Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.2945

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **6 (2):** 664-669 (2018)

International Journal of Pure & Applied Bioscience

Research Article

OPEN ACCESS

Estimation of Heterosis for Seed Yield, Morphological Traits and *Alternaria* Blight Resistance in Linseed (*Linum usitatissimum* L.)

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Received: 3.05.2017 | Revised: 27.06.2018 | Accepted: 5.07.2018

ABSTRACT

*A study was conducted for the estimation of heterosis involving 13 parents and their 26 F_1s (direct cross) for seed yield, morphological traits and incidence of Alternaria blight resistance in linseed. The analysis of variance (ANOVA) showed highly significant differences among the parents and their F_1s for all the characters under study, indicated that sufficient variability was existed in the present set of breeding material and further evaluation would be meaningful. The cross (JAWAHAR 1 x EC 322680) showed positive and significant heterosis over mid parent (64.12**), better parent (28.89**) and standard variety (28.89**) for seed yield and also showed significant heterosis for number of capsules per plant and corolla size whereas one other cross (GS 234 x EC 322680) showed significant heterosis over mid parent (67.92**) and better parent (35.54**) for seed yield. Hence these crosses would be exploited for isolating transgressive segregants for seed yield and its contributing components for genetic improvement of linseed.*

Key words: *Heterosis, Linseed, Alternaria blight, Seed yield, Morphological traits.*

INTRODUCTION

Linseed (*Linum usitatissimum* L.) commonly known as 'alsi', and it is mainly cultivated for fiber (flax fiber) and seed oil (linseed oil) or both (dual purpose linseed). In India, among the oilseeds crops grown during Rabi season, linseed is next in importance to rapeseed-mustard in area as well as in production. At global level, India ranks second in terms of area after Canada and in terms of production; it occupies fourth positions after Canada, China and USA, respectively. Across the world it covers 2270.35 thousand hectare area with production of 2238.94 thousand tons having productivity of 986.16 kg per hectare, where as in India it covers 338 thousand hectares area and production of 147 thousand tons with the productivity of 434.91 kg per hectare[1]. The fiber of linseed is known for its high strength and durability therefore, used in the manufacturing cloth, paper, strawboard and water resistant pipes. The by-product, oilcake is a valuable dairy feed containing 36% protein, of which 85% is digestible.

Cite this article: Kumar, P., Kamboj, G., Kumar, R. and Singh, P. K., Estimation of Heterosis for Seed Yield, Morphological Traits and *Alternaria* Blight Resistance in Linseed (*Linum usitatissimum* L.), *Int. J. Pure App. Biosci.* **6(2):** 664-669 (2018). doi: http://dx.doi.org/10.18782/2320-7051.2945

The linseed oil is rich in fatty acids alpha linolenic acid (ALA) an essential Omega-3 fatty acid and lignin oligomers accounting for 57 % of total fatty acids in its biochemical composition[8]. Therefore every part of linseed is utilized commercially either directly or after processing with numerous medicinal uses. Linseed primarily a rainfed crop is cultivated on marginal and sub-marginal soils under input starved condition. Moreover, *Alternaria* blight, powdery mildew, rust and wilt are the major biotic stresses associated with it. Therefore, the average yield of linseed is very low. Other reasons of low productivity are narrow genetic base coupled with age old cultivation method and susceptibility of the varieties to *Alternaria* blight, rust, wilt and powdery mildew diseases. Genetic improvement of any trait largely depends on the magnitude and direction of available heterosis. The phenomenon of heterosis has proved to be the most important genetic tool in boosting the yield of self as well as cross pollinated crops and is recognized as the most important breakthrough in field of crop improvement. The best hybrids for yield and related traits can be achieved by evaluating the promising diverse lines and their cross combination[10]. Commercial exploitation of heterosis in linseed in the form of hybrid varieties is a breakthrough in the field of linseed improvement[6]. Hence, heterotic studies can provide the basis for the exploitation of valuable hybrid combinations in future breeding programs. Therefore the main objective of present investigation was to identify the heterotic cross for seed yield, morphological traits and *Alternaria* blight resistance in linseed.

MATERIAL AND METHODS

The base materials consisted of 13 genotypes (H 36, JRF 4, POLF 19, PANJAB FLAX, EC 322680, EC 541194, EC 607789, EC 1465, JAWAHAR 1, GS 234, EC 1424, FRW 1, and EC 541196) and their 23 F_1s crosses. These genotypes were taken on the basis of morphological differences with respect to various traits. The pedigree, salient features and source of these parents are appended in Table 1. The experimental materials were evaluated during crop season 2008-2009 in a randomized blook design with three replications at Crop Research Farm Nawabganj, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur. Each genotype was sown in a single row plot of three meter length and spacing was 40 cm between the rows and 5 cm within rows. All recommended agronomic package of practices were followed during the crop growth period for raising good crop. The data were recorded on five randomly selected plants from each genotype for plant height (cm), corolla size (mm), number of primary branches per plant, days to maturity, number of capsules per plant, incidence of *Alternaria* blight [0-5 scale: 0 = no disease (free), 1 = 0-10% area of leaves/buds infection (R), 2 = 10-25% area of leaves/buds infection (MR), 3 = 25-50% area of leaves/buds infection (MS), 4 = 50-75% area of leaves/buds infection (S), 5 = above 75% area of leaves/buds infection (HS)], capsule size (at the time of maturity in cm), number of seeds per capsule (from randomly selected capsules), seed size (in mm at the time of maturity), 1000 seed weight (g) and seed yield per plant (g). The mean data for each character was subjected to analysis of variance following the method suggested by Panse and Sukhatme[7]. The percent increase or decrease of F_1 hybrids over the parental value was calculated by using the formula suggested by Fonseca and Patterson[3].

$$\text{Heterosis (\%)} \frac{\text{F1 mean value} - \text{Parental mean value}}{\text{Parental mean value}} \times 100 \; F_1\text{s}$$

mean = Mean value of F_1s hybrid, Parental mean = Mean value of parent.

RESULTS AND DISCUSSION

The analysis of variance (Table 2) revealed that the differences among the parents and their F_1s were highly significant for all the characters under study, indicated that sufficient variability was existed in the present set of material and further genetic analysis would be meaningful. The percentage of

heterosis over mid parent, better parent and standard variety for seed yield, morphological traits and *Alternaria* blight resistance are presented in table 3. The estimates of heterosis showed that none of the crosses were found significantly to be high heterosis (over mid parent, better parent and standard parent) for all the traits under study. Negative and significant values of heterosis are considered to be desirable for days to maturity and incidence of *Alternaria* blight whereas positive and significant values are considered to be desirable for other yield components.

None of the crosses showed significant negative heterosis for plant height and days to maturity over better parent, mid parent and standard variety. For primary branches per plant, the heterosis was ranged from -43.82 (EC 1465 × JRF 4) to 38.09 % (PANJAB FLAX × FRW 1) over mid parent, from -52.15 (GS 234 × POLF 19) to 25.14 % (PANJAB FLAX × FRW 1) over better parent and from -50.00 (EC 1465 × JRF 4) to 33.33 % (EC 541194 × EC 607789) over standard variety. The cross (EC 541194 × EC 607789) showed highly significant and positive heterosis over standard variety. Positive heterosis was also reported by Reddy *et al.*[8], Choudhary *et al*.[2] and Kumar *et al.*[5] for primary branches per plant. The presence of significantly positive heterosis for primary branches per plant in crosses indicates their potential use in developing high yielding genotypes in linseed.

The heterosis over mid parent, better parent and standard variety ranged from -40.39 (EC 607789 × EC 1424) to 46.02 % (EC 541196 × EC 1465), -46.56 (EC 607789 × EC 1424) to 44.47 % (EC 541196 × EC 1465) and -38.03 (EC 607789 × EC 1424) to 41.99 % (FRW 1 × EC 322680), respectively for corolla size. Positive and significant heterosis was observed in nine crosses over mid parent, three crosses over better parent and nine crosses over standard variety. Two best crosses namely (EC 541196 × EC 1465) and (JAWAHAR 1 × EC 322680) showed positive and significant heterosis over all three parents (mid parent, better parent and standard variety) for corolla size.

The range of heterosis for number of capsules per plant was from -77.82 (FRW 1 × EC 322680) to 92.48 % (EC 541194 × EC 607789), -80.23 (FRW 1 × EC 322680) to 40.05 % (EC 607789 × EC 1424) and -78.19 (FRW 1 × EC 322680) to 123.06 % (EC 541194 × EC 607789) over mid parent, better parent and standard variety, respectively. Out of 23 crosses, ten crosses over mid parent, nine crosses over better parent and nine crosses over standard variety showed positive and significant heterosis for this trait. The cross (EC 541194 × EC 607789) exhibited highest significant and desirable heterosis over all three parents (mid parent, better parent and standard variety) for number of capsules per plant. Importance of positive and significant heterosis for this trait was also reported by Choudhary *et al*.[2], Kumar and Poul[4], Kumar *et al*.[5], Reddy *et al.*[8] and Singh *et al.*[9] in linseed crop.

For capsule size, the extent of heterosis over mid parent, better parent and standard variety ranged from -31.51 (EC 541194 × EC 607789) to 33.33 % (FRW 1 × JRF 4), -33.33 (EC 541194 × EC 607789) to 33.33 % (FRW 1 × EC 322680) and -42.86 (EC 541194 × EC 607789) to 14.29 % (FRW 1 × JRF 4), respectively. Two crosses namely (FRW 1 × JRF 4) and (FRW 1 x EC 322680) showed positive and highly significant heterosis over mid parent and better parent for capsule size. Positive and significant heterosis in linseed for capsule size was also reported by Choudhary *et al*.[2] and Singh *et al.*[9] in linseed crop.

The heterosis for number of seeds per capsule ranged from -36.84 (EC 541196 × EC 01465) to 15.95 % (PANJAB FLAX × FRW 1), -40.00 (EC 541196 × EC 1465) to 8.04 % (JAWAHAR 1 × POLF 19) and -27.97 (EC 541196 × EC 1465) to 8.04 % (JAWAHAR 1 × POLF 19) over mid parent, better parent and standard variety, respectively. None of the crosses showed positive and significant heterosis over mid parent, better parent and standard variety. The cross JAWAHAR 1 × POLF 19 exhibited positive but non significant heterosis over all three parent (mid parent,

better parent and standard) for number of seeds per capsule.

For 1000 seed weight, the heterosis over mid parent, better parent and standard variety ranged from -68.11 (EC 541194 x EC 607789) to 44.33 % (FRW 1 × JRF 4), -71.84 (EC 541194 × EC 607789) to 44.09 % (FRW 1 × JRF 4) and -74.61 (EC 541194 × EC 607789) to 72.69 per cent (EC 1465 × JRF-4), respectively. Out of 23 crosses, four crosses over mid parent, two crosses over better parent and one cross over standard variety showed positive and significant heterosis. Positive and significant heterosis for 1000 seed weight were also reported by Choudhary *et al*.[2], Kumar and Poul[4], Kumar *et al*.[5], Reddy *et al.*[8] and Singh *et al.*[9] in linseed.

In the present study, a wide range of variation in the estimates of heterobeltiosis, average heterosis and standard heterosis in positive and negative direction was recorded for seed yield For seed yield per plant, the heterosis over mid parent, better parent and standard variety ranged from-79.40 (EC 541194 × EC 607789) to 67.90 % (GS 234 × EC 322680), -82.28 (EC 541194 × EC 607789) to 35.54 % (GS 234 × EC 322680) and -85.25 (FRW 1 × POLF 19) to 28.89 % (JAWAHAR 1 × EC 322680), respectively. Out of 23 crosses, six crosses over mid parent, two crosses over better parent and one cross over standard variety exhibited positive and significant heterosis for seed yield. The cross (JAWAHAR 1 × EC 322680) exhibited positive and highly significant heterosis over mid parent, better parent and standard variety. Similar findings for exploitation of positive and significant heterosis were also reported by Choudhary *et al*.[2], Kumar and Poul[4], Kumar *et al*.[5], Reddy *et al.*[8] and Singh *et al.*[9] for seed yield in linseed crop.

The extent of heterosis over mid parent, better parent and standard variety ranged from-56.92 (EC 541194 × EC 607789) to 138.55 % (EC 541194 × EC 1424), -40.98 (EC 541194 × EC 607789) to 355.79 % (FRW 1 × JRF 4) and -58.37 (GS 234 × POLF 19) to 103.34 % (FRW 1 × EC 322680), respectively. Out of 23 crosses, three crosses over mid parent, one cross over better parent and five crosses over standard variety showed significant and negative heterosis. The cross (EC 541194 × EC 607789) showed highest negative but non-significant heterosis over mid parent, better parent and standard variety for incidence of *Alternaria* blight.

Table 1: Salient feature of parents of linseed

Variety	Pedigree	Source of origin	Salient features
H 36	–	–	Yield components
JRF 4	–	–	Flax type, resistant to Alternaria blight
POLF 19	–	Polland	Resistant to Alternaria blight & wilt
PANJAB FLAX	–	–	Flax type
EC 322680	Exotic material	–	Earliness
EC 541194	Linum angustifolium (wild spp.)	Russia	Small seeded, multiple resistance
EC 607789	Exotic material	Cambridge UK	Spring type
EC 1465	Exotic material	–	Earliness
JAWAHAR 1	Selection from KP-29	Raipur	Yield Components
GS 234	–	–	Resistant to budfly
EC 1424	Exotic material	–	Resistant to budfly
FRW 1	–	–	Susceptible to wilt
EC 541196	Linum bienne (wild spp.)	Russia	Small seeded, multiple resistance

Table 2: Analysis of variance for seed yield and other morphological traits in linseed (*Linum usitatissimum* L.)

Source of Variation	D. F.	Corolla size	Plant height	Primary branches/plant	Days to maturity	Capsules /plant	Incidence of *Alternaria* blight	Capsule size	Seeds per capsule	1000-seed weight	Seed yield
Replication	2	1.119	260.875	1.398	28.875	212.875	33.093	0.453	0.676	4.186	1.073
Treatment	35	34.078**	782.752**	21.598**	31.573**	4123.378**	880.491**	2.091**	2.544**	9.182**	22.982**
Error	70	3.634	24.701	0.760	1.270	46.889	11.036	0.806	0.894	0.130	0.238

*,** Significant at 5% and 1% probability level respectively

Table 3: Estimation of heterosis over mid parent, better parent and standard variety for seed yield and other morphological traits in linseed (*Linum usitatissimum* L.)

F1- Cross Combination	Corolla size			Plant height			Primary branches/plant			Days to maturity			Capsules/plant		
	MP	BP	SV	MP	BP	SV	MP	BP	SV	MP	BP	SV	MP	BP	SV
JAWAHAR 1 X POLF 19	–3.53	–14.06	9.96	2.07	–13.42	24.30**	–20.00	–33.33	–33.33	–1.11	–0.88	–1.33	15.25**	11.84*	11.84*
JAWAHAR 1 X JRF 4	24.96*	00.00	00.00	9.72*	–13.49	49.99**	–33.33	–33.33	–33.33	0.62	3.00**	–1.33	–39.77	–45.49	–45.49
JAWAHAR 1 X EC 322680	30.54**	27.95**	27.95**	15.31**	2.87	31.18**	2.76	00.00	5.50	1.24*	3.71**	–1.10	25.08**	16.51**	16.51**
GS 234 X POLF 19	8.26	–7.78	17.99	–1.00	–-21.40	12.84*	–37.16	–52.15	–38.83	2.09**	3.11**	2.65**	29.27**	22.56**	28.66**
GS 234 x JRF 4	4.00	–13.33	–22.02	4.97	–21.96	35.31**	–31.73	–39.11	–22.17	4.04**	7.16**	2.65**	55.10**	37.39**	44.23**
GS 234 x EC 322680	14.00	10.44	5.99	9.07	–9.36	15.59**	–4.72	–13.04	11.17	4.49**	7.89**	2.87**	5.54	–3.85	0.93
EC 1465 x POLF 19	–22.22	–34.36	–16.01	7.27	–7.67	32.56**	–30.88	-35.76	–50.00	2.88**	3.11**	2.65**	25.49**	25.49**	18.07**
EC 1465 x JRF 4	14.92	4.49	–8.04	–5.93	–24.87	30.27**	–43.82	–50.00	–50.00	4.86**	7.16**	2.65**	3.20	–3.97	–9.65
EC 1465 x EC 322680	26.01*	20.81*	15.96	7.98	–2.16	24.77**	–21.27	–31.59	–27.83	5.32**	7.89**	2.87**	–16.40	–19.87	–24.61
PANJAB FLAX X FRW 1	7.95	4.61	35.99**	8.34	–10.12	34.40**	38.09*	25.14	11.17	–0.45	-2.55	–1.77	5.18	0.28	10.59*
PANJAB FLAX X GS 234	13.19	–1.62	19.98*	13.73**	–11.04	33.03**	–7.69	–21.77	00.00	0.34	2.54**	–1.77	–34.05	–35.61	–32.40
PANJAB FLAX X EC 1465	21.89*	4.92	27.95**	–5.05	–19.64	20.17**	13.40	6.38	–5.50	2.37**	4.62**	0.22	–1.77	-4.67	–4.67
H 36 x POLF 19	8.35	1.59	29.99**	–24.74	–29.09	15.14**	26.00	13.40	–5.50	1.46*	2.97**	–0.44	18.46**	12.58*	5.92
EC 607789 x EC 1424	–40.39	–46.56	–38.03	87.93**	83.52**	43.11**	5.50	–5.09	5.50	1.69**	3.93**	–0.44	65.95**	40.05**	42.68**
EC 607789 x EC 1465	15.71	1.76	17.99	20.25**	5.39	9.16	23.45	4.95	16.67	1.69**	3.93**	–0.44	3.97	–9.28	–14.64
EC 541194 x EC 607789	–27.57	–27.57	–16.01	17.12**	–5.10	19.27**	16.96	14.29	33.33**	3.93**	3.93**	–0.44	92.48**	37.96**	123.06**
FRW 1 x POLF 19	–5.44	–6.18	21.96*	2.29	–13.24	23.85**	00.00	–16.67	–16.67	–0.99	00.00	–0.44	7.62	–0.28	9.97
FRW 1 x JRF 4	22.03*	–10.79	15.96	5.24	–17.46	43.11**	–11.17	–11.17	–11.17	0.89	3.93**	–0.44	–9.78	–21.75	–13.71
FRW 1 x EC 322680	25.64**	9.23	41.99**	6.31	–5.76	20.17**	–13.47	–15.79	–11.17	0.89	4.18**	–0.66	–77.82	–80.23	–78.19
EC 541194 x EC 1465	3.94	–8.59	5.99	–0.76	–9.48	13.76**	2.74	–14.29	00.00	1.69**	3.93**	–0.44	–42.76	–54.72	–26.79
EC 541196 x EC 1465	46.02**	44.47**	29.99**	18.08**	5.85	9.63	–16.32	–37.95	00.00	–0.99	-0.44	–0.44	18.27**	–13.25	–18.28
EC 541194 x EC 1424	23.08*	10.35	27.95**	19.72**	–4.74	19.72**	–18.96	–28.57	–16.67	0.56	3.24**	–1.10	–47.04	–56.84	–30.21
EC 541196 x EC 1424	20.83*	19.57	9.96	38.41**	31.84**	8.26	2.27	–24.19	22.17	–2.08	–1.97	–1.10	55.55**	11.31*	13.39*

*,** Significant at 5% and 1% probability level respectively

Table 4: Estimation of heterosis over mid parent, better parent and standard variety for seed yield and other morphological traits in linseed (*Linum usitatissimum* L.)

Cross Combination	Incidence of *Alternaria* blight			Capsule size			Seeds per capsule			1000 seed weight			Seed yield		
	MP	BP	SV	MP	BP	SV	MP	BP	SV	MP	BP	SV	MP	BP	SV
JAWAHAR 1 X POLF 19	22.99**	24.76**	21.31**	7.69	00.00	00.00	12.50	8.04	8.04	–14.78	–25.29	–25.29	16.28**	1.73	1.73
JAWAHAR 1 X JRF 4	92.89**	333.33**	24.05**	7.69	00.00	00.00	–5.88	–7.73	–3.96	–6.91	–23.93	–23.93	18.08**	–2.34	–2.34
JAWAHAR 1 X EC 322680	57.26**	74.32**	43.28**	2.62	–4.71	–4.71	–14.32	–15.97	–15.97	–21.02	–26.96	–26.96	64.12**	28.89**	28.89**
GS 234 X POLF 19	–37.69	14.42	–58.37	16.67	16.67	00.00	00.00	–3.96	–3.96	–36.91	–40.83	–49.11	40.19	2.71	–22.99
GS 234 x JRF 4	–22.93	–12.49	–74.95	00.00	00.00	–14.29	–29.41	–30.79	–27.97	–41.39	–49.09	–56.21	13.79	–12.76	–42.93
GS 234 x EC 322680	–1.57	60.43**	–41.62	11.17	11.17	–4.71	–2.08	–3.96	–3.96	–12.84	–13.37	–25.49	67.92**	35.54**	–22.78
EC 1465 x POLF 19	51.49**	61.96**	38.38**	00.00	00.00	–14.29	–16.06	–22.22	–15.97	1.17	–3.89	–27.69	–17.00	–17.23	–37.95
EC 1465 x JRF 4	120.96**	340.30**	26.05**	5.50	5.50	9.57	–28.39	–29.27	–24.00	–4.31	–7.27	72.69**	–20.93	–25.78	–44.66
EC 1465 x EC 322680	28.50**	31.05**	7.70	16.67	16.67	00.00	–5.88	–11.11	–3.96	2.88	–7.63	–21.53	–20.56	–29.87	–47.71
PANJAB FLAX X FRW 1	–14.38	–2.67	–17.29	2.62	–4.71	–4.71	15.95	7.45	16.08	–14.03	–25.33	–35.32	–49.79	–61.32	–75.48
PANJAB FLAX X GS 234	101.06**	299.29**	45.28**	12.77	4.71	4.71	00.00	–3.96	–3.96	6.17	5.79	–8.36	13.25	–12.19	–44.35
PANJAB FLAX X EC 1465	21.64**	37.79**	17.74**	–7.69	–14.29	–14.29	–4.08	–11.11	–3.96	–25.34	–33.53	–42.42	0.74	–6.82	–30.52
H 36 x POLF 19	31.41**	50.26	46.11**	2.76	00.00	9.57	–4.08	–11.11	–3.96	–25.93	–30.56	–47.75	–47.65	–52.78	–55.95
EC 607789 x EC 1424	24.73**	120.99**	9.96	–2.74	–10.04	–14.29	–2.08	–11.11	–3.96	–21.99	–27.38	–41.79	–75.07	–76.09	–73.25
EC 607789 x EC 1465	24.75**	54.76**	32.23**	2.74	00.00	–14.29	–14.32	–22.22	–15.97	–26.45	–27.12	–49.74	–48.97	–55.94	–54.73
EC 541194 x EC 607789	–56.92	–40.98	–57.06	–31.51	–33.33	–42.86	4.30	00.00	–3.96	–68.11	–71.84	–74.61	–79.40	–82.28	–81.79
FRW 1 x POLF 19	40.80**	50.91**	28.35**	11.17	11.17	–4.71	–8.03	–14.78	–7.93	8.72*	0.42	–24.45	–72.99	–80.33	–85.25
FRW 1 x JRF 4	129.58**	355.79**	30.49**	33.33**	33.33**	14.29	–9.50	–11.11	–3.96	44.33**	44.09**	–8.15	38.78**	5.75	–30.82
FRW 1 x EC 322680	143.21**	147.40**	103.34**	33.33**	33.33**	14.29	–5.88	–11.11	–3.96	35.67**	18.82**	0.94	–3.56	–22.68	–55.95
EC 541194 x EC 1465	35.39**	47.24**	7.10	–16.67	–16.67	–28.57	–17.65	–22.22	–15.97	–34.83	–42.98	–48.59	–52.12	–52.25	–64.39
EC 541196 x EC 1465	15.78*	43.13**	22.29**	26.60	5.50	–9.57	–36.84	–40.00	–27.97	18.72**	–16.69	–43.68	–57.72	–67.12	–75.48
EC 541194 x EC 1424	138.55**	193.65**	46.11**	–5.36	–10.04	–14.29	–17.65	–22.22	–15.97	–35.58	–39.17	–45.14	–48.79	–57.45	–52.39
EC 541196 x EC 1424	41.79**	150.16**	24.47**	12.35	–10.04	–14.29	–26.32	–30.00	–15.97	–20.82	–46.94	–57.47	–52.65	–67.55	–63.68

*,** Significant at 5% and 1% probability level respectively

Table 5: Mean performance of parents and F_1s for seed yield and other morphological traits in linseed (*Linum usitatissimum* L.)

Parents	Corolla size	Plant height	Primary branches/plant	Days to maturity	Capsules/ plant	Incidence of *Alternaria* blight	Capsule size	Seeds/ capsule	1000-seed weight	Seed yield
H 36	18.67	118.00	5.00	145.67	90.67	53.90	6.33	9.00	6.30	9.17
JRF 4	10.00	126.00	6.00	144.33	86.67	12.33	6.00	8.67	6.07	6.43
POLF 19	21.33	104.33	4.00	150.00	100.67	41.88	6.00	7.67	7.20	7.37
PANJAB FLAX	20.33	108.67	5.33	144.33	107.00	46.57	7.00	7.67	8.29	6.23
EC 322680	16.00	92.67	6.33	143.67	92.33	35.40	6.00	8.00	8.13	5.60
EC 541194	19.33	91.33	19.33	144.33	173.00	31.33	6.00	8.00	8.63	7.28
EC 607789	19.33	56.67	6.67	144.33	75.00	54.50	5.67	7.33	6.60	10.10
EC 1465	14.67	75.27	4.67	150.67	100.67	36.80	6.00	9.00	6.47	7.33
JAWAHAR 1	16.67	72.67	6.00	150.67	107.00	43.07	7.00	8.33	9.57	9.83
EC 1424	15.33	54.00	5.33	152.00	109.00	21.43	6.67	9.00	7.67	11.00
FRW 1	21.67	71.63	4.33	153.00	118.00	36.63	6.00	9.00	6.10	3.37
EC 541196	15.00	59.67	9.67	152.33	47.00	54.18	4.00	10.00	2.60	4.07
F1S										
JAWAHAR 1 X POLF 19	18.33	90.33	4.00	148.67	119.67	52.25	7.00	9.00	7.15	10.00
JAWAHAR 1 X JRF 4	16.67	109.00	4.00	148.67	58.33	53.43	7.00	8.00	7.28	9.60
JAWAHAR 1 X EC 322680	21.33	95.33	6.33	149.00	124.67	61.71	6.67	7.00	6.99	12.67
GS 234 X POLF 19	19.67	82.00	3.67	154.67	137.67	17.93	7.00	8.00	4.87	7.57
GS 234 x JRF 4	13.00	98.33	4.67	154.67	154.33	10.79	6.00	6.00	4.19	5.61
GS 234 x EC 322680	17.67	84.00	6.67	155.00	108.00	25.14	6.67	8.00	7.13	7.59
EC 1465 x POLF 19	14.00	96.33	3.00	154.67	126.33	59.60	6.00	7.00	6.92	6.10
EC 1465 x JRF 4	15.33	94.67	3.00	154.67	96.67	54.29	6.33	6.33	6.00	5.44
EC 1465 x EC 322680	19.33	90.67	4.33	155.00	80.67	46.39	7.00	8.00	7.51	5.14
PANJAB FLAX X FRW 1	22.67	97.67	6.67	148.00	118.33	35.62	6.67	9.67	6.19	2.41
PANJAB FLAX X GS 234	20.00	96.67	6.00	148.00	72.33	62.57	7.33	8.00	8.77	5.47
PANJAB FLAX X EC 1465	21.33	87.33	5.67	151.00	102.00	50.71	6.00	8.00	5.51	6.83
H 36 x POLF 19	21.67	83.67	5.67	150.00	113.33	62.93	6.33	8.00	5.00	4.33
EC 607789 x EC 1424	10.33	104.00	6.33	150.00	152.67	47.36	6.00	8.00	5.57	2.63
EC 607789 x EC 1465	19.67	79.33	7.00	150.00	91.33	56.95	6.00	7.00	4.81	4.45
EC 541194 x EC 607789	14.00	86.67	8.00	150.00	238.67	18.49	4.00	8.00	2.43	1.79
FRW 1 x POLF 19	20.33	90.00	5.00	150.00	117.67	55.28	6.67	7.67	7.23	1.45
FRW 1 x JRF 4	19.33	104.00	5.33	150.00	92.33	56.20	8.00	8.00	8.79	6.80
FRW 1 x EC 322680	23.67	87.33	5.33	149.67	23.33	87.58	8.00	8.00	9.66	4.33
EC 541194 x EC 1465	17.67	82.67	6.00	150.00	78.33	46.13	5.00	7.00	4.92	3.50
EC 541196 x EC 1465	21.67	79.67	6.00	150.00	87.33	52.67	6.33	6.00	5.39	2.41
EC 541194 x EC 1424	21.33	87.00	5.00	149.00	74.67	62.93	6.00	7.00	5.25	4.68
EC 541196 x EC 1424	18.33	78.67	7.33	149.00	121.33	53.61	6.00	7.00	4.07	3.57

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