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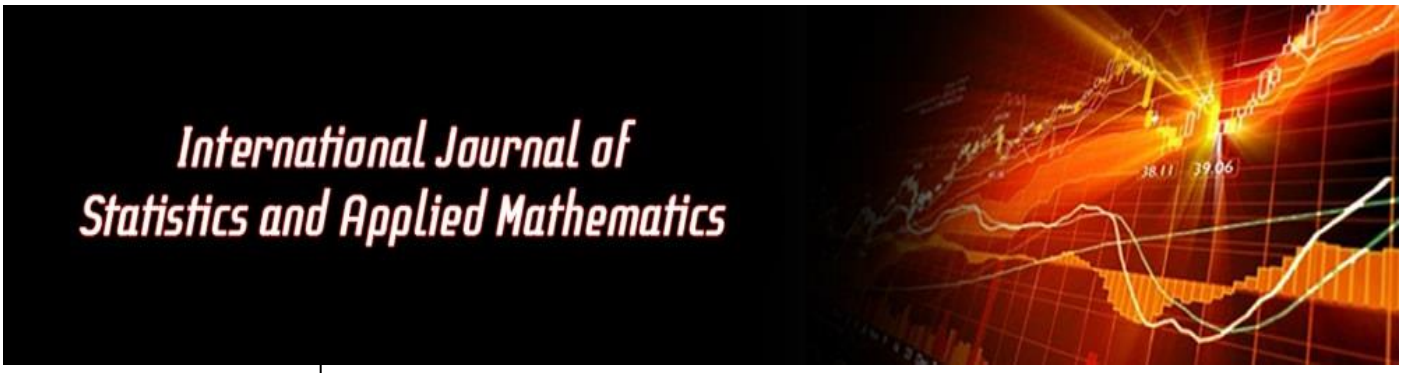

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Pramod Kumar Prajapati
Lab Technician, College of Agriculture, Tikamgarh JNKVV, Jabalpur, Madhya Pradesh, India

Shiv Ratan
AICRP on Oilseed, College of Agriculture, Tikamgarh JNKVV, Jabalpur, Madhya Pradesh, India

Devendra K Payasi
Regional Agricultural Research Station, Sagar, Madhya Pradesh, India

Yogendra Singh
College of Agriculture, JNKVV, Jabalpur, Madhya Pradesh, India

Rakesh Kumar
Ph.D. Research Scholar, Department of Genetics and Plant Breeding, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh, India

Kundan Muwel
Programme Assistant, KVK Umaria, Madhya Pradesh, India

Corresponding Author:
Pramod Kumar Prajapati
Lab Technician, College of Agriculture, Tikamgarh JNKVV, Jabalpur, Madhya Pradesh, India

Status of genetic variability and characters association performance with promising donors in linseed (*Linum usitatissimum* L.) genotypes

Pramod Kumar Prajapati, Shiv Ratan, Devendra K Payasi, Yogendra Singh, Rakesh Kumar and Kundan Muwel

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Abstract
Twelve cultivars are studied in the AICRP on oilseeds experiment field in the college of agriculture Tikamgarh in purpose to get scientific data for the nature and scale of genetic variability and correlation with identified promising donor for crossing programme. three replications of the experiment were done using an RBD design and the data were collected up to the beginning of flowering for days., days to 50 % flowering, plant stand per hectare, plant height, primary branches per plant, capsules per plant, number of seeds per capsule, biological yield per plant, days to maturity,1000 seed weight, yield per plant, yield per ha., protein content (%),oil content (%).The mean per se performance for yield attributing and quality traits of twelve linseed genotypes including state check has been studied with Genotype JLS-67 was found earliest and highest seed yield per hectare also with highest seed yield per plant was recorded among all the genotypes and genotype JLS-9 exhibited the maximum primary branches and maximum seed per capsule per plant which was found at par with state check and the maximum number of capsules per plant was observed in genotype JLS-79. Highest biological yield per plant was observed in genotype JLS-27. Same as the maximum test weight was recorded in genotype JLS-93 and in genotype Kartika analyzed highest for protein and oil content. In correlation studies Seed yield per plant showed highest positive correlation with 1000 seed weight. Identification of Promising donors for various agro-morphological traits in above twelve genotypes found that the genotypes JLS-67 and JLS-93 are the best for the earliness, the genotypes JLS-79 and JLS-66 for capsules per plant and the genotypes JLS-93, JLS-9, Kiran, JLS -67 for seeds per capsule, genotype JLS-93 for 1000 seed weight (g) and the genotypes for seed yield per hectare (kg) JLS-67, JLS 66. The genotype JLS recorded highest yield per plant (g) and genotypes Kartika, Kiran, JLS-93, JLS-79, Sharda and JLS-27 for Protein content in percent. Kartika, JLS-121, JLS-9, Sharda, JLS -67 identified as promising donors for future hybridization program towards development of nutri-rich high yielding varieties.

Keywords: Genetic variability, promising donors, earliness, yield, hybridization

Introduction
Flax or linseed (*Linum usitatissimum* L., 2n=30, X=15) is a member of the family Linaceae and the order Malpighiales (Sultana,1992) [15]. In terms of cultivation area and seed output, it is the second major *rabi* oilseed crop after mustard. Linseed plants have several various utilities, it is cultivated commercially for its seed, which is processed into oil and after extraction of oil, a high protein stock feed is left (Sankari, 2000; Kurt and Bozkurt, 2006) [14, 9] and its oil contains high level of alpha linolenic acid and omega-3 and omega-6 fatty acid (Hiltunen and Holm, 2000) [7]. Linseed oil is used in a wide variety of applications, including additives in PVC plastics, anti-rust agents, lacquers and paints (Kanta-Oksa 1992, Chimielarz *et al*. 1995 and Rusch gen Klaas 1999) [8, 4, 12]. Linseed holds a significant position on the global market as a result of its many commercial uses and it is a precious crop, and each component of the plant has a unique economic value. India produced 120.7 thousand tons linseed from 179.9 thousand ha. area in 2019-2020 with average productivity 671 kg/ha. While Madhya Pradesh harnessed 45 thousands ton from 5 thousand ha. area with average productivity 867 kg/ha. in 2019-2020.

(Anonymous, Ministry of Agriculture and Farmer Welfare, 2019) [3]. The most important requirement for any breeding programme is variability. The level of genetic variability between genotypes in the segregating population determines the extent of genetic variability and improves the potential for selection. Therefore, assessing variability is crucial for traits that are significant economically. Correlations are crucial because they show the level of reliance between two or more characters. If there is genetic overlap across features, direct selection of one trait may result in changes to other traits. Identification of trait-specific superior accessions can be obtained by phenotypic and phenological evaluation of a crop species based on standard descriptors (Diederichsen and Richards, 2003) [6]. Yield levels need is to either develop high-yielding varieties or alter genetic architecture. Improvement in any crop depends on the availability of a wide range of genetic variation. Under present investigation, potential donors were identified having superiority over either state check of mean which ever was higher for each agro-morphological trait.

Materials and Methods

During the *rabi* crop season 2020-21, an experiment conducting in RBD design with 12 linseed genotypes with state check JLS-66 was carried out in the AICRP Experimental Field on Oilseeds at the college of agriculture in Tikamgarh, Madhya Pradesh. Experiment was conducted in November 2021 with 3×3m plot size and row to row and plant to plant distance was maintained 30 cm and 10 cm, respectively. The recommended agronomic practices were followed to raise healthy crop. The observations were recorded on five randomly selected plants from each genotype in each replication on fourteen agro-morphological characters *viz*; days to flowering initiation, days to 50 % flowering, plant stand per hectare, plant height, primary branches per plant, capsules per plant, number of seeds per capsule, biological yield per plant, days to maturity,1000 seed weight, yield per plant, yield per ha., protein content (%), oil content (%).The treatment means for all the characters were subjected to computed and compared with state check (JLS-66). The correlation coefficient is a measure of the degree of association between two traits worked out at the same time. The correlations are important from the point of view of quantitative inheritance of characters and are of practical value for changing two or more traits simultaneously by selection. It resolves the complex relationships between events into simple forms of association. Genotypic correlation coefficient and phenotypic correlation coefficient were estimated by Al-jibouri *et al.* (1958) [17] Statistical software INDOSTAT was used for analysis of data.

Results and Discussion

Genetic Variability: The means were recorded for fourteen yield and quality traits on twelve linseed genotypes (Table 1). Result of means showed that all the characters *viz*., days to flower initiation, days to 50% flowering, plant stand, number of primary branches/plant, number of capsules/plant, number of seeds/capsule, biological yield per plant, days to maturity, 1000 seed weight, seed yield per plant, plant height, yield per hectare, protein content in per cent and oil content in per cent was recorded. This indicates that sufficient variability is present in most of the important characters among different genotypes. Days to flower initiation ranged from 41 to 61 days among the genotypes with an average of 53 days. Genotype JLS-67 was found earliest (41 days) among all the genotypes while genotype JLS-79 took maximum days (61days) for flowering initiation. Days to 50 per cent flowering varied from 50 to 68 DAS with an average of 60 DAS in all the genotypes observed. Genotype JLS-93 and JLS -67 both took the minimum days (50 DAS) and proved their statistical earliness over rests while the maximum days (68 days) was taken by genotype JLS-79 among all entries tested to flower 50 per cent. In all the entries tested, sufficient plant population was recorded at physiological maturity. Plant Stand per hectare ranged from 340 to 424 thousand while mean of all treatments was 390 thousand. Genotype JLS-67 has the maximum 424 thousand plants per hectare Whereas, genotype Kartika (340000) had minimum numbers of plants per hectare. Plant height varied from 51 to 77 cm with an average value of plant height across all the genotypes was 65 cm. The genotype Sharda (51 cm) had shortest stature whereas, genotype JLS-27 (77 cm) was tallest among all the twelve genotypes. Number of primary branches reflected moderately narrow range of variability among the genotypes tested. Number of primary branches per plant ranged from 2.72 to 2.98 with an average value of 2.88. Among all the genotypes genotype JLS-9 exhibited the maximum 2.98 primary branches per plant whereas, JLS-27 (2.72) possessed minimum number of primary branches. Capsules per plant had a sizeable amount of variability among the genotypes under present investigation. Range for number of capsules per plant was started from 51.2 to touch the peak at 68.4 with the mean of 58.8 capsules. The maximum number of capsules per plant was observed in genotype JLS-79 (68.4) whereas; the minimum number was recorded for JLS-9 (54.0). Number of seeds per capsule varied from 8.2 to 8.8 with mean of all genotypes was recorded as 8.5. The maximum and at par seeds per capsule were observed in genotype JLS-9 (8.8), Kiran (8.8), JLS-93 (8.8) Whereas, the minimum (8.2) seeds per capsule was noted in genotype JLS-122. Biological yield per plant varied from 13.4 g to 20.2 g with 17.1g average weight. The maximum biological yield per plant was observed in genotype JLS-27 (20.2 g) while genotype Sharda (13.4 g) had the minimum biological yield per plant. Days to maturity ranged from 109.3 to 118.7 DAS with an average of 114.7 DAS. Minimum number of days taken by Genotype JLS-67 (109.3 DAS) while genotype JLS-79 attained maturity at 118.6 DAS which are highest among all fourteen genotype. 1000-seed weight ranged from 5.1 g to 8.5 g with an average of 7.2 g. Among the genotypes studied, the maximum test weight was recorded in genotype JLS-93 (8.5 g) and lowest seed weight observed in genotype Kiran (5.1g) among all. The entries under study. Seed yield per hectare ranged from 1174.0 kg to 1759 kg with an average of 1621.3 kg per hectare. The highest seed yield was recorded in genotypes JLS-67 (1759 kg). While genotypes *viz*., JLS-121 (1174 Kg) could produced lowest seed yield per hectare among all the genotypes. Seed yield per plant ranged from 2.5 to 4.2 g with a mean of 3.3 g per plant. The maximum seed yield per plant was recorded in genotype JLS-67 (4.2 g) while the minimum was recorded in genotype JLS-27 (2.5). Protein content was varied from 21.3 to 25.7 per cent with a mean of 23.5 per cent showed comparatively narrow range of variability. Genotype Kartika (25.7 %) possessed the significantly higher protein content whereas, genotype JLS-66 (21.3 %) had the lowest protein content. Genotypes reflected moderately low magnitude of variability for oil content. Although, oil content was ranged from 35.5 to 40.4 per cent with a mean of all genotypes was 38.0 per cent. The genotypes namely, Kartika

(40.4 %) While the minimum oil content was exhibited by Kiran (35.5 %) in above twelve genotypes.

Correlation

In study of correlation (Table 2), seed yield per plant exerted positive phenotypic and genotypic correlation with 1000 seed weight (0.605, 0.554) followed by plant stand (0.159, 0.151), seeds per capsule (0.122, 0.104), oil content in per cent(0.096, 0.109), primary branches per plant (0.074, 0.087), capsules per plant (0.025, 0.044), while exhibited negative phenotypic and genotypic correlation with days to flower initiation(-0.719, -0.681), days to 50% flowering (-0.706 -0.662), days to maturity(-0.693, -0.579), biological yield per plant (-0.677,-0.637) plant height (-0.660, -0.624), protein content in per cent(-0.360, -0.360) and yield per hectare(-0.01, -0.360). The results reported by Yadav (2001) [16] agreement with seed yield per plant was positively correlated with number of capsules per plant, number of seeds per capsule, 1000 seed weight at both phenotypic and genotypic levels. Further, similar study also reported by Akbar *et al*. (2001) [1]. Similarly, seed yield of linseed had significant positive correlation for primary branches per plant, capsules per plant (Reddy *et al*. 2013) [11] and (Ranjana *et al*. 2018) [10] and 1000 seed weight (Ranjana *et al*. 2018) [10] at phenotypic and genotypic Level. Further, results cited by Sahu *et al*. (2016) [13] for number of capsules per plant, Choudhary *et al*. (2017) [5] for plant stand, number of capsules per plant, test weight and Ankit *et al*. (2019) [2] for 1000 seed weight had strong positive association ship with seed yield were similar with results of current study at both genotypic and phenotypic levels (Table.2).

Promising donors: During experimental studies Genotypes JLS-67 and JLS-93 are indentified for earliness and genotypes JLS-27,Kartika,Kiran, JLS-79,JLS-9 were indentified for tallness whereas genotypes JLS-9 indentified highest Primary branch per plant and genotypes JLS-79 and JLS-66 indentified highest Capsules per plant, further JLS-93, JLS-9, Kiran, JLS -67 genotypes indentified highest Seeds per capsule and genotypes JLS-27, Kartika, Kiran, JLS-79, JLS-9 were indentified for highest Biological yield per plant and lowest days taken for maturity in genotypes JLS-67, JLS-93, JLS-9 and JLS-93 genotypes identified for highest 1000 seed weight and genotypes JLS-67, JLS 66 identified for Yield per hectare (kg) and JLS-67 genotypes identified for highest Yield per plant (g) and genotypes Kartika, Kiran, JLS-93, JLS-79, Sharda, JLS-27 identified for highest Protein content in percent. The genotypes Kartika, JLS-121, JLS-9, Sharda, JLS -67, identified highest Oil content in percent in above 12 genotypes (Table.3).

Table 1: List of genotypes used in the study

S. No.	Genotypes	Pedigree	Source
1	JLS-122		AICRP on Linseed, Regional Agricultural Research Station Sagar, M.P.
2	JLS-73		AICRP on Linseed, Regional Agricultural Research Station Sagar, M.P.
3	Kartika		AICRP on Linseed, Regional Agricultural Research Station Sagar, M.P.
4	JLS-27		AICRP on Linseed, Regional Agricultural Research Station Sagar, M.P.
5	JLS-9		AICRP on Linseed, Regional Agricultural Research Station Sagar, M.P.
6	Kiran		AICRP on Linseed, Regional Agricultural Research Station Sagar, M.P.
7	JLS-79		AICRP on Linseed, Regional Agricultural Research Station Sagar, M.P.
8	JLS-93		AICRP on Linseed, Regional Agricultural Research Station Sagar, M.P.
9	Sharda		AICRP on Linseed, Regional Agricultural Research Station Sagar, M.P.
10	JLS-121		AICRP on Linseed, Regional Agricultural Research Station Sagar, M.P.
11	JLS-67		AICRP on Linseed, Regional Agricultural Research Station Sagar, M.P.
12	JLS-66 (State check)		AICRP on Linseed, Regional Agricultural Research Station Sagar, M.P.

Table 2: Mean per se performance of linseed genotypes

Sr. No.	Genotype	Days to flowering initiation	Days to 50% flowering	Plant Stand (000)/ha	Plant height (cm)	Primary Branches / plant	Capsules /plant	Seeds/ Capsule	Biological Yield (g)	Days to maturity	1000 seed weight (g)	Yield / ha (kg)	Yield/ plant (g)	Protein content (%)	Oil Content (%)
1	JLS-122	55	61	368	65	2.87	61.0	8.20	17.1	115.0	7.6	1611	3.40	22.7	38.4
2	JLS-73	56	62	415	63	2.86	63.0	8.27	17.0	116.0	6.8	1757	2.90	22.8	36.8
3	Kartika	55	62	340	73	2.91	57.6	8.40	19.1	116.3	5.6	1649	2.90	25.7	40.4
4	JLS-27	53	59	376	77	2.72	53.0	8.40	20.2	114.3	7.7	1574	2.50	23.7	37.0
5	JLS-9	53	59	404	71	2.98	54.0	8.80	18.5	113.0	8.1	1648	3.20	21.4	39.5
6	Kiran	59	66	413	73	2.90	60.0	8.80	19.0	118.0	5.1	1756	2.80	25.4	35.5
7	JLS-79	61	68	401	73	2.92	68.4	8.48	19.0	118.6	5.4	1729	3.10	24.6	36.6
8	JLS-93	42	50	385	57	2.95	51.2	8.80	15.0	111.0	8.5	1522	3.80	24.7	36.7
9	Sharda	54	60	402	51	2.92	62.6	8.33	13.4	114.3	7.2	1537	3.40	23.8	39.4
10	JLS-121	55	61	370	57	2.94	52.6	8.33	15.0	115.6	7.5	1174	3.40	22.4	40.0
11	JLS-67	41	50	424	64	2.78	58.6	8.70	16.7	109.3	8.2	1759	4.22	23.3	38.6
12	JLS-66 (State check)	53	58	378	59	2.87	63.9	8.28	15.3	115.0	7.9	1740	4.00	21.3	36.3
Mean		53	60	390	65	2.88	58.8	8.5	17.1	114.7	7.20	1621.3	3.30	23.5	38.0
C.V		2.04	1.79	1.99	2.27	2.51	5.71	0.54	3.15	0.90	4.87	4.20	3.83	0.26	1.96
S.E+		0.62	0.61	4.49	0.85	0.04	1.94	0.02	0.31	0.60	0.20	39.33	0.07	0.03	0.42
C.D. at 5 %		1.83	1.81	13.18	2.51	0.12	5.69	0.07	0.91	1.76	0.59	115.37	0.21	0.10	1.25
Range		41-61	50-68	340- 424	51-77	2.7-2.9	51.2-68.4	8.2-8.8	13.4-20.2	109.3-118.7	5.1-8.5	1174-1759.3	2.50-4.20	21.3-25.7	35.5-40.4

Table 3: Genotypic and phenotypic correlation coefficients with seed yield and its contributing characters in linseed genotypes

Sr. No.	Characters	r	Days to flowering initiation	Days to 50 % Flowering	Plant Stand (Numbers)	Plant height (cm)	Primary Branches/ Plant	Capsules/ Plant	Seeds/ Capsule	Biological yield (g)	Days to maturity	1000Seed weight (g)	Yield/ ha(kg)	Protein Content (%)	Oil content (%)	Seed yield /plant (g)
1	Days to flowering initiation	r_g	1.000	0.991	-0.134	0.378	0.184	0.537	-0.412	0.384	0.985	-0.768	0.048	0.103	-0.126	-0.719
		r_p	1.000	0.976**	-0.148	0.370*	0.186	0.430**	-0.408*	0.376*	0.889**	-0.705**	0.069	0.103	-0.091	-0.681
2	Days to 50 % flowering	r_g		1.000	-0.086	0.413	0.210	0.587	-0.347	0.414	1.006	-0.844	0.084	0.212	-0.153	-0.706
		r_p		1.000	-0.099	0.386*	0.208	0.458**	-0.340*	0.410	0.904**	-0.786**	0.111	0.206	-0.126	-0.662
3	Plant Stand (Numbers)	r_g			1.000	-0.086	-0.092	0.340	0.466	-0.073	-0.222	0.016	0.454	-0.126	-0.394	0.159
		r_p			1.000	-0.088	-0.092	0.190	0.443**	- 0.097	-0.186	0.036	0.389*	-0.120	-0.378*	0.151
4	Plant height (cm)	r_g				1.000	-0.363	-0.032	0.244	1.009	0.368	-0.495	0.427	0.317	-0.216	-0.660
		r_p				1.000	-0.237	-0.011	0.237	0.974**	0.323	-0.455**	0.368*	0.312	-0.159	-0.624
5	Primary Branches / plant	r_g					1.000	0.091	0.318	-0.391	0.220	-0.180	-0.414	-0.011	0.286	0.074
		r_p					1.000	-0.161	0.122	-0.207	0.207	-0.102	-0.160	-0.000	0.218	0.087
6	Capsules/ plant	r_g						1.000	-0.424	-0.021	0.580	-0.542	0.666	0.025	-0.386	0.025
		r_p						1.000	-0.344	0.005	0.408	- 0.462**	0.452**	0.018	-0.234	0.044
7	Seeds/ Capsule	r_g							1.000	0.219	-0.388	0.042	0.209	0.258	-0.176	0.122
		r_p							1.000	0.211	-0.378	0.040	0.177	0.251	-0.167	0.104
8	Biological yield (g)	r_g								1.000	0.384	-0.490	0.427	0.320	-0.224	-0.677
		r_p								1.000	0.318	-0.468**	0.385*	0.307	-0.167	-0.637
9	Days to maturity	r_g									1.000	-0.867	0.076	0.274	-0.273	-0.693
		r_p									1.000	-0.786**	0.051	0.254	-0.188	-0.579
10	1000 seed weight (g)	r_g										1.000	-0.331	-0.652	0.211	0.605
		r_p										1.000	-0.267	-0.616	0.199	0.554
11	Yield/ ha(kg)	r_g											1.000	0.124	-0.527	-0.01
		r_p											1.000	0.117	-0.460**	-0.01
12	Protein Content (%)	r_g												1.000	-0.115	-0.360
		r_p												1.000	-0.102	-0.360
13	Oil content (%)	r_g													1.000	0.096
		r_p													1.000	0.109
14	Seed yield / plant (g)	r_g														1.000

*, ** = Significant at 5 % and 1 % levels, respectively. rg - Genotypic correlation, rp - Phenotypic correlation

Conclusion

Promising donors for various agro-morphological traits

Genotype JLS-67: Flowering initiation, 50% flowering, early maturity, Yield per hectare, Yield per plant, Seeds per capsule, Oil content.

Genotype JLS-79: Capsules per plant, Biological yield per plant. Plant height, Protein content.

Genotype JLS-93: 1000 seed weight, Seeds per capsule, Days to maturity, flowering initiation, 50% flowering, Protein content.

Genotype JLS-9: Days to maturity, Oil content, Biological yield, Seeds per capsule, Primary Branches, Plant height.

Genotype Kartika: Oil content, Protein content, Biological yield, Plant height.

Genotype Kiran: Seeds per capsule, Biological yield, Plant height.

Genotype JLS-27: Biological yield, Plant height, Protein content.

Genotype JLS-66: Yield per hectare, Capsules per plant.

Genotype Sharda: Protein content, Oil content.

Genotype JLS-121: Oil content.

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