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Combining ability studies in sesame (*Sesamum indicum* L.)

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Abstract
In the present investigation eight parents were grown for making half diallel crosses [n (n-1)/2] among them and next year eight parents and 28 f_1 hybrids were grown in CRBD with three replications for evaluation of yield and yield attributing traits to assess the combining ability was carried out by using the procedure given by griffing (1956) of method 2 model. Analysis of variance for combining ability revealed that the mean sum of squares associated with gea and sea were highly. Significant for all the characters except for plant height and it is noticed that additive as well as non- additive genes were operating in the expression of these traits, indicating existence of hudge amount of genetic variability in the experimental material. Parent TKG-22 was the best general combiner for high seed yield and early maturing along with most of the yield attributing traits. Parent JLS-120 was also identified as good general combiner for seed yield along with most of the yield contributing traits. Five cross combination Viz JTS-8xTKG-22, JTS-8xJLS-120, PT-2xJLS-120, RT-366xTKG-22 and MT-11-8-2xRT-368 identified as good specific combiner for seed yield and its contributing characters. Cross RT-366xRT-368 showed highly significant negative sea effects in desirable direction for early maturing.

Keywords: general combining ability (GCA), specific combining ability (SCA), seed yield, sesame

Introduction
Sesame (*Sesamum indicum* L.)is an important oilseed crop belongs to the family pedaliacea. It is cultivated in around 60-65 countries of the world, while Asian and African countries are the major producers asia is rich in diversity of cultivated types while Africa is prosperous in wild verities. Due to the presence of diverse wild species “Ethiopia” (Africa) is considered as the primary centres of origin, while India and japan are considered as the two secondary centers of origin of this crop. Sesame is diploid (2n+26) in nature and is commonly known as Til, Tilli, Gigelly, Ellu, sim-sim, Benni seed, nurvulu, Velvor rasi and sesame in different part of India and often referred as the epithet “The queen of oilseeds”. Generally the oil content in sesame ranges from 34 to 63 percent (Sharma *et.al* 2014) [6]. The superior performance of parents is not always as true indicator of superior combining ability because it depends upon the complex interaction of genes. Combining ability analysis provides precise estimates of nature and magnitude of gene action involved in the inheritance of quantitative characters. it is helpful for identification of good general combiner parents and good specific combiner hybrids. GCA and SCA studies provide basic information regarding the genetic properties of the lines based on which breeding methods are formulated for further improvement of the crop. Keeping in view of above facts, the present investigation was carried out to identify the good general combiner and good specific combiners for increasing the seed yield and its components in sesame.

Material and Methods
Experiment was conducted at research farm department of plant breeding & Genetics, RVSKVV, College of Agriculture, Gwalior. (M.P). In kharif season 2014 eight parents were grown for making half diallel crosses [n(n-1)/2] among them and then next year in Kharif 2015 eight parents and 28 f_1 hybrids were grown in CRBD with three replications for evaluation of yield and yield attributing traits. Five competitive plants from each parent and hybrid were selected randomly for collection of data of yield and yield attributing characters such as days to 50% flowering, days to maturity, plant height, number of primary branches, capsule on main axis, total number of capsules/plant, 1000 capsule length seed weight, number of seeds/capsule, seed yield/plant and harvest index. The combining ability analysis was carried out by using the procedure given griffing (1956) of method 2 model 1.

Result and Discussion

Analysis of Variance

Analysis of variance for combining ability revealed that the mean sum of squares associated with gea and sea were significant for all the traits except 1000 seed weight. Since gea and sea mean square were found to be significant for most of the characters revealed that additive as well as non-additive genes were operating in the expression of these traits which is in agreement with Banerjee and Kole 2009 [1]. This indicated the existence of huge amount of genetic variability in the experimental material.

General Combining Ability (GCA) Effects

The results revealed that TKG-22 exhibited positive significant GCA effects for seed yield per/plant, seeds/capsule, harvest index, capsules on main axis, and capsule length (cm) thereby revealed good general combiner for these traits, while significant negative GCA effect for days to maturity. JLS-120 showed positive significant GCA effect for seed yield per plant, seeds per capsule, number of capsules per plant, capsule on main axis and number of primary branches per plant indicating good general combiner for these traits. Sikarwar (2002) [7] reported parent JLT-3 was good general combiner for number of capsule on main axis, total number of capsules per plant number of seeds per capsule and seed yield per plant Vavdiya *et al*. (2014) [8] suggested line IC-81564 was good general combiner for days o maturity, number of branches per plant capsule length and seed yield per plant and tester GT-10 for number of branches per plant, number of capsules per plant and seed yield per plant. Raikwar (2018) [5] reported parent ES-230 showed highly significant and positive gea effects for seed yield per plant and parent SI-1147 was good general combiner for number of primary branches per plant, number of capsules per plant, days to maturity and seed yield per plant Mishra *et.al* (2009) [4] studied variety VRI-1 and GT-10 was good general combiner for capsules per plant, Kalika and HT-1 for seeds per capsule.

Specific Combining Ability (SCA) Effects

Six crosses Viz JTS-8xTKG-22, (low x high) JTS-8XJLS-120 (low x low), PT-2xJL5-120 (low x low), RT-366 x TKG-22 (medium x high), RT-366xRT-368 (medium x low) and MT-11-8-2 xRT-3678 (medium x low) identified as good specific combiner for seed yield per plant along with majority of the characters. JTS-8 x TKG-22 showed highly significant positive sea effects for capsules on main axis, number of capsules per plant and harvest index. JTS-8xJLS-120 exhibited significant positive effects for number of capsules per plant and seed per capsule.PT-2xJLS-120 possessed significant positive sca effects for plant height, capsules on main axis, number of capsules plant and seeds per capsule. Highly significant positive. Sea of the cross RT-366xTKG-22 recorded for number of capsule per plant and seeds per capsule. The cross MT-11-8-2xRT-368 showed highly significant positive sca effects for number of capsules per plant and harvest index. The cross RT-366xRT-368 showed highly significant and negative sca effects for days to maturity in desirable direction.

Sikarwar (2002) [7] suggested cross RT-46xTKG-21 was the best specific combiner for seed yield per plant along with majority of the traits such as plant height, number of branches per plant, number of capsules on main axis, total number of capsules per plant, number of capsules per plant and 1000 seed weight. Raikwar (2018) [5] suggested cross ES-230XNIC-8401 was good specific combiner for plant height, number seed capsule, days to maturity and seed yield per plant, and combination IS-1162xNIC-16220 was promising for number of capsules per plant and capsule length. Chaudhary, *et. al* (2016) [2] reported G.Til-2x JLS-116 was good specific combiner for plant height, number of branches per plant, number of capsules per plant, capsule length, days to maturity, number of seed per capsule, 1000 seeds weight and seed yield per plant.

Table 1: Analysis of variance for yield and its attributing characters of parents and their different crosses in sesame

Source of Variation	DF	Days to 50% flowering	Days to maturity	Plant height	Capsule length	No. of primary branches	No. capsules on main axis	Total no of capsules per plant	1000 seed weight	Seed / Capsule	Seed yield /plant	Harvest index
Rep	2	15.06	0.48	43.76**	0.03	0.29	1.60*	3.91	0.02	7.43	0.16*	0.98
Genotypes	35	12.21**	4.97**	38.50**	0.03*	0.21	6.48**	17.91**	0.18	10.22**	2.07**	5.79**
Parents	7	8.86	4.57**	47.40**	0.05**	0.25**	3.15**	6.78	0.1370	2.51	1.49**	12.15**
Crosses	27	13.52**	5.23**	37.45**	0.02	0.21**	7.50**	21.45**	0.19	12.44**	2.16**	4.35**
C vs. P	1	0.45	0.64	4.51	0.04	0.03	2.15**	0.21	0.20	4.23	3.87*	0.03
Error	70	5.04	1.36	5.84	0.02	0.10	0.39	4.30	0.17	2.13	0.24	1.65

Table 2: Analysis of General combining ability for yield and its attributing characters of parents and their different crosses in sesame

S. No	Parents	Days to 50% flowering	Days to maturity	Plant height	Capsule length	No. of primary branches	Capsules on main axis	Total no of capsules per plant	1000 seed weight	Seed /capsule	Seed yield /plant	Harvest index
1	JTS 8	-0.18	0.31	1.37**	-0.04	0.32**	-0.41**	0.61	-0.03	0.26	-0.39**	-0.72**
2	PT-2	-0.24	-0.46**	-2.66**	-0.04	-0.03	-0.86**	-0.36	0.14**	-0.27	0.11	-0.12
3	RT-366	-0.61	0.14	-0.28	-0.05**	-0.09	-0.41**	0.49	-0.04	-0.64**	-0.38**	0.09
4	MT-11-8-2	-0.21	0.08	0.86**	-0.02	-0.17**	0.35**	-0.04	-0.02	-0.72**	0.09	0.39
5	RT-368	0.86**	-0.09	-0.43	0.03	-0.07	0.09	-0.87**	-0.01	-0.64**	0.16	-0.21
6	PT-10	0.19	0.64**	1.78*	-0.01	0.05	0.47**	-1.02**	-0.05	0.40	-0.09	0.27
7	TKG 22	-0.31	-0.42*	-0.79	0.10*	-0.04	0.31**	0.37	-0.04	0.66**	0.17*	0.55**
8	JLS-120	0.49	-0.19	0.16	0.01	0.11*	0.47**	0.83**	0.06	0.96**	0.52**	-0.24

Table 3: Analysis of specific combining ability for yield and its attributing characters of parents and their different crosses in sesame

Crosses	Days to 50% flowering	Days to maturity	Plant height	Capsule length	No. of primary branches	Capsules on main axis	Total no of capsules per plant	1000 seed weight	Seed/ capsule	Seed yield /plant	Harvest index
JTS-8×PT-2	3.37**	-0.25	0.89	-0.03	0.12	-2.28**	-0.05	-0.18	-2.35**	-0.52**	-0.87
JTS-8×RT366	2.07**	-1.18**	-4.44**	-0.03	0.09	-3.00*	-3.77**	0.12	2.35**	-0.50**	1.27**
JTS-8×MT-11-8-2	3.00**	0.89	1.53	-0.04	-0.08	-0.38	-0.87	-0.05	-2.37**	-0.82**	2.68
JTS-8×RT368	-2.73**	1.39**	4.34**	0.00	0.09	2.07**	-1.31	-0.11	-1.18	-0.27	0.71
JTS-8×PT10	-4.40**	1.32	6.37**	-0.03	0.07	4.23**	-2.41**	0.29	3.11**	0.04	-1.31**
JTS-8×TKG-22	0.10	0.72	-0.86	-0.07	-0.23	1.05**	3.81**	0.03	1.15	1.92**	1.69**
JTS-8×JLS-120	-1.36	-1.51	-9.22**	0.02	-0.12	-0.13	4.73**	0.12	2.92**	1.64**	0.13
PT-2×RT-366	-0.86	-0.41	-0.96	-0.07	0.13	0.30	0.96	0.16	-2.78**	0.14	2.26**
PT-2×MT-11-8-2	-1.93	1.32**	-0.86	0.06	0.14	0.20	-1.57	0.18	2.26**	-0.11	1.19
PT-2×RT-368	0.00	-0.85	3.16**	-0.02	-0.03	0.36	-0.87	0.06	1.01	-0.06	-0.02
PT-2×PT-10	1.00	-1.25**	-3.64**	0.06	-0.38**	-0.66**	-0.19	-0.24	-0.56	0.19	0.00
PT-2×TKG-22	0.50	-1.51**	1.46	-0.06	0.06	-0.14	1.44	0.42	1.53**	0.33	-0.34
PT-2×JLS-120	1.04	-0.75	2.51**	0.06	-0.20	0.86**	5.92**	-0.31	2.53**	1.47**	-1.49**
RT-366×MP-11-8-2	-0.23	-1.28**	-0.31	0.01	-0.07	-0.12	-2.09**	-0.16	-0.80	0.21	-1.61**
RT-366×RT-368	-1.63	-1.11**	-1.81	0.03	-0.04	-1.07**	-0.73	0.29	-1.15	0.56**	-0.80
RT-366×PT-10	-0.63	-0.51	0.31	-0.04	-0.01	-0.16	-0.79	0.07	-1.65**	-0.19	-1.46
RT-366×TKG-22	2.54**	-0.11	1.28	0.05	0.20	2.07	3.40**	0.11	1.88**	0.95**	-0.18
RT-366×JLS-120	-0.93	0.65	5.72**	0.03	-0.35**	1.62**	0.97	0.07	0.92	-0.50**	-0.78
MT-11-8-2×RT-368	-0.36	0.29	-0.50	-0.04	0.04	0.27	2.78**	0.09	-0.44	0.47**	2.27**
MT-11-8-2×PT-10	0.64	-0.11	-3.36**	-0.09	0.29	-0.20	1.04	-0.40*	-0.17	0.06	-1.51**
MT-11-8-2×TKG-22	-4.86**	1.95**	-1.20	-0.03	-0.19	-0.32	-1.05	-0.29	0.69	-0.14	-1.72**
MT-11-8-2×JLS120	1.67	-1.28**	2.85**	0.04	-0.13	-0.32	-1.12	0.16	-0.40	-0.19	0.86
RT-368×PT-10	1.57	0.39	3.05**	0.01	-0.15	1.26**	2.89**	0.09	0.68	-0.03	-0.01
RT-368×TKG-22	-2.26**	-1.21**	0.61	0.11	0.11	-0.58	-1.22	-0.51*	-0.68	-1.52**	-0.85
RT-368×JLS-120	1.60	2.22**	0.70	0.03	-0.17	0.54	-2.40**	0.32	0.25	0.19	0.37
PT-10×TKG-22	2.07*	-1.61**	-3.45**	-0.05	0.02	-1.39	-3.06**	0.17	-0.23	0.23	-0.74
PT-10×JLS-120	1.27	1.82**	-0.48	-0.03	-0.19	-1.05	-1.38	-0.16	-2.06**	-0.69**	0.44
TKG-22×JLS-120	-1.23	0.89	-0.63	-0.18**	-0.06	-0.93	-0.81	0.30	-0.79	0-0.5	0.05

Conclusion

Analysis of combining ability suggested an idea about breeding methodology to be applied and use of promising crosses for further improvement in wheat. In self –pollinated crops like sesame, SCA effects are not much important as they are mostly related to non-additive gene effects excluding those of arising from complementary gene action or linkage effects they cannot be fixed in pure lines. Further superiority of the hybrids might not indicate their ability to yield transgressive segregates; rather SCA would provide satisfactory criteria. However, if a cross combination exhibiting high SCA as well as high performance having at least one parent as good general combiner for a specific trait, it is expected to throw desirable transgressive segregants in later generations. These crosses were the results of good x good general combiner. JTS-8×TKG-22, JTS-8×JLS-120, PT-2×JLS-120, RT-366×RT-368, RT-366×TKG-22 and MT-11-8-2×RT-368 these crosses were the result of good x poor general combiner so these crosses hold great promise in improving the seed yield in future breeding programme of sesame.

1. Good general combiners like TKG-22 and JLS-120 can be used in the development of high yielding varieties and later in promising segregating generations in sesame.
2. New recombinant promising single plants may be selected in F_2 generations of good cross viz., JTS-8×TKG-22, JTS-8×JLS-120, PT-2×JLS-120, RT-366×RT-368, RT-366×TKG-22 and MT-11-8-2×RT-368 both parents involved in these crosses having good general combining ability effects so these crosses are highly desirable for effective selection.

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