ADVANCE RESEARCH JOURNAL OF
CROP IMPROVEMENT
Volume 7 | Issue 1 | June, 2016 | 171-175
e ISSN-2231-640X

DOI : 10.15740/HAS/ARJCI/7.1/171-175
Visit us: *www.researchjournal.co.in*

Heterosis and inbreeding depression in linseed

■ V. K. CHOUDHARY, S. RAM[1], S. K. SINGH[2], M. CHAKRABORTY[1], ARUN KUMAR[1] AND E. AHMAD[3]

AUTHORS' INFO

Associated Co-author :

[1]Department of Plant Breeding and Genetics, Birsa Agricultural University, Kanke, RANCHI (JHARKHAND) INDIA

[2]Department of Plant Breeding and Genetics, Rajendra Agricultural University, Pusa, SAMASTIPUR (BIHAR) INDIA

[3]Zonal Research Station (BAU) Chianki, RANCHI (JHARKHAND) INDIA

Author for correspondence:
V.K. CHOUDHARY
Department of Seed Technology (STR), Tirhut College of Agriculture, Dholi, MUZAFFARPUR (BIHAR) INDIA
Email:vkchoudharypat12@gmail.com

ABSTRACT : Five improved varieties of linseed namely, Meera, Shekhar, T-397, KL - 221 and JLS -9 were crossed to obtain six F_1s and F_1s were selfed to get F_2s. The estimates of heterosis revealed that none of the cross exhibited significant heterosis for all the characters over mid parent, better parent and check variety. The degree and direction of heterotic response varied not only from character to character but also from cross to cross. In general, considerable amount of significant desirable heterosis over mid parent, better parent and check variety were observed for few characters under study. Inbreeding depression in F_2 generation was estimated for all the characters and it was observed positively significant for seed yield per plant, stearic acid content, oleic acid content, linolenic acid content, linoleic acid content, palmitic acid content, primary branches per plant, capsule diameter, number of capsules per plant revealed significant positive inbreeding depression indicating detoriation in their performance in next generation.

KEY WORDS : Linseed, Heterosis, Inbreeding depression

How to cite this paper : Choudhary, V. K., Ram, S., Singh, S. K., Chakraborty, M., Kumar, Arun and Ahmad, E. (2016). Heterosis and inbreeding depression in linseed. *Adv. Res. J. Crop Improv.*, **7** (1) : 171-175, **DOI : 10.15740/HAS/ARJCI/7.1/171-175**.

Paper History : Received : 28.12.2015; **Revised :** 01.05.2016; **Accepted :** 27.05.2016

Linseed (*Linum usitatissimum* L.) is commonly known as 'alsi' or 'tisi. It mainly cultivated for fibre (flax fibre) and seed oil (linseed oil) or both (dual purpose linseed), but recently it has gained a new interest in the emerging market of functional food due to its high content of fatty acids, alpha linolenic acid (ALA), an essential Omega-3 fatty acid and lignin in linseed (Reddy *et al*., 2013). Traditionally, the oil pressed from the seed (linseed oil) has been used for a variety of industrial purposes for manufacturing of surface coating oils, varnish, linoleum, oil cloth, printing inks etc. and the oil free meal could be fed to livestock. Omega-3 fatty acids lower levels of triglycerides in the blood, thereby reducing heart disease, and also show promise in the battle against inflammatory diseases such as rheumatoid arthritis. On global scenario, India ranks second in an area (approx. 2.96 lakh hectares) and third in production with 1.49 lakh tones (Anonymous, 2014). In spite of vast area and varied utility of crop, country has very low productivity (502 kg/ha) against world average of 827 kg/ha (Anonymous, 2014).

Heterosis is a complex genetic phenomena depending upon the balance of additive, dominance and interaction components as well as the distribution of the genes in the parental lines. Manifestation of hybrid vigour in crop plants has been observed by plant brereders mainly in cross pollinated crops. But in self pollinated crops also hybrid vigour has been reported (Gill, 1987) and is being utilized commercially in many crops like rice, etc. In crop improvement programme, heterosis breeding is a quick and convenient way of combining desirable traits in the production of F_1 hybrids (Ramesh *et al*., 2013 and Jhajharia *et al*., 2013). Magnitude of heterosis provides a basis for genetic diversity and guideline to the choice of desirable parents for developing superior F_1 hybrids so as to exploit hybrid vigour and for building gene pool to be exploitation in population improvement. Exploitation of heterosis in linseed in the form of hybrid varieties is a break through in the field of linseed improvement (Pali and Mehta, 2014). Development of better hybrids using stable high yielding lines will raise the yield of this crop. In order to achieve high yielding cross combination, it is essential to evaluate available promising diverse lines in their hybrid combinations for yield and its components. In present investigation heterosis in six F_1 crosses over mid parent, better parent and over economic check (LC-54) and inbreeding depression in F_2 were studied. This study reveals good scope for isolating suitable parents for hybrid development and to select potent transgressive segregants which can be further evaluated for enhanced yield potential.

Research Procedure

The basic materials for the present investigation comprised of five improved varieties of linseed namely, Meera, Shekhar, T-397, KL - 221 and JLS -9, 6F_1s and one check variety (LC-54) were used for present investigation. The experiment was carried out at the experimental area of the Department of Plant Breeding and Genetics, BAU, Kanke, Ranchi during *Rabi* season of 2013-14

The experimental farm is situated at 23^0 17' N latitude, 85^0 19' E longitude and 625 meters above mean sea level. Maximum and minimum temperature ranges between 25^0C to 19^0C and 11^0 C to 9^0 C, respectively. The monsoon normally sets in second week of June and continues upto middle of October. The observations were recorded on 10 randomly taken plants per entry and per replication in case of parents, F_1s and check, 20 plants from BC_2 and 30 plants in case of F_2 generation. Observations were recorded for days to 50 per cent flowering, days to maturity, plant height (cm), number of primary branches per plant, number of capsules per plant, capsule diameter (mm), number of seeds per capsule, 1000 seed weight (g), seed yield per plant (g), oil content (%), fatty acid content (%)

Research Analysis and Reasoning

The value of heterosis from Table 1-7 revealed that none of the cross exhibited significant heterosis for all the characters over mid parent, better parent and check variety. The degree and direction of heterotic response varied not only from character to character but also from cross to cross. In general, considerable amount of significant desirable heterosis over mid parent was observed for most of the characters except days to 50 per cent flowering, plant height, test weight and oil content. Significant and desirable heterosis was observed over mid parent in all the crosses for only one character *i.e.* number of capsules per plant.

Significant and desirable heterosis over mid parent was observed in five crosses (Meera x T-397, Meera x KL-221, Meera x JLS-9, Shekhar x T-397 and Shekhar x KL-221) for traits primary branches per plant and linolenic acid content. Significant desirable heterosis in four crosses (Meera x T-397, Meera x KL-221, Shekhar x T-397 and Shekhar x KL-221) each for linolenic acid content and stearic acid content, three crosses each

Table 1 : Estimates of heterosis and inbreeding depression in linseed at Ranchi

Hybrid combinations	Days to 50% flowering				Plant height (cm.)			
	MP	BP	Check	ID	MP	BP	Check	ID
Meera x T397	-5.42	-11.38*	-10.29*	-2.29	-1.43	-7.00	8.55	11.67
Meera x KL-221	-4.86	-8.54	-7.41	1.78	-5.75	-16.74 **	-2.81	-1.22
Meera x JLS-9	2.56	-2.44	-1.23	7.92	-3.97	-18.78 **	-5.19	-6.05
Shekhar x T397	1.12	-2.17	-7.41	0.44	5.66	-5.38	-2.06	5.75
Shekhar x KL-221	-5.03	-5.65	-10.70*	-2.76	4.83	0.36	-10.17	-1.20
Shekhar x JLS-9	-7.52	-9.13	-13.99**	-5.74	6.22	5.49	-13.64	1.44
CD. (P=0.05)	6.65	7.68	7.68	_	7.56	8.73	8.73	_
CD. (P=0.01)	9.04	10.44	10.44		10.27	11.86	11.86	

* and ** indicate significance of values at P=0.05 and 0.01, respectively

Table 2: Estimates of heterosis and inbreeding depression in linseed at Ranchi

Hybrid combinations	No .of primary branches/plant				No .of capsules/plant			
	MP	BP	Check	ID	MP	BP	Check	ID
Meera x T397	55.80 **	27.98 *	126.32 **	43.72 **	40.01 **	27.92 **	32.37 **	39.05 *
Meera x KL-221	48.89 **	19.64	111.58 **	44.78 **	31.80 **	19.00 *	23.14 *	37.54 **
Meera x JLS-9	61.51 **	27.38 *	125.26 **	44.39 **	34.21 **	26.56 **	30.97 **	42.90 **
Shekhar x T397	67.52 **	55.56 **	106.32 **	27.55	48.06 **	41.65 **	32.75 **	3.60
Shekhar x KL-221	52.63 **	38.10 *	83.16 **	32.18	48.06 **	41.65 **	32.51 **	3.60
Shekhar x JLS-9	22.87	8.73	44.21 *	18.98	41.69 **	40.15 **	31.35 **	26.59 *
CD. (P=0.05)	1.20	1.39	1.39	_	10.43	12.04	12.04	_
CD. (P=0.01)	1.63	1.89	1.89		14.17	16.37	16.37	

* and ** indicate significance of values at P=0.05 and 0.01, respectively

Table 3 : Estimates of heterosis and inbreeding depression in linseed at Ranchi

Hybrid combinations	No.of seeds/capsule				Capsule diameter			
	MP	BP	Check	ID	MP	BP	Check	ID
Meera x T397	11.88	7.62	26.26 **	7.08	21.95 **	12.70 *	22.22 **	28.73 **
Meera x KL-221	6.93	2.86	20.67 *	5.56	-14.58 **	-15.98**	-8.89	-19.51
Meera x JLS-9	2.49	-1.90	15.08	6.80	4.48	0.41	8.89	6.53
Shekhar x T397	18.78 *	17.00 *	30.73 **	14.53	8.86 *	-1.56	12.00 *	10.71
Shekhar x KL-221	13.71	12.00	25.14 **	12.50	-2.85	-6.64	6.22	11.72
Shekhar x JLS-9	-10.20	-12.00	-1.68	-7.95	8.94 *	2.34	16.44 **	21.76 *
CD. (P=0.05)	0.92	1.07	1.07	_	0.68	0.78	0.78	_
CD. (P=0.01)	1.25	1.45	1.45		0.92	1.06	1.06	

* and ** indicate significance of values at P=0.05 and 0.01, respectively

Table 4 : Estimates of heterosis and inbreeding depression in linseed at Ranchi

Hybrid combinations	Days to maturity				Seed yield/plant (g)			
	MP	BP	Check	ID	MP	BP	Check	ID
Meera x T397	-0.38	-4.18 *	-2.26	0.51	61.19 **	54.29 *	126.89 **	35.56 **
Meera x KL-221	2.85	-2.46	-0.50	3.02	54.19 *	36.57	100.84 **	41.84 *
Meera x JLS-9	4.02 **	-1.47	-0.50	3.49	28.90	10.86	63.03 *	48.97 **
Shekhar x T397	-2.05	-5.67 **	-4.01 *	-0.52	74.85 **	71.69 **	139.50 **	65.61 **
Shekhar x KL-221	-2.72	-7.64 **	-6.02 **	-1.33	18.94	7.83	50.42	44.69
Shekhar x JLS-9	-4.68 **	-9.61 **	-8.02 **	-0.54	8.90	-4.22	33.61	39.62
CD. (P=0.05)	3.76	4.35	4.35	_	2.09	2.42	2.42	_
CD. (P=0.01)	5.12	5.91	5.91		2.84	3.28	3.28	

* and ** indicate significance of values at P=0.05 and 0.01, respectively

Table 5 : Estimates of heterosis and inbreeding depression in linseed at Ranchi

Hybrid combinations	Test weight (g)				Oil content (%)			
	MP	BP	Check	ID	MP	BP	Check	ID
Meera x T397	0.01	-4.65	25.51 **	1.63	-0.59	-1.26	0.09	1.28
Meera x KL-221	7.11	-0.78	30.61 **	13.67	-2.07	-4.05 **	-2.74 *	-1.69
Meera x JLS-9	-3.51	-9.30	19.39 *	0.85	-1.37	-2.70 *	-1.37	-0.46
Shekhar x T397	6.08	4.12	29.08 **	14.62	-1.04	-1.71	-1.37	1.92
Shekhar x KL-221	12.31	7.00	32.65 **	19.62	0.69	-1.35	-0.37	2.74
Shekhar x JLS-9	7.66	4.12	29.08 **	11.86	-0.46	-1.80	0.01	0.46
CD. (P=0.05)	1.00	1.15	1.15	_	0.85	0.98	-0.46	_
CD. (P=0.01)	1.36	1.57	1.57		1.15	1.33	1.33	

* and ** indicate significance of values at P=0.05 and 0.01, respectively

(Meera x KL-221, Meera x JLS-9 and Shekhar x T-397) for oleic acid content, seed yield per plant and capsule diameter, one cross each for palmitic acid content and number of seeds per capsule. Heterosis over better parent and check was observed significant and in desirable direction for all the six crosses for number of capsules per plant and days to maturity. Heterosis was significant and in desirable direction in all the crosses over check variety for characters primary branches per plant and test weight. The result of Kansal and Gupta (1981); Patil and Chopra (1983); Dakhore *et al.* (1987); Yadav (2001); Kusalkar *et al.* (2002); Kiran and Bhateria (2012) and Singh *et al.* (1987) were in confirmity of the present finding with respect to different traits. While considering the significant and useful heterosis over mid parent, better parent and economic parent, the best crosses were Meera × T-397 and Shekhar × T-397 for seed yield per plant. It was also found that increase in seed yield in these crosses were mostly due to desirable heterotic response of important component traits like primary branches per plant, number of capsules per plant, number of seeds per capsule, capsule diameter and test weight (Kansal and Gupta (1981); Rao and Singh (1983); Dakhore *et al.* (1987); Singh *et al.* (1987); Wang *et al.* (1996); Kusalkar *et al.* (2002); Kiran and Bhateria (2012) and Singh *et al*. (2014), also reported the contribution of these components to the heterosis for seed yield per plant).

Inbreeding depression in F_2 generation was estimated for all the characters. The result indicted that four crosses each for seed yield per plant, stearic acid content and oleic acid content, three crosses each for linolenic acid content, linoleic acid content, palmitic acid content, primary branches per plant, and two crosses for capsule diameter while five crosses for number of capsules per plant revealed significant positive inbreeding depression indicating detoriation in their performance in next generation. Singh *et al.* (1987)*;* Srivastava *et al.* (2003) and Kiran and

Table 6 : Estimates of heterosis and inbreeding depression in linseed at Ranchi

Hybrid combinations	Palmitic acid content (%)				Stearic acid content (%)				Oleic acid content (%)			
	MP	BP	Check	ID	MP	BP	Check	ID	MP	BP	Check	ID
Meera x T397	8.69 **	6.56 **	65.69 **	0.14	-9.66 **	-12.46 **	-31.72 **	17.78 ***	-29.67 **	-30.55 **	-34.87 **	6.49 **
Meera x KL-221	-37.33 **	-50.77 **	-26.46 **	-9.76 **	10.53 **	-19.00 **	27.25 **	40.03 ***	5.75 **	-16.74 **	32.48 **	8.78 **
Meera x JLS-9	-27.06 **	-42.67 **	-14.36 **	-8.80 **	8.10 **	-21.79 **	27.98 **	-88.84 **	46.56 **	25.90 **	15.11 **	32.86 **
Shekhar x T397	-44.64 **	-47.81 **	-18.84 **	24.14 **	8.12 **	6.32 **	-17.07 **	24.05 **	17.72 **	6.46 **	23.44 **	14.35 **
Shekhar x KL-221	-28.47 **	-42.08 **	-20.23 **	20.39 ***	-50.33 **	-63.25 **	-42.26 **	-15.73 **	-19.37 **	-30.31 **	10.90 **	-11.70 **
Shekhar x JLS-9	-0.68	-19.53 **	10.83 **	28.42 **	47.79 **	7.95 **	76.63 **	57.60 **	-33.98 **	-48.30 **	-40.06 **	-22.45 **
C.D. (P=0.05)	0.12	0.14	0.14	_	0.14	0.16	0.16	_	0.17	0.19	0.19	_
C.D. (P=0.01)	0.17	0.20	0.20		0.19	0.22	0.22		0.22	0.26	0.26	

** and *** indicate significance of values at P=0.05 and 0.01, respectively

Table 7 : Estimates of heterosis and inbreeding depression in linseed at Ranchi

Hybrid combinations	Linoleic acid content (%)				Linolenic acid content (%)			
	MP	BP	Check	ID	MP	BP	Check	ID
Meera x T397	-29.81 **	-35.82 **	-26.77 **	0.01	3.48 **	2.91 **	-0.09	4.94 **
Meera x KL-221	-30.12 **	-33.51 **	-24.14 **	-19.01 **	5.90 **	1.84 **	-2.21 **	15.40 **
Meera x JLS-9	5.29 **	0.93 *	25.55 **	-19.01 **	-28.71 **	-28.90 **	-31.35 **	28.75 **
Shekhar x T397	13.88 **	11.15 **	5.12 **	4.76 **	10.90 **	3.51 **	0.49	0.85
Shekhar x KL-221	16.47 **	9.14 **	12.42 **	32.48 **	4.43 **	3.51 **	-9.77 **	-13.29 **
Shekhar x JLS-9	20.97 **	4.27 **	29.71 **	26.16 **	6.76 **	-0.10	-3.54 **	-12.67 **
CD. (P=0.05)	0.11	0.13	0.13	_	0.50	0.57	0.57	_
CD. (P=0.01)	0.15	0.17	0.17		0.67	0.78	0.78	

* and ** indicate significance of values at P=0.05 and 0.01, respectively

Bhateria (2012) also reported the inbreeding depression in these traits.

Literature Cited

Anonymous (2014). Annual progress report, All india co-ordinated research project on linseed. Project co-ordinating, linseed unit, C.S.A. University of Agriculture and Technology, Kanpur (U.P.) INDIA.

Dakhore, S.R., Narkhede, M.N. and Khorgade, P.W. (1987). Heterosis in relation to combining ability effects in linseed (*Linum usitatissimum* L.). Panjabrao Krishi Vidyapeeth, *Res. J.,* **11** (1): 7-12.

Gill, K.S. (1987). Recent concepts in breeding self pollinated crops. Proceedings of the first Symposium on crop improvement, pp. 83-129. Punjab Agricultural University, LUDHIANA (PUNJAB) INDIA.

Jhajharia, S., Choudhary, P., Jhajharia, A., Meena, L.K. and Singh, D. (2013). Heterosis and combining ability in safflower (*Carthamus tinctorius* L.) germplasm lines. *Bioscan*. **8** (4) : 1453- 1460.

Kansal, K.K. and Gupta, S.C. (1981). Note on heterosis in linseed. *Indian J. Agric. Sci.* **51** (9): 680-682.

Kiran, Sood K. and Bhateria, S. (2012). Detection of genetic components of variation for yield, fibre and quality traits in flax (*Linum usitatissimum* L.) *J. Agric. Sci.*, **4**(10): 224-231.

Kusalkar, A.M., Patil, B.R., Thawari, S.B. and Khatod, J.P. (2002). Heterosis studies in linseed (*Linum usitatissimum* L.*). J. Soils & Crops*, **12** (2): 196-198.

Pali, V. and Mehta, N. (2014). Combining ability and heterosis for seed yield and it's attributes in linseed (*Linum usitatissimum* L.). *Bioscan*, **9** (2): 701-706.

Patil, U.D. and Chopra, P.R. (1983). Heterosis in relation to general and specific combining ability effects in linseed. *Indian J. Genet.,* **43** : 226-228.

Ramesh, M., Lavanya, C., Sujatha, M., Sivasankar, A., Aruna Kumari, J. and Meena, H. P. (2013). Heterosis and combining ability for yield and yield component characters of newly developed castor (*Ricinus communis* L.) hybrid. *Bioscan*, **8** (4) : 1421-1424.

Rao, S.K. and Singh, S.P. (1983). Heterosis and inbreeding depression in linseed. *Indian J. agric. Sci.,* **53** (6) : 409-417.

Reddy, M. P., Reddy, B. Rajasekhar and Maheshwari, J.J. (2013). Screening of linseed genotypes for resistance against budfly, *Alternaria* and powdery mildew, genetic parameters for yield components in linseed (*Linum usitatissimum* L.). *Internat J.Curr.Microbiol.App.Sci.*, **2** (9) : 267-276.

Singh, P., Srivastava, A.N., Singh, I.B. and Mishra, R.(1987). Heterosis and inbreeding depression in relation to *per se* performance in linseed. *Farm Sci. J.,* **2** (1): 68-73.

Singh, V. K., Verma, P. N., Sharma,V., Verma, I.K., Paswan, S.K. and Chauhan, M.P. (2014). Estimation of heterosis for yield and its contributing attributes in linseed (*Linum usitatissimum* L.). *Ecoscan*, (Special issue), **6**: 81-84.

Srivastava, R.L., Swarnkar, S.K., Kerkhi, S.A., Dubey, S.D. and Malik, Y.P. (2003). Heterosis and inbreeding depression in linseed under salt affected soil. ISOR National Seminar : stress management in oilseeds,Jan. 28-30, 2003. Rajendranagar, Hyderabad (A.P.) INDIA.

Wang, Yu. Fu., Yan, Z., Jian, F., Guagjum, Q., Yun, Lu., Guang, W., Vu, Diankui, W., Lijun, Ya., Yan, H., Wang,Y.F., Yan, Z.F., Fan. J., Qiao, G.J., Lu, Y., Wu, G.W., Wang, D.K., Yang, L.J. and Wang (1996). Study on heterosis and affinity of flax. *Chiana 's Fibre Crops*, **2**: 10-13.

Yadav, R.K. (2001). Heterosis for yield and yield components in linseed (*Linum usitatissimum* L). *Plant Archiv.,* **1**(1 & 2) : 95 - 98.

7th Year
★★★★★ of Excellence ★★★★★