5**	2.4	4.9
17	(1x4)(3x6)	-7.6	8.0	-13.5**	-13.5**	15.0**	39.7**	-4.9	-4.9
18	(1x4)(5x6)	-13.9*	-5.0	-3.0	-13.5**	0.0	11.0	12.5**	9.8**
19	(1x5)(2x3)	-30.0**	5.4	5.7	0.0	-22.3**	30.1**	-18.4**	-2.4
20	(1x5)(2x4)	-27.3**	-11.2	0.0	-5.4	-8.0	20.6**	22.5**	19.5**
21	(1x5)(2x6)	4.6	16.4*	22.9**	16.2**	45.3**	63.2**	0.0	-2.4
22	(1x5)(3x4)	-23.7**	-6.9	-8.6	-13.5**	2.5	16.3*	-7.5	-9.8**
23	(1x5)(3x6)	-27.5**	-11.5	-18.9**	-18.9**	-17.3**	0.48	-4.9	-4.9
24	(1x5)(4x6)	-1930**	-1.1	-8.6	-13.5**	0.43	12.4	0.0	-2.4
25	(1x6)(2x3)	-33.3**	0.45	-21.4**	-10.8*-	-29.7**	17.7*	-18.4**	-2.4
26	(1x6)(2x4)	-6.6	-10.2	-5.4	5.4	-10.2	17.7*	30.0**	26.8**
27	(1x6)(2x5)	10.1	20.1**	30.3**	16.2**	46.8**	63.6**	15.4**	9.8**
28	(1x6)(3x4)	-6.3	7.1	6.1	-5.4	7.2	21.5**	17.9**	12.2**
29	(1x6)(3x5)	-19.0**	2.1	-10.8*	-10.8*	-7.5	18.2**	11.9**	14.6**
30	(1x6)(4x5)	-13.4*	7.8	-2.6	0.0	-3.1	35.9**	-11.6*	-7.3
31	(2x3)(4x5)	-45.6**	-18.0*	-28.6**	-18.9**	-41.4**	-1.9	-22.4**	-7.3
32	(2x3)(4x6)	-42.5**	-13.4	-28.6**	-18.9**	-38.6**	2.9	0.0	19.5**
33	(2x3)(5x6)	-31.2**	3.7	-9.5*	2.7	-16.0**	40.7**	-18.4**	-2.4
34	(2x4)(3x5)	-28.8**	-10.2	-10.8*	-10.8*	-13.9**	12.9	-9.3**	-4.9
35	(2x4)(3x6)	-26.4**	-13.8	-13.5**	-13.5**	-16.4**	9.6	24.4**	24.4**
36	(2x4)(5x6)	9.8	21.2**	21.6**	21.6**	29.6**	69.9**	-5.0	-7.3
37	(2x5)(3x4)	-23.3**	-12.3	-3.0	-13.5**	-5.5	7.2	-5.1	-9.8**
38	(2x5)(3x6)	-29.1**	-17.1*	-18.9**	-18.9**	-19.7**	-2.4	14.6**	14.6**
39	(2x5)(4x6)	-1.0	8.0	15.6**	0.0	19.7**	33.5**	10.3**	4.9
40	(2x6)(3x4)	-14.0*	-1.8	12.1*	0.0	5.9	20.1**	10.0**	7.3
41	(2x6)(3x5)	-24.7**	-5.0	-10.8*	-10.8*	-4.5	22.0**	-9.5**	-7.3
42	(2x6)(4x5)	-31.3**	-14.5*	-21.1**	-18.9**	-30.0**	-1.9	-14.0**	-9.8**
43	(3x4)(5x6)	-24.0**	-13.2	-9.1	-18.9**	-7.6	4.8	20.5**	14.6**
44	(3x5)(4x6)	-5.5**	-6.0	-10.8*	-10.8*	-4.9	21.5**	19.0**	22.0**
45	(3x6)(4x5)	-13.2*	8.0	0.0	2.7	1.0	41.6**	2.3	7.3

*,** significant at 0.05 and 1.01 levels of probability, respectively

Table (7): Actual and Expected performance of 45 sesame quadrallel-crosses for seed yield/pl. in Shandweel and El-Matana environments.

No. of crosses	Quadrallel crosses	Shandweel			El-Matana		
		Rank	Actual	Expected	Rank	Actual	Expected
1	(1x2)(3x4)	3	77.4	36.9	5	32.2	27.6
2	(1x2)(3x5)	31	33.8	43.6	13	26.9	26.6
3	(1x2)(3x6)	42	23.0	47.7	17	26.2	26.3
4	(1x2)(4x5)	18	44.5	36.2	30	24.1	24.3
5	(1x2)(4x6)	11	55.3	40.3	41	21.5	24.0
6	(1x2)(5x6)	44	21.8	47.0	37	22.6	23.1
7	(1x3)(2x4)	25	38.9	35.7	36	22.6	26.1
8	(1x3)(2x5)	14	50.3	54.4	33	23.5	26.9
9	(1x3)(2x6)	29	36.3	45.7	23	25.2	26.5
10	(1x3)(4x5)	5	67.9	65.3	14	26.8	24.2
11	(1x3)(4x6)	8	58.9	56.6	1	41.4	23.8
12	(1x3)(5x6)	38	29.4	75.3	16	26.4	24.6
13	(1x4)(2x3)	40	28.9	42.7	11	27.7	24.6
14	(1x4)(2x5)	1	101.9	70.5	28	24.4	25.6
15	(1x4)(2x6)	7	61.1	39.5	15	26.4	23.6
16	(1x4)(3x5)	10	58.5	48.5	18	25.6	25.3
17	(1x4)(3x6)	32	33.6	57.9	8	29.2	23.3
18	(1x4)(5x6)	24	40.1	45.4	34	23.2	24.3
19	(1x5)(2x3)	30	36.0	58.7	12	27.2	24.3
20	(1x5)(2x4)	16	45.9	27.5	22	25.2	24.6
21	(1x5)(2x6)	12	54.7	40.2	4	34.1	22.9
22	(1x5)(3x4)	33	33.4	57.8	29	24.3	26.0
23	(1x5)(3x6)	2	79.0	30.2	42	21.0	24.3
24	(1x5)(4x6)	13	54.4	39.3	32	23.5	24.5
25	(1x6)(2x3)	39	29.1	37.7	27	24.6	23.8
26	(1x6)(2x4)	22	42.1	24.5	26	24.6	22.5
27	(1x6)(2x5)	20	43.4	27.8	3	34.2	22.7
28	(1x6)(3x4)	4	73.9	42.0	21	25.4	23.7
29	(1x6)(3x5)	21	42.5	45.3	25	24.7	24.0
30	(1x6)(4x5)	37	29.4	32.1	9	28.4	22.7
31	(2x3)(4x5)	19	43.6	51.5	44	20.5	25.3
32	(2x3)(4x6)	41	27.4	38.5	40	21.5	24.7
33	(2x3)(5x6)	34	33.3	54.6	7	29.4	24.5
34	(2x4)(3x5)	15	47.4	35.8	31	23.6	27.8
35	(2x4)(3x6)	28	36.4	32.8	35	22.9	25.7
36	(2x4)(5x6)	45	18.6	24.6	2	35.5	24.2
37	(2x5)(3x4)	27	36.5	47.7	38	22.4	29.6
38	(2x5)(3x6)	36	32.1	45.4	45	20.4	26.7
39	(2x5)(4x6)	43	22.7	21.2	10	27.9	25.4
40	(2x6)(3x4)	6	66.5	31.9	24	25.1	27.4
41	(2x6)(3x5)	9	58.7	32.6	19	25.5	26.6
42	(2x6)(4x5)	26	37.9	26.4	43	20.5	23.7
43	(3x4)(5x6)	35	32.9	52.9	39	21.9	25.8
44	(3x5)(4x6)	23	41.1	37.5	20	25.4	25.2
45	(3x6)(4x5)	17	44.7	55.5	6	29.6	23.6